THE NOTION OF REASONABLENESS IN THE CONSTRUAL OF RATIONALITY IN SCIENCE

A Thesis Submitted to the University of Hyderabad
For the Award of the Degree of

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by:

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DEDICATION

A thought-provoking Advertisement by the *Child Relief and You* (CRY) Foundation on the Television…

If you are not able to read this because it is written upside down, don't feel bad. You are more fortunate than millions in the world. For, those are the illiterate children and they will not even know that something is written in a language, but it will look like only a pictures of lines and curves!

As I submit the thesis for the award of the Doctoral Degree
My heart goes out to think of such unfortunate children in millions,
Who never get a chance of stepping into
Even a primary school in their lifetime…
They are the beautiful flowers that bloom to be unnoticed,
Great potentialities sadly go unrealized!

I remind myself, and gently invite my Colleagues as well,
To be aware of our great responsibilities towards
The integrated development of the society
From whom we have received in abundance…

DECLARATION

I hereby declare that the thesis entitled, ***THE NOTION OF REASONABLENESS IN THE CONSTRUAL OF RATIONALITY IN SCIENCE***, has been carried out by me for the award of the degree of Doctor of Philosophy in Philosophy, at the Department of Philosophy, School of Humanities, University of Hyderabad, Hyderabad.

This thesis has been written under the supervision of **Prof. Prajit K. Basu,** Department of Philosophy, University of Hyderabad, and has been approved by him for submission. It has not been submitted in part or in full, for any other degree in any university or institute.

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CERTIFICATE

This is to certify that **S. Stephen Jayard** has carried out the research work embodied on the present dissertation entitled, ***THE NOTION OF REASONABLENESS IN THE CONSTRUAL OF RATIONALITY IN SCIENCE***, for the degree of Doctorate of Philosophy in Philosophy under my supervision.

I declare to the best of my knowledge that no part of this dissertation / thesis has been earlier submitted for the award of research degree in part or in full elsewhere.

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CONTENTS

INTRODUCTION

INTRODUCTION

The gap between the popular understanding of science and the actual picture of science seems to be widening in the 21st century. The highly elitist image of science is being constantly and consistently questioned with better awareness of the actual proceedings of science through the history. As one of the consequences of this questioning, the contemporary debates in Philosophy of Science don't fail to focus on the notion of rationality in science[1]. By the turn of the 20th century it was taken for granted that science was the repository of rationality. However, Thomas Kuhn's stunning statement, "History, if viewed as a repository for more than anecdote or chronology, could produce a decisive transformation in the image of science by which we are now possessed"[2], predicted the drubbing of the received image of science and questioned the very rational picture of science. More knowledge in history of science revealed that many non-rational elements too shaped the course of science. That is why Ian Hacking also suggests that there is a crisis of rationality[3]. Soon there emerged two powerful paradigms of science, **rational and non-rational**, underscoring or underestimating the role of rationality respectively. The proponents of both these paradigms stood at the extremes and ***that triggered my interest*** to study this issue a bit closer to find out what the actual status of affair is. Further, rational paradigm overemphasized the role of rationality to the extent of sidelining the social and human elements in science. I want to arrive at a rather *integrated understanding of rationality in science,* which, perhaps, would include the strengths, and avoid the weaknesses of both the models.

The following **objectives** are in my mind as I begin this research. I make an attempt:

a) To show that the highly glorified picture of science given by the ***Logical Positivists*** is in fact an inaccurate view and similarly the opposing view of the ***Historicists*** is equally inadequate. While the former's view of science as ***the*** paradigm of absolute knowledge

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[1] The recent decade seems to see lots of research in two broad areas of ***rationality*** and ***realism*** the former includes the epistemological issues of what reason is, what evidence and method are, what the rationale behind giving special importance (if any!) to observation language over theoretical language, while observation itself theory laden; and the latter involves ontological questions such as what reality is (if ever we will be able to know it!), what is in the world, what is true about the world and so on *I am interested more in the former issues,* which are related to rationality, because what we know about the world largely depends on how we know it.

[2] Kuhn, 1970, p.1

[3] Hacking, 1983, p 1

is a distortion of reality, the latter's predominant emphasis on the subjective and social elements of science leads to the other extreme bias of total relativism and skepticism. In showing how the prejudices and the world-views of the scientists affect the actual process of science, the historicists go to the extreme of seeing no rationality, no stability, no methodology in science, so much so, one of them, Paul Feyerabend, declares 'anything goes' in science.

b) To show that the recent trends, specifically the projects of the ***Historical Realists,*** in the past few decades, give us a very reasonable and more realistic picture of science. They, for instance, Dudley Shapere, whose ideas I elaborate at length in Chapter III, make efforts to show that science is the most rational enterprise; but they hasten to add that there are changes possible, in the aim, procedures and the methods of science, including the criterion of rationality. However, these changes do take place in a very responsible way, as per the demands of the situations at hand

c) To arrive at an integrated picture of rationality in science, this holistic understanding suggests that we speak of '***Reasonableness in Science'*** rather than rationality in science.

d) To investigate into some of the features of this notion of reasonableness and to elaborate on the feature of ***Consensus in the Scientific Community***, because this, in my opinion, assumes a greater importance in the modern scientific researches. (I discuss, for example, the experiments on Gravitational Waves to substantiate the special role of the scientific community in modern science).

I would like, at the outset, to begin with some general clarifications on the basic understanding of science, rationality and rationality as understood in science.

Etymologically, the English word '**science**' comes from the Latin verb *scire*, to know. Knowing is done through senses and the faculty of intellect. Many languages have two different verbs to know through senses and to know through intellect (***Tamil***: *arithal* and *Uithunarthal*; **Greek**: *epitamai* and *gnôskô*, ***Latin*** *scire* and *novisse*; ***French***: *savoir* and *connaître*; ***German***: *wissen* and *kennen*; ***Dutch***: *weten* and *kennen*; ***Italian***. *sapere* and

conoscere; ***Spanish***: *saber* and *conocer*). **Sensitive Knowledge** is obtained through the faculties of five external senses (sight, hearing, taste, smell and touch) and four internal senses (common sense, imagination, memory and the estimative sense) of animals and human beings. It is concerned with things in their individual concreteness, like, this table or that pen. **Intellectual Knowledge** is obtained through the faculty of intellect, which is believed to be unavailable for sub-human beings. Intellect enables humans to rise above the concrete individuality to the level of abstraction or universality and to form an *idea* or *concept*. By manipulating these two concepts, intellect helps humans to arrive at a *judgment* (e.g. Stone is hard). Through the act of *reasoning* intellect derives a new proposition from other sets of propositions. **Scientific Knowledge** involves both and still goes further; it must satisfy *three conditions*: **a)** it must be at the ***intellectual level*** (to ensure universality, not merely individuality of sense-perception); **b)** it must have at least some element of ***certainty*** and **c)** it must provide an ***insight into the causes*** of the object under study So scientific knowledge is not merely stating of facts but also knowing the causes and their working among themselves.

Speaking about the meaning of the term 'science' we see that there are several layers of meaning. ***In a subjective sense***, it implies the *actual operation* of the human intellect, by which one comes to have a scientific insight, for instance, into a mathematical theorem, a physical or historical problem. Also it indicates one's *habitual ability* or *an internal capacity* to tackle scientific problems with confidence. In this sense we may call one 'a person of science', 'a woman with a scientific mind'. ***In an objective sense***, it denotes the object of 'science in the subjective sense'. This is what is grasped by the intellectual operations. Science also means ***the whole of cognitive activities***, both intellectual and sensitive, by which humanity acquires knowledge about itself and the surroundings. In this sense it can be differentiated from other disciplines of human activities; e g. faith and science, science and art, science and politics. Science also denotes ***a particular realm of human knowledge***, with proper characteristics. Finally, 'Science' is used as a collective noun to mean ***the whole body of people devoted to science.*** E.g. Science needs to be responsible in its researches. Of course, all these meanings are closely related to one another. The common element in all these meanings is that 'science' is always somehow related to humans and their specific activities of intellectual cognition. Science has always elements of both subjectivity and

objectivity; it is never purely subjective or objective. For, though it is a result of human thinking, it can be spoken or written down for the others to work on it.

Science is never static but dynamic, having birth, growth, modifications and it changes in its scope and depth. A ***descriptive definition*** of science[4], therefore, can be given as follows: Science is a logically ordered system of true or at least probably true statements They are universal statements concerning the essences, the causes and the nature of objects and processes in a definite field of knowledge. They refer to the investigations, arguments, explanations and demonstrations upon which the conclusions are based.[5]

Rationality[6] in general is understood in many ways. There is no one final understanding or definition of rationality. The three important conditions (logical, epistemological, and practical) that are usually given to determine rationality of a belief or a theory are: **the consistency** (for some it is a necessary and sufficient condition to be rational), **the truth** (therefore a false belief is irrational) and **the ability** to use the most efficient means to arrive at expected ends[7]. Some of the traditional views of rationality include taking rationality to be **the fundamental assumption for human existence** (the basic relationship among humans assumes that they are rational, and their rationality is seen as the 'gift' of the long evolutionary process) or taking **rationality to be equated with justification** (therefore, a justified belief will entail a rational belief; and when a belief is unjustified it is irrational) or

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[4] There are various ways of classifying sciences For instance, a) **Empirical Sciences, which include** Natural Sciences (Physics, Chemistry, Biology) *and* Social Sciences (Psychology, Political Science, Sociology etc) and **Non-empirical Science** (Mathematics, Logic etc) b) **Science of Living beings** (Zoology, Botany, Anthropology, Psychology, Sociology etc) and **Science of non-living beings** (Astronomy, Geology, Physics, Chemistry etc.) Here we are obviously concerned with the Natural sciences in this study

[5] For a discussion on the notion of scientific knowledge here I rely on various sources, like *The New Encyclopaedia of Britannica – Macropedia,* 1997, *Routledge Encyclopaedia of Philosophy*, 1988

[6] In the ancient times reason and rationality have been understood as two different faculties, with a clear-cut hierarchy. Reason, as it provides first principles, is superior to rationality. Greek philosophers made a distinction between reason (*nous*) and rationality (*dianoia* or *logos*), in Latin it is *intellectus* and *ratio* respectively. The core of rationality is in giving argumentation but the argumentation has its limits, that is, the conclusion depends on the certainty of the premises Reason is the faculty providing the first principles, rationality is expected to operate upon those principles In the modern times and more so in the contemporary times, both are not seen as two different faculties, and even they are treated as two layers or functional modes of our reflective activity. In all our rational activity we always use reason, reason is the capacity which allows us to come to grips with the conditions we find ourselves in (For a short exposition on this, see **http://www.uni-jena.de/welsch/reason.htmll).** In my thesis I too don't stress on the difference, if any, between reason and rationality, but use it rather synonymously

[7] For more elaboration on this, see Sayeed, 2007

confining **rationality to goal-orientedness** of an action (therefore an action which undertakes the best means to arrive at the desired goal is rational).[8]

Philosophers nowadays generally make the distinction between *rationality of belief* (which is also referred to as theoretical / evidential / epistemic reasoning) and *rationality of action* (which is known as practical / pragmatic / means-end reasoning). The former deals with how well a person's network of beliefs represents the external world, while the latter gives us the account how well a person's actions maximize the satisfaction of their desires, given their beliefs. More analyses and reflections upon rationality seem to suggest that **not all our activities can be brought under strict scanner of such traditional understanding of rationality**[9]. I take up these and a few more traditional accounts of rationality for a critical evaluation to see how they are inadequate in capturing the notion of rationality, given the multi-dimensional and complex nature of human experiences.

Speaking about **Rationality in Science** it is usual that science is seen as the exemplar of rationality; and because it is a rational enterprise there is always progress within science. **Rationality is even equated with scientificity.** It always accumulates more and more knowledge, moving towards the true picture of the world. Therefore, Karl Popper observes: "But science is one of the very few activities – perhaps the only one – in which errors are systematically criticized and fairly often, in time, corrected... in other fields there is change but rarely progress".[10] Rationality in science consists in the unbiased applications of the scientific method, where each step takes towards the goal Scientificity and rationality are taken to be synonymous, so much so, that what is unscientific is seen as irrational ***All the proponents of rational model of science agree on the following basic tenets:*** **a)** science always strives to attain a particular goal, likes to know more about the facts of the world, or at least nearing the true picture of the world, or to produce theories with more truth content. The theory that comes later, being richer in content, always moves towards truth; **b)** there is

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[8] In Chapter 5, I briefly analyse such traditional views of rationality to show how they are inadequate to capture the holistic notion of rationality (reasonableness) in science

[9] The discussions on rationality become more crucial in the context of universality or relativity of rationality· Are there standards of rationality which are valid at all times, at all places, across all groups of peoples? Or are those standards culturally, as well as temporally, dependent? The traditional notion of universal, *a historical* and *a temporal* notion of rationality is being questioned by different trends in modern times for different reasons. However for our purpose I limit our discussion on rationality in the context of science as such, and don't trespass into the areas of socio-cultural, or religious or ethnic aspects of rationality

[10] Popper, 1963, p. 216.

a specific method to arrive at the goal; and **c)** theory choice is to be explained by *internal* factors, that is, it depends on the relation between the theories and available evidence

The above model of rationality in science has been severely criticized during the second half of the 20th century. Hilary Putnam defends the view that 'scientific' is not co-extensive with rational. He discusses three important areas of human lives, where science has nothing to say, not even it can affirm that those facts exist: **a)** the domain of objective values, **b)** the domain of freedom; and **c)** the domain of rationality itself[11] It is also claimed by the proponents of the non-rational model that the changes in scientific progress and the theory choice in science can't be rationally explained as there are many social, psychological and non-rational elements are at work. **A rationalist model has to tackle the following hurdles**[12]: **a)** the issue of incommensurability, which claims that with major theory changes, the meanings of the terms in those theories radically change; **b)** the goal of science has to be explicated; **c)** they have to show that the principles of comparison between the successive theories are in fact a means to arrive at that goal; **d)** they have to show that adhering to these principles ensures progress in future and also in the past; and **e)** they have to show that the actual history fits with this model and that the social and psychological factors have only a minimal role in the course of science[13]. In this study, as we are going to see, both the rational and non-rational models of rationality in science are assessed and efforts are made to arrive at a holistic understanding of rationality in science

My thesis has five chapters altogether. **The First Chapter** offers a brief presentation of the 20th century theories of scientific rationality. ***Section 1*** deals with the views of two important proponents of rational model of rationality in science, namely, Carl Hempel and Popper. While ***Hempel*** insists upon, among many other things, the goal-means relation to explicate the rationality in science, according to ***Popper***, rationality depends on method; science is rational because it has a unique method and that is the method of Falsificationism. In ***Section 2***, I present the views of two important proponents of non-rational models of rationality in science, namely, Kuhn and Feyerabend. ***Kuhn***, who is the most prominent critiques of rational model of science, agrees that science is a rational enterprise, though for

[11] Putnam, 1979, p 115.
[12] Newton-Smith, 1996, p 267
[13] More discussions on Science, Rationality and Rationality in Science are taken up in Chapter 5

different reasons (i.e. the principle of rationality emerges from the scientific community itself). He is convinced of rationality in science so much that he argues: "if history or any other empirical discipline leads us to believe that the development of science depends essentially on behaviour that we have previously thought to be irrational, then we should conclude not that science is irrational, *but that our notion of rationality needs adjustment here and there*"[14]. ***Feyerabend*** is the most vigorous and influential critique of the received view of science. He vehemently attacks the high pedestal-status given to science in modern times, to show that there is no unique method in science. He even appeals to save the modern society from science, as the society once needed liberation from religions.

In **the Second Chapter** I proceed to evaluate those theories. ***Section 1*** critiques the proponents of rational model, Hempel and Popper. I take up two prominent critiques, Kuhn and Kitcher, to evaluate Hempel and then I try to spell out how rationality in science can't be confined only to goal-means relation. Similarly, while gratefully acknowledging Popper's immense contributions to philosophy of science, I do attempt to show how the theory of falsification has serious lacunae. In ***Section 2***, I evaluate the ideas of Kuhn and Feyerabend. Regarding the views of Kuhn, I try to show how certain precautionary steps need to be taken to help avoid Kuhnian position from slipping into relativism. Then I critically look at Feyerabend claim, 'anything goes'. I argue to show that though there may not be any universal a-historical and a-temporal method in science it is not the case that anything goes, as there are elements in science to prevent extreme relativism and skepticism.

I discuss in **the Third Chapter** the ideas of Dudley Shapere His ideas, in my opinion, deserve a lengthy discussion because I find his analyses of rationality in science and methods of science seem to be very helpful to arrive at a comprehensive account of rationality in science. In ***Section 1***, I present ***Shapere's evaluation*** of the ideas of the proponents of the rational and non-rational models of science, discussed above. Among other things, he sharply criticizes the Logical Positivists' notion of pure observation as the foundation of science. He argues that observations are theory-infected The theory-ladenness affects the relevance of observation, what counts as observation and the very interpretation

[14] Kuhn, 1970c, in R S Cohen and R C Buck, 1971, p 144 Italics mine

and meaning of observation terms.[15] While assessing Popper, among many other things, Shapere focuses on his notion of background knowledge The position of the background knowledge is not as temporal and tentative as Popper thinks, it is more lasting and secure than Popper argues for. ***Section 2*** presents salient features of Shapere's contribution. I look into his idea of background information and the concept schema of observation. He explicates the notion of reason in science in terms of Goal success of the domains in science. He also analyzes both empiricism and rationalism and arrives at a new view of empiricism, which he calls, ***Rational Descendent of Classical Empiricism*** [16]

The Fourth Chapter is set aside for assessing the contributions of Shapere. Four important critiques of Shapere, namely, Leplin, Losee, Doppelt and Linden, are taken up in ***Section 1***. Leplin questions Shapere's notion chain-of-reasoning connections between the usages of scientific terms at various stages. Since Shapere sees no inviolable principles in science, Losee argues to that a normative account of philosophy is not possible without at least one inviolable principle, without which Shapere's non-presuppositionists programme gets very weak. While Doppelt charges, among many other things, Shapere of moderate relativism, Linden finds fault with Shapere's analysis of the notion of observation ***Section 2*** deals with Shapere's specific response to all these critiques Shapere clarifies some of the misconceptions of his critiques, while dismissing some other criticisms as baseless. I come out with my personal evaluation of Shapere's ideas in ***Section 3***. I look into Shapere's notion of observation in detail; his case-study of neutrino experiment has direct relevance to my efforts to understand a similar case-study on gravitational wave experiment. With both these experiments I try to figure out how the scientific community comes to have a consensus to call something as observation or observable. This notion of consensus, I am going to argue, plays a very important role in the research frontiers of modern science.

In the final and **the Fifth Chapter**, I attempt to arrive at a **Holistic Understanding of Rationality** in science, basing on the analyses in the previous Chapters. I now argue that

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[15] Shapere, 1984b, in 1984a, p 106

[16] As the term suggests there are elements of both rationalism and empiricism in his approach. It agrees with the classical empiricism that all our knowledge is based on the *interactions* with the world, but at the same it departs from it, in understanding what that interaction means an interaction is determined by our knowledge, it means differently in different fields and it may exclude or ruthlessly limit the role of sense perception. I focus on a few important concepts of Shapere like the Chain-of-Reasoning and the Rejection of Essentialism, by which he circumvents the issue of the thesis of incommensurability

rationality does play a role in our lives and in science but that is not everything. "Rationality helps", as Henry Harris has it, "but it is not a prescription for making discoveries"[17]. In ***Section 1***, I briefly analyse some of the traditional accounts of rationality to show their limitations. Often rationality is taken to be the fundamental existential experience, which may be treated as the gift of the long evolutionary process. But this, in my opinion, would simplify the concept of rationality and one may not be enthused to explore the great potentialities of humans. Often rationality is identified with truth or very popularly, with scientificity. But a bit deeper analysis will help us to realize that rationality/irrationality cannot be merely identified with true/false beliefs, nor that it can be reduced to scientificity. As Putnam asserts, "'Scientific' is not coextensive with 'rational' There are many perfectly rational beliefs that cannot be tested 'scientifically'"[18]. Popper also shows that "poetic inventiveness" and "the invention of criticisms"[19] are also main components of rationality. Rationality cannot be reduced to logical consistency and justification, or to mere goal-means relationship. I also focus on the notion of equating rationality with deducibility to bring out its limitations. As I criticize the traditional accounts of rationality I am not under the illusion that every aspect of the received view has to be rejected or reformulated. For instance, Inductive Reasoning, a positive legacy of the Received View, is still a very meaningful and essential part of rationality. However the notorious problem of inductive reasoning is quite alarming. Having briefly examined some of the solutions and dissolutions, I offer a short discussion on ***Bayesian theory of reasoning,*** which seems to be rather a convincing solution to the problem of induction. Induction may be seen as a part of our neural wiring. No logical or deductive evidence is needed to support its working. 'Inter-subjective' testing enables us to remove the subjective elements and biases to the extent of making science **(reasonably!) rational**. Basing on such analyses I try to show that science is rational in spite of inductive reasoning.

Section 2 takes up the views of some philosophers, who being convinced of the short comings of the traditional views of rationality, look for an alternative account of rationality. Philosophers like, **Hilary Putnam** ('Integrated View of Rationality'), **Stephen Toulmin** (denial of over-reliance of rationality), **Christopher McMahon** ('Collective Rationality')

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[17] Harris, 1981, p.46.
[18] Putnam, 1979, p 115. For instance he gives the beliefs in the area of human freedom (More on this, in **5.1.4**).
[19] Popper, 1994, p.40.

and **Stephen Nathanson** ('Reasonable form of Rationalism') propose alternatives to the traditional accounts of rationality, which captures the notion of rationality in a much more adequate manner. In ***Section 3***, I present my understanding of rationality in science in terms of ***Reasonableness***. Though it is not easy to define the notion of reasonableness, the features of reasonableness, I am sure, will enable us to understand it better. Reasonableness plays a very important role, as in the common day-to-day life, in the world of science as well. I see its role, in science, at three levels, though they cannot be strictly demarcated, nor that they are exhaustive: **Reasonableness at the Personal Level** of the Scientists – Imagination, the Agent, Judgment and Intuition; **Reasonableness in Scientific Methodology** - Rejection of Zero-tolerance, An Enriched Notion of Objectivity, The Need for Skeptical Attitude, and The Need for Common Sense; and **Reasonableness in Scientific Practice** – Embracing Pragmatism and the Consensus of the Scientific Community. These features, though overlapping sometimes, as I attempt to show, constitute the notion of reasonableness in science. **These features are, I argue, so important and constitutive of science that it is more meaningful to speak of 'Reasonableness in Science' rather than 'Rationality in Science'[20].** I also highlight how reasonableness is important in other domains like, Skepticism and Critical Thinking

Section 4 is entirely devoted to a discussion on the notion of *Consensus in the Scientific Community*. For, of all the features of reasonableness, the consensus, as I am trying to show, plays an important role especially in the context of research frontiers in modern science, where the experiments or empirical observations often don't seem to arrive at unambiguous conclusions. Certain experiments need the consensus of the community to reach some meaningful and useful conclusions, without which those experiments are incomplete and unproductive. With the insights from Shapere's analysis of neutrino experiment and my analysis of gravitational wave experiments, **I try to explicate how the role of scientific community begins to have a very prominent role in deciding upon important concepts in science, for instance, observation.** So we are forced to include the aspect of consensus in the holistic understanding of rationality (reasonableness) in science.

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[20] However, one can still use the term of 'Rationality' in science, provided that account of rationality includes all these features of reasonableness that are explicated here!

When one considers the various features of Reasonableness seriously, science obviously becomes a very reasonable enterprise. Perhaps, more awareness of the social elements and the actual practice of science seem to suggest that **as long as those features of reasonableness** (discussed in Chapter 5), **are part and parcel of science, it seems not to be of much use to speak of Rationality** (in the traditional sense) **in science, but only of Reasonableness in science.** To look for rationality where only reasonableness is possible would be like looking for a right thing at a wrong place, and vice versa! Further, as we realize that for a comprehensive picture of science we need to look at it in sociological terms. Social factors, however, are not all that is there to decide the rationality of science, as there is a 'hidden-hand editor' of reality. **There is reality out there, no matter how limited our understanding of it is, to influence the scientific theories.** For instance, if the whole humanity decides on one fine morning that hereafter the earth will revolve the sun from West to East, will that make the sun rise in the West? Surely not! Can we change the reality just by our social consensus? Not at all! **Thus, the consensus among the scientific community and the social factors make the notion of rationality (reasonableness!) definitely social, but certainly not irrational, nor arational.**

In **Conclusion** I briefly recapitulate of the main line of arguments of the dissertation. I would sound arrogant, or better ignorant, if I claim that my account of rationality in science is final and absolute. As of now I seem to be convinced of the central notion of reasonableness (perhaps, instead of rationality!) in science. I am, however, indeed liberally open with regard to the features of reasonableness. The list of the features I have given here is not exhaustive and their description is not complete either. The notion of reasonableness is very important in many other domains as well Therefore, I do mention some of the possible areas for my further exploration in future. I am interested, for instance, to see the role of reasonableness in the domains of *Feminism, Judicial Systems Scientific Mysteries and Limitations of Science*

CHAPTER 1

THEORIES OF RATIONALITY IN SCIENCE OF THE 20TH CENTURY

1.0 Introduction

In this Chapter, I offer a brief survey of the important theories of Rationality in Science, proposed in the 20th century. The diverse approaches to understand rationality in science may be broadly grouped under two categories: rational and non-rational models. ***Section 1***, *'Proponents of the Rational Model'* focuses on the works of ***Carl Hempel*** and ***Karl Popper***, while ***Section 2***, *'Proponents of the Non-Rational Model'*, is devoted to discuss the ideas of ***Thomas Kuhn*** and ***Paul Feyerabend***. For Hempel rationality in science is guaranteed by the goal orientedness of all its activities, while Popper argues that falsifiability of scientific claims makes science *par excellence*. Kuhn argues that the rationality in science has to take into consideration the historical context also, as theory choice cannot be made purely on logical grounds. It very much depends on the decisions of the scientists in the field. Theory choice in science is like a 'religious conversion' or a 'leap of faith', which is governed by social, emotional and religious considerations and not so much by logic or reason. According to Feyerabend, science does not enjoy any special status as a rational enterprise since it does not have any specific method to be followed. I now proceed to present their ideas here and then in **Chapter 2**, I appraise their views.

1.1 AN OVERVIEW OF RATIONAL MODELS OF RATIONALITY IN SCIENCE

1.1.1 A Hempelian Account of Goal Oriented Rationality

Logical Positivism[21] was a highly influential school of philosophy of science in the beginning of the 20th century. I take Hempel to be the representative of this school. For my purpose here I focus on his ideas having relevance for the rationality in science

[21] With the arrival of relativity and quantum theories the classical scientific theories (and classical philosophies which tend to interpret science, its methods, and its goals) seemed to have been refuted By 1920s, the Vienna Circle (VC), which is said to be the origin of Logical Positivism, and later Logical Empiricism, aimed to come out with new views of the nature of knowledge and the methods of reasoning by which the knowledge-seeking

1.1.1.1 Major Paradigms of Scientific Rationality

According to Hempel, there are two major schools of thought regarding methodology: ***the analytic-empiricist school (Prescriptive)*** and ***the historic-sociological school (Descriptive).*** One of the first models of rationality in science within the first school was developed by the Logical Positivists. For them the methodological principles serve as the criteria for rationality in formulating and in testing scientific claims and for theory choice. "The methodology of science, thus understood, is concerned solely with certain logical and systematic aspects of science which form the basis of its soundness and rationality – in abstraction from, and indeed to the exclusion of, the psychological and historical facets of science as a social enterprise"[22]. One of such methodological criteria is the 'testability in principle' of the claims. Therefore, for instance, they reject neoviatlism (as entelechy is not testable), the doctrines of Marxism and psychoanalysis. On the other hand, according to the ***second school***, methodological principles cannot be formulated merely on *a priori* basis and the actual practice of the scientists is to be considered· "It insists that an adequate theory of scientific method must be based on a close study of the practice of scientific inquiry and should be able to explain at least some aspects of actual scientific theorizing, past as well as present"[23].

These two trends can also be seen as: ***methodological rationalism*** and ***methodological naturalism***. The methodological rationalists demand *a priori* norms to which all scientific claims must conform. For example, Hempel claims that these "norms are established on *a priori* grounds, by logical analysis and reconstruction of the rationale of the scientific search for knowledge"[24]. On the other hand, methodological naturalists, like Kuhn and Feyerabend insist that scientific inquiry has to be understood in terms of actual practice of the scientists. An important focus of both the trends is 'theory choice'. And questions like, 'Are there

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enterprise must proceed It also wanted to clarify the ideas about the goals of such knowledge-seeking enterprise. In short, its major theses were The nature of science, and the 'meaning' of what it means to be scientific can be fixed in advance, and independent of science itself, To understand this nature one must use the tools of the new logic to analyze the limited metascientific terms and that analysis will specify what counts as science; and To use the same tools to determine what counts as a legitimate scientific reasoning Philosophers of science of this school styled themselves along these lines and thought that specific rules of logic (deduction / induction) to be followed in scientific reasoning.

[22] Hempel, 2001a, in Fetzer (ed), 2001, p 357

[23] Hempel, 2001a, in Fetzer (ed), 2001, p 358

[24] Hempel, 2001b, in Fetzer (ed.), 2001, p 375

general principles governing the choice between two competing theories?' and 'If so, can those principles be the criteria for rationality as envisaged by logical empiricism?', preoccupy the debate. Logical empiricism looks for criteria to establish general rules to determine higher probability or rational credibility, while the historicist schools reject such an effort. They argue that there are certain general considerations which do influence scientists in the preferability of theories. But these considerations are the shared preferences or values of the given scientific community and never can act as absolute binding principles to adjudicate upon the theory choice.

1.1.1.2 Hempel's Evaluation of Kuhn's Notion of Rationality

Hempel's evaluation of Kuhn's ideas throws some light on Hempel's own understanding of rationality. Hempel **agrees with Kuhn** on two accounts. **First**, a normative account of science has to be compatible with actual practice of science. The aim and function of a normative account is to improve the particular domain. Therefore a normative account cannot lead to improvement unless it is compatible with practice. **Second**, scientific inquiry is always a social event, taking place in a socio-historical milieu. To comprehend science rather well only logic and other *a priori* considerations are not enough; rather it needs to be understood in terms of what the scientists do in actual practice of science.

Hempel, however, **disagrees with Kuhn** on several grounds. **First**, to understand whether an action is rational or not, we need to have a clear notion of rationality. To analyze the notion of rationality, one needs to know what kinds of considerations support or deny attributions of rationality. Hempel is not able to see any clear notion of rationality in Kuhn's account. **Second**, Hempel sees Kuhn's desiderata to be infested with problems. Take, for instance, the notion of simplicity. All the hitherto attempts by logicians and philosophers, argued Hempel, to arrive at a clear notion of simplicity for theories don't seem to have rendered any satisfactory result so as to use simplicity as a criterion in choosing theories[25]. Further, one cannot arrive at one overall criterion of rational preferability for competing theories. If, as it happens sometimes, each of the two competing theories fulfills various desiderata in different degrees, then it becomes difficult for one to prefer one theory over the

[25] Hempel, 2001a, in Fetzer (ed.), 2001, p 364

other. According to Hempel, "to secure one general standard of comparison, the various desiderata would have to be rank-ordered in point of relative importance: and there is no plausible way in sight to achieve such an ordering"[26]. Moreover, a well-established theory sometimes determines test findings as acceptable data. Significant deviations in experiments are overlooked in order to suit the theoretical predictions and expectations. For example, in the famous Millikan's oil drop experiment[27], often the observed motion of the oil drops did not match the theoretical predictions, but they were overlooked and were not mentioned in the final publication of the results. All these were swept under a big carpet, called 'disturbing factors' of the experimental set up, upholding the intactness of the theoretical predictions. As it is quite natural that individual scientists would differ in their tastes and relative priorities these norms cannot be deciding factors in all the situations. Therefore, Hempel argues that in the case of theory choice "commitment to those norms does not ensure a uniform decision as to which of two theories outranks the other, by way of satisfying the entire set of desiderata"[28] Therefore, according to Hempel, the desiderata are not sufficient conditions to determine the theory choice. When there is a conflict of desiderata, theory choice can however, be decided by larger considerations, which are traceable to goal. But Kuhn does not take into account the goal of the scientific community.

Third, there is no adequate explanation in Kuhn's account to consider current practices as a normative one. Hempel argues that "the assignment of prescriptive reading to a descriptive account of scientific research is not ... straightforward".[29] Purely descriptive account of scientific rationality is impossible. It is impossible for the same reason as pure observation is impossible. Any kind of explanation or understanding of descriptive realm is in some sense a kind of interpretation of it. And an interpretation must have a certain basis other than the descriptive realm. Therefore an account of methodology of science must have both the justificatory (goal-means relations) and descriptive aspects (context-related elements of the action).

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[26] *Ibid*, p. 365
[27] For details: Holton, "Subelectrons, Presuppositions, and the Millikan-Ehrenhaft Dispute", in Holton, *1978a*, 25-83.
[28] Hempel, 1998, p.457
[29] Hempel, 2001b, in Fetzer (ed), 2001, p 383

Fourth, Hempel argues, contra Kuhn, that the behaviour of scientific community can't be the only yardstick for the rationality of science. Kuhn tries to supplement the desiderata with other factors like learning from experience, demanding for consistency, considerations of language in which scientific terms are expressed and so on. In spite of all these Hempel asserts, "there cannot, of course, be a definitive, unconditional justification"[30] ***Kuhn attributes a prescriptive reading to a descriptive account of scientific research***. Hempel charges that Kuhn assumes science to be the best example of rational enterprise and this is a broad epistemological valuation. Kuhn gives much importance to the behaviour of scientists, but unfortunately often we find their behaviours not as contributing to scientific growth, but interfering with it – for instance, out of jealousy they may conceal their methods or results; or just for a short-cut victory they may create or manipulate evidence and experimental evidence or overlook falsifications. How can all these, Hempel argues, be included as prescriptive account of science?

Fifth, Hempel nevertheless does not accuse Kuhn of irrationalism. For, one can be irrational only if one goes against any well-established standards of rationality. Hempel claims that he is "not aware of any rule or standard that could be seriously held to be a binding requirement of scientific rationality that has been neglected or rejected by Kuhn".[31] In the same breath it should also be noted that though Hempel defends Kuhn from the attacks of irrationalism, Hempel does not seem to be at ease to call Kuhn's view of science as rational either. It is because, ***rationality consists in adopting appropriate and well-reasoned out means to obtain desired ends,*** and Kuhn's desiderata include social and psychological elements as noted above. So Hempel prefers to call Kuhn's position "*adaptive*, but surely not *rational*: they are not adopted as a result of goal-directed *reasoning*"[32].

1.1.1.3 Features of Rationality in Science

For Hempel an account of rationality requires a reference to goal-means relationship. He further elaborates the notion of rationality with the notion of context-dependence. He also proposes conditions which make a claim rational.

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[30] Hempel, 1983, p 572
[31] Hempel, 2001a, in Fetzer (ed), 2001, p 366
[32] Hempel, 2001a in Fetzer (ed), 2001, p 369

1.1.1.3.1 Rationality in terms of the goal of an action: An action by itself can't be judged to be rational or irrational. Rationality of an action is decided upon three factors: i) with the reference to the goal the action is supposed to lead to, ii) the relevant information available to the agent prior to performing any action, and iii) the beliefs entertained by the agent regarding the pursuit of his goal. Therefore, for Hempel ***the concept of rationality is decided by the goals and the means (methods) to achieve them***. A rational account of scientific inquiry must stipulate certain goals and some appropriate methodological principles to be pursued. It has also to show how these principles can be used in an effective manner to obtain the intended goals and "only to the extent that this can be done does the conception of science as the exemplar of rationality appears to be viable"[33] In this understanding the methodological principles don't give us the rules in absolute categorical norms to dictate what is to be done, but "rather what way of proceeding is rational in the sense of offering the best chance of attaining a certain scientific objective"[34].

1.1.1.3.2 Context-dependence of Rationality: Rationality of an action does depend on its context; an action which is rational in one context may be irrational in another. However, **in any context the goal of an action renders the action rational.** To quote Hempel, "A given action or a mode of procedure cannot be qualified as rational or as irrational just by itself, but only in considerations of the goal that it is aimed at"... He gives an example· it is obviously rational when one jumps into a river to save a drowning child, though it is a big risk for one's own life. But will we see one's action rational if one jumps into the full flooded river to get to the other side faster, say, instead of using the long-winding bridge?... Thus he makes it clear that "A mode of procedure is rational, relative to a certain goal and a given body of means-end information, if, judged by that information, the procedure offers an optimal chance of attaining the goal".[35] Hempel acknowledges that the methodological principles are necessary but not sufficient to decide upon rationality. This is to an extent compatible with some aspects of the Descriptivists' position. Hempel also points out that the logical positivists, by mistake, thought them to be sufficient. They expected the direct implementation or conformity of these methodological principles in the practice of science. But it is not the case. The adherence of scientists to the methodological rules is quite

[33] Hempel, 1998, p. 463.
[34] Hempel, 2001a, in Fetzer (ed), 2001, p 362.
[35] Hempel, 2001a, Fetzer (ed.), 2001, p 361

embedded in the socio-historical context. To sufficiently explain whether a particular scientific activity as rational or not, one has to analyze how the standards are elaborated or understood or interpreted in that particular context. Thus the analysis of the context as well as the conditions of goal is necessary to determine the rationality of an action.

1.1.1.3.3 Conditions for Rationality: Hempel delineates a few conditions to rationally accept a claim: **a)** if the claim is testable or has actually been tested, **b)** if there is a logical consistency among the claims in a set of which the claim under consideration is a member, and **c)** if there is a deductive closer for every acceptable set (*meaning, if K` is a subset of an acceptable set K and S` is logically deducible from K`, then S` must be included in K The reason is that the deductive consequences of sentences that have been accepted as presumably true must be presumed true as well, and thus included in K*). These conditions are not for theory choice but for the more fundamental issue of ascertaining rationality of science. These, for him, are "some modest necessary conditions of scientific rationality"[36]. These conditions are applicable if the goal of science is to arrive at empirical belief of the world with more accuracy, comprehensiveness, simplicity and so on. In case, if we aim at the knowledge of the world with more emotional security and aesthetic satisfaction then different standards of rationality would have to be brought in. Perhaps, in that case, factual accuracy need not be insisted upon. If the goal of science is to obtain a reliable knowledge about the world, which enables correct predictions, a knowledge which helps us to escape or prevent harm, a knowledge that indicates means for achieving desired ends, then we need to check the hypothesis / theories with the relevant data derived from the world.

1.1.1.4 Relaxed Rational Reconstruction of Rationality

Due to the status of the desiderata, as proposed by Kuhn, there is a danger that the objectivity is lost. But though the desiderata are vague, and though they can't impose an algorithmic procedure in the choice, Hempel argues, they can impose certain considerations as to direct science towards certain goal, thus providing an objective orientation. External factors influence the theory choice but those factors are constrained by desiderata, and methodological principles; they are necessary (though may not be sufficient); the external

[36] Hempel, 2001a, Fetzer (ed.), 2001, p 363

influences need not violate the necessary conditions of rationality. Hempel introduces what he calls ***'relaxed rational reconstruction'***, where some methodological principles are explicit and precise but others are vague, though they may be important ones. In this relaxed but objectivist enterprise, scientific claims are appraised not by mere subjective standards, but also by objective norms, "like the demand for conformity with the standards of deductive logic, and the prohibition of logical inconsistencies"[37]

This notion of 'relaxed rational reconstruction' leaves open the possibility of having methodology of science with more precise standards, it sees the goal of science not as something fixed once and for all but changes as scientific inquiry advances Though there may be some constraints on objectivity and those standards may be partly vague, it is not "a view of science as an enterprise in which 'anything goes'".[38] It is possible to maintain science as an exemplar of rationality, only when scientific inquiry is shown to have specific goal and methodological principles to achieve it; and the means "will have to exhibit the instrumental rationality of the principles in relation to the goals".[39] Finally, for Hempel, ***goal-oriented action decides the rationality of the scientific inquiry***, and if it is not so, "scientific inquiry would have to be viewed neither as rational nor as irrational, but as arational"[40]

1.1.2 Karl Popper - A Falsifying Rationalist

In the 20th century Karl Popper is another important proponent of rational model of science. According to him, Philosophy of science would do well if it confines itself only to the realm of the context of justification. The context of discovery can be relegated to the non-rational domains. The latter is concerned with the process of creation of a theory, which may be explained by sociology, psychology, creative imagination, intuition, inspiration and even dreams. [41] But a scientific theory is justified by falsification and thus falsification becomes the corner-stone of Popper's philosophy of science.

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[37] Hempel, 2001b, Fetzer (ed.), 2001, p 389.
[38] *Ibid*, p 391
[39] Hempel, 1998, p.463.
[40] Hempel, 2001a, in Fetzer (ed), 2001, p 370
[41] Frederick Kekule serves as a striking example, as he stumbles upon the idea of the molecular structure of benzene in a dream – six carbon and six hydrogen atoms are positioned in a ring shape, as though a snake tries to sink its teeth into its own tail.

I discuss below some important features of the theory of falsification. The problem of demarcation between science and non-science and the problem of induction are, according to Popper, inter-related. When the former is solved the latter gets dissolved. [42] First I discuss how he dissolves the problem of induction and then proceed to see how he vouchsafes for scientificity based on falsification.

1.1.2.1 Falsification – The Solution to the Problem of Induction

The most severe attack on induction, as we know, came from Hume. He put forth the problem of induction first in his *Treatise of Human Nature* (1739)[43]:

> Let men be once fully persuaded of these two principles, that there is nothing in any object, considered in itself, which can afford us a reason for drawing a conclusion beyond it; and, that even after the observation of the frequent or constant conjunction of objects, we have no reason to draw any inference concerning any object beyond those of which we have had experience.

Further, Hume shows, in his *Enquiry concerning Human Understanding*, that nature consists of innumerable regularities. But from the observed regularities one cannot logically infer a conclusion about future. Thus he shook the very foundation of all cognitive exercises as he showed that inductive inference was not rational

Popper, along with Hume, agrees that that the experiences with the known instances cannot justify a conclusion about the unknown ones. He acclaims Hume for the same: "I found Hume's refutation of inductive inference clear and conclusive"[44]. But Popper, though he acknowledges the clash between the probable nature of inductive reasoning and the empirical demand for certainty in science, does not end up with anti-rationalism, as the scientific theories depend on *critical reasoning*. That is why, even scientific revolutions are rational, because "it is rationally decidable whether or not a new theory is better than its

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[42] Popper brings out this idea in many of his writings For instance, Popper, 1959, p 54
[43] As quoted by Indurkhya, 1990, pp 95-114.
[44] Popper, 1963, p. 42.

predecessor"[45]. However, unlike Hume, he does not think that induction is essential and necessary in our reasoning process.

For a critical rationalist, like Popper, the inability to justify a theory is not at all the main concern. Therefore he says, "(the inability to justify) never worries the critical rationalist"[46]. Since all our human knowledge, including scientific knowledge, is only conjectural and hypothetical, we don't need any validity for that knowledge. Only deductive arguments are legitimate in guaranteeing certainty, and therefore for Popper, the method of science is basically 'proposing conjectures and refuting them'. Though scientific theories are always beyond conclusive verification yet he is sure of providing a rational footing to science, for, "while theories cannot be logically proved by empirical observations, they can sometimes be refuted by them".[47] Though the universal theories are perpetually conjectures and hypotheses, ***we have a right for preference based on falsification***. The testability of theories differentiates a scientist from a lunatic. It is not that the scientists always propose their theories on firm observational basis and the lunatics lack that; rather the only difference between them is that the scientists' theories are able to pass the tests (based on observation), whereas those of the lunatics easily fail the tests[48]. **This leads to the next aspect of falsification as the foundation for Scientificity and Scientific Rationality.**

1.1.2.2 Falsification – The Foundation of Scientificity and Scientific Rationality

Though falsificationism can be contrasted against Positivists' *Verificationism*, Popper proposes the former also as the criterion of demarcation between science and non-science. For instance, Einstein's theory of relativity is falsifiable, and therefore it is scientific, whereas Marx's theory of history, Freud's psycho-analysis and Alfred Adler's so-called 'individual psychology' "...though posing as sciences, had in fact more in common with primitive myths than with science; ... they resembled astrology rather than astronomy"[49]. The proponents of these three theories would turn any relevant phenomenon as verifying their claims and practically no instance is given which can falsify those theories. This

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[45] Popper, 1994, p. 12
[46] Popper, 1992, p. 28.
[47] Howson and Peter Urbach (ed), 1993, p 5
[48] Schilpp, 1974, p. 1021.
[49] Popper, 1999a, p.66.

constant verification was taken to be the source of their being scientific but, Popper argues that "this apparent strength was in fact their weakness"[50].

Falsification is, therefore, a criterion for *scientificity*. It is not a criterion for *meaningfulness* as the Positivists would hold. For, "...if a theory is found to be non-scientific, or 'meta-physical' (as we might say), it is not thereby found to be unimportant, or insignificant, or 'meaningless', or 'nonsensical'"[51], though they cannot be given the status of science as it is not backed by empirical or observational evidence in the normal sense of scientific evidence. So the criterion to find out whether a statement is scientific or not depends on whether the statement is falsifiable or not. His criterion does not demand actual refutation of a statement, but it is enough that that statement be *refutable in principle*. Though Popper denies any epistemologically special set of statements he leaves a margin for a set of 'basic statements'. They are basic not in the sense of assuring us of epistemological certainty but they belong to the set which act as 'potential falsifiers', i.e. a single or a set of basic statements. These basic statements are necessary to make a theory truly scientific. For example, the theory 'all Indians are rich' is incompatible with the basic statement 'here is a poor Indian'. The latter serves as a potential falsifier. Therefore he clearly states: "A statement or theory is, according to my criterion, falsifiable if and only if there exists at least one potential falisifier..."[52].

Scientificity consists in testability. This testability is rationality of science, which is identified with falsifiability. Testability cannot be identified with verifiability or probability[53]. Falsifiability has nothing to do with the content of the statement, rather it is an entirely logico-empirical characteristic of any statement to be scientific. Popper gives many examples[54] – from ancient times of Parmenides, through the modern times of Galileo, Newton, and as late as 20th century's Quantum Physics – to show that science advances by falsifications, which lead to problem-situations. These, in turn, compel the scientists to come out with new innovative and ingenious hypotheses. Therefore, problems, not observations, are the starting point for science. When the scientific community encounters a problem, it

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[50] *Ibid.*, p. 67.
[51] *Ibid.*, p. 70.
[52] Popper, 1992, p. xx.
[53] Popper elaborates on this idea in Sections 4 & 6 of Chapter I of 1959
[54] Popper, 1992, pp. xxvi-xxx.

proposes a solution, which may be out of an intense intuition or a creative imagination. Then tests are carried on to falsify it. If it passes the test it is tentatively accepted (Corroborated) or else it is discarded. Therefore falsifiability plays a crucial role and progress of science depends on highly falsifiable hypotheses

Thus the corner-stone of Scientificity and rationality in science is falsification. For only falsity of universal laws or theories can be logically, conclusively deduced, but not their truth. *A sophisticated version of falsificationism* demands not just a falsifiability of a hypothesis but demands that "A hypothesis should be more falsifiable than the one for which it is offered as a replacement"[55]. More falsifiability is always better for a theory. For instance, 'Students of the Hyderabad Central University are hard-working' is more falsifiable than 'Students of Philosophy of the Hyderabad Central University are hard-working'. For, any instance that refutes the latter refutes the former too and the former gives us more information than the latter. Therefore, once a refuting instance occurs one must mercilessly dethrone that theory, however successful and attractive in the past the theory might have been. Fro Popper, "Once a mistake, or a contradiction, is pin-pointed, there can be no verbal evasion: it can be proved, and that is that".[56] Sometimes modifications are made in a theory to improve upon the problematic theory. These modifications are not *ad hoc*, as they are independently testable. For the growth of science *falsifying* a cautious conjecture is more important than *confirming* a cautious hypothesis. For "If a *bold* conjecture is falsified, then all that is learnt is that yet another crazy idea has been proved wrong.... Similarly, the confirmation of cautious hypotheses is uninformative. Such confirmations merely indicate that some theory that was well established and regarded as unproblematic has been successfully applied once again"[57].

Popper's contribution in the area of rationality in science is very interesting and crucial. I'll come back to Popper's ideas in the next chapter for evaluating them. Now I proceed to the next section to discuss the views of the proponents of non-rational model of rationality in science.

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[55] Chalmers, 1992, p 50
[56] Schilpp (ed), 1974, p 248
[57] Chalmers, *1992*, p 55

1.2 AN OVERVIEW OF PROPONENTS OF NON-RATIONAL MODELS OF RATIONALITY IN SCIENCE

Historicist theories of rationality are proposed as an alternative to the traditional theories of rationality. The historicist theories of rationality demand that an adequate theory of rationality must in some way fit the history of science and show that most of the episodes in the history of science are rational. In this Section, I take up the views of two important proponents of non-rational model of rationality in science, namely Thomas Kuhn and Paul Feyerabend.

1.2.1 Thomas Kuhn - A 'Paradigm' for Paradigms

Here I discuss Thomas Kuhn's ideas in two broad categories – *Early Kuhn* and *Later Kuhn*, focusing on the important Kuhnian concepts like **Paradigm, Incommensurability and Theory Choice.**

1.2.1.1 Early Kuhn (Till late 1970s)

1.2.1.1.1 Science as a Cycle

The notion of scientific rationality saw a radical change with Kuhn's *The Structure of Scientific Revolutions,* (hereafter *SSR)* (1962). Science, for Kuhn, is basically a long period of normal science, occasionally interrupted by crises which lead to short periods of revolutions: Normal science – anomalies get intensified - crisis – revolution – emergence of a new paradigm – normal science – anomalies get intensified - ... The main preoccupation of normal science is the puzzle-solving activity. A scientist is primarily a puzzle-solver, who is always busy trying to apply the known solutions to the problems at hand, and not so much of an innovator. "Under normal conditions", opines Kuhn, "the research scientist is not an innovator but a solver of puzzles, and the puzzles upon which he concentrates are just those which he believes can be both stated and solved within the existing scientific traditions"[58]. When the existing theories get into conflict with the fresh observational data, anomalies

[58] Kuhn, 1977d, in Kuhn 1977b, p 234

arise and mostly anomalies are overlooked. Not that every anomaly is expected to lead to a crisis. A normal scientist must learn to ignore them, or else she can't carry on with her research. So Kuhn says, "... if an anomaly is to evoke a crisis, it must usually be more than just an anomaly.... The scientist who pauses to examine every anomaly he notes will seldom get significant work done"[59]. She needs to have a basic faith in the puzzle solving ability of the present theory; for "without that faith their work would be wasteful of time and talent"[60] Kuhn, therefore, looks at an anomaly, not necessarily as an obstacle in the research, but a source of growth. Therefore as Rouse puts is, "They (anomalies) need to be resolved to the extent necessary to get on with research. If an anomaly is sufficiently obstructive, or interesting in its own right, it can replace the original research topic"[61]. But when anomalies grow too many in number and too strong in their intensity to tolerate, a crisis sets in leading to a revolution. After this short period of revolution, once again a long period of normal science ensues.

With the emergence of a new paradigm a lot of changes in the belief system takes place. For instance, when the phlogiston theory of combustion was replaced by the oxidation theory of combustion, a great change in the world of chemistry took place As James Ladyman points out, "Up until this time (of oxidation theory) it had been thought almost universally that there was really only one kind of 'air', although it could be of different degrees of purity; after this revolution it was accepted that oxygen is but one among the constituents of ordinary air"[62]. It is not, therefore, a piecemeal or a gradual change. Change is always a whole-sale change, not just bits and pieces.

1.2.1.1.2 Paradigm - A Primary Concept

Paradigm is almost synonymous with a scientific community, in the sense of both the logical and physical closeness. Here are a few examples of a paradigm Aristotelian physics, Copernican astronomy, Newtonian physics, Ptolemaic astronomy, the phlogiston and the

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[59] Kuhn, 1962, p. 82
[60] Kuhn, 1977d, in Kuhn 1977b, p 236.
[61] Rouse, 1987, p. 33.
[62] Ladyman, 2002, p.103

Oxygen theories of combustion, (Daltonian Chemistry)[63], the fluid theory of electricity, the caloric theory of heat, particle physics, wave optics, relativistic physics, quantum physics. In a narrower sense the communities of physicists, chemists, botanists can be said to belong to different paradigms. Within the paradigm of chemistry, major sub-groups, like organic chemists, protein chemists or physical chemists are possible.

Each paradigm imposes its own ontology on scientific thinking and has its own empirical data, so much so that one scientist working in a paradigm cannot understand the data of another paradigm. Each paradigm has its own facts: [64]

> Led by a new paradigm, scientists adopt new instruments and look in new places. Even more important, during revolutions scientists see new and different things when looking with familiar instruments in places they have looked before. It is rather as if the professional community had been suddenly transported to another planet where familiar objects are seen in a different light and are joined by unfamiliar ones as well.

Paradigms are constitutive of science. Each paradigm has its own problems, its solutions and methodology. It binds the scientists so deeply that the scientists belonging to different paradigms "disagree about what is a problem and what is a solution; they will inevitably talk through each other when debating the relative merits of their respective paradigms".[65] **Paradigms are constitutive of meaning**. Paradigms determine the meanings of the terms used in scientific theories. And finally, **paradigms are constitutive of subject matter of discourse**. Within a paradigm there is a strong consensus-thinking. It is present in mathematics and astronomy from the very beginning. But in modern science such consensus is only a recent phenomenon[66].

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[63] *The phlogiston theory* was first proposed by Becher (1635-1682), and developed by Stahl (1660-1734), according to the theory phlogiston is the 'combustible principle', which is present in all flammable objects, it is emitted out while burning. By itself it is unobservable, colourless, tasteless and with no smell But when it is found in a material object it may give that object observable properties. *The Oxygen theory* of Lavoisier was the first step towards the chemical atomic theory of John Dalton (1766-1844), according to which matter consists of indivisible atoms; though there are different kinds of atoms, atoms of the same kind are identical in every respect, like shape, size, weight etc Most of the things in the world are compounds rather than basic elements.

[64] Kuhn, 1970a, p.111

[65] *Ibid.*, p.109

[66] Kuhn explains this with the example of *Optics* from antiquity till the end of the 17th century one cannot trace out any single or a set of paradigms for optics, Newton's particle theory of optics ruled the world of optics throughout the 18th century till the beginning of the 19th century, wave theory was accepted during the second half of that century; now in the 20th century there is a consensus in optics, where light is seen both as

Paradigms, thus, play an essential role in the process of scientific inquiry Kuhn demands a very strict adherence to the paradigm on the part of the scientists. They would do anything to be faithful to it. They seem even to be 'immoral' in maintaining the value of a paradigm. As James Ladyman puts it, "According to Kuhn, scientists are often very much attached to a paradigm, and sometimes particular individuals will do almost anything to retain it in the face of contradictory evidence, including perhaps, distorting experimental data, using institutional power to stifle dissent, using poor reasoning and bad arguments to defend the status quo, and so on."[67]

1.2.1.1.3 *The Essential Tension*

Kuhn agrees with the normal expectation that a scientist essentially needs flexibility and open-mindedness. But he points out another need, which is equally important, if not more, which he terms as 'convergent thinking'. He observes, "'Convergent thinking' is just as essential to scientific advance as is divergent"[68] He elaborates further that only the traditional concepts of flexibility and open-mindedness are not enough for the revolutionary growth of science. It badly needs a firm rootedness in the present tradition: "Only investigations firmly rooted in the contemporary scientific tradition are likely to break that tradition and give rise to a new one"[69]. From the very beginning a sort of training in convergent thinking has been taking place in the world of science and without that the present developments of science are well nigh impossible. The convergent thinking is instilled in the fresh minds through the students' text books, which contain the accepted problem solutions. It is ensured by paradigms The student is then made to solve the new problems that resemble the ones taught in the textbooks and lectures, with the same methods. Therefore a paradigm can be said to be a blessing in disguise, in the sense, for though it does not easily allow new creative ideas, it certainly ensures the steady movement of science. Edwin Hung gives an analogy: "Perhaps taking paradigms as railway tracks

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wave and particles. In these three phases all the problems and solutions in optics were framed only in accordance with the then prevalent theories in mind [Kuhn, 1977d, pp 231-2]

[67] Ladyman, 2002, p 119.

[68] Kuhn, 1977d, in Kuhn 1977b, p 226

[69] *Ibid.*, p 227

would be a better analogy. The rails in one sense constrain the movements of the train, but in doing so guide it smoothly in a definite direction"[70]

Having said all these, therefore, one realizes that a scientist, worthy of her name, must be an enthusiastic innovator and a faithful traditionalist at the same time! She needs to possess the qualities of openness and conservatism at the same time. So Kuhn observes very clearly, "the productive scientist must be a traditionalist who enjoys playing intricate games by pre-established rules in order to be a successful innovator who discovers new rules and new pieces with which to play them"[71]. And precisely this is the *essential tension* Kuhn speaks of.

1.2.1.1.4 Paradigm – Re-visited!

Kuhn received varied criticisms against his notion of paradigm. He himself points out that Shapere's criticism[72] on the concept of paradigm is the most thought provoking and thoroughly negative account[73]. Masterman[74] finds about 22 ways of using the concept of paradigm in Kuhn's *The Structure of Scientific Revolutions*, ranging from "a concrete scientific achievement" to "a characteristic set of beliefs and achievements including instrumental, theoretical and metaphysical commitments together"[75]. With his 2nd edition of *SSR* (1970) he preferred a ***'disciplinary matrix'*** to 'paradigm', in which, "All or most of the objects of group commitment that my original text make paradigms, parts of paradigms, or paradigmatic are constituents of the disciplinary matrix, and as such they form a whole and function together".[76] In his "Second Thoughts on Paradigm" also he tries to clarify the doubts and answer the queries raised by the critics.[77]

With the notion of 'disciplinary matrix' Kuhn attempts to solve many confusions concerning the notion of Paradigm. He explains: "(Disciplinary matrix is) 'Disciplinary' because it is

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[70] Hung, 1997, p.358.
[71] Kuhn, 1977d, in Kuhn 1977b, p.237
[72] Shapere, 1964b, pp. 383-394
[73] Kuhn, 1977a, Suppe (ed.), 1977, pp 459-482
[74] Masterman, 1970, in Lakatos and Alan Musgrave, 1970a, 59-90
[75] Kuhn, 1977a, in Suppe, 1977, p 460
[76] Kuhn, 1970a, p. 182.
[77] Kuhn, 1977a, in Suppe (ed), 1977

the common possession of the practitioners of a professional discipline; 'matrix' because it is composed of ordered elements of various sorts, each requiring further specification"[78]. The disciplinary matrix includes these important elements: a) symbolic generalizations, b) models, both ontological and heuristic, c) values, and d) exemplars – which are essential for the scientific community to obtain or validate genuine knowledge. All sciences have their own set of symbolic generalizations, which are used without any qualms for justification. He gives an example from physics: f = ma. A student of physics uses this formula without any question about its validity or so, because everyone in the community at a given time accepts it without any difficulty. When a new problem is shown to be analogous to a problem that has been already solved, the members try to apply the same solution to the present problem. These exemplars make the newcomers learn about the fundamental and already accepted concepts, like force, field, element, compound etc., and these will not clear without the exemplars of the given community[79].

The scientific community agrees upon certain assumptions which can't be tested (like giving preference to field theory over particle theory). These assumptions show the direction of further research. They all agree with the characteristics of a good scientific theory[80]: **a) Accuracy** – that is, a theory's consequences should be in demonstrated agreement with the results of existing experiments and observations; **b) Consistency** – a theory must be consistent, not only internally with other theories of the paradigm, but also with other currently accepted theories applicable to related aspects of nature; **c) Broad Scope** – a theory's consequences should extend far beyond the particular observations, laws, or sub-theories it was initially designed to explain; **d) Simplicity** – the theory must be able to bring order to phenomena that in its absence would be individually isolated and, as a set, confused; and **e) Fruitfulness** – it should disclose new phenomena or previously unnoticed relationships among those already known[81].

I now discuss the view held by Kuhn during the second phase (early 1980 onwards), where several of the above discussed notions seem to undergo some important changes.

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[78] Kuhn, 1977a, in Suppe, 1977, p 463
[79] *Ibid*, p. 471
[80] Kuhn, 1977e, in Kuhn 1977b, pp 321-22
[81] Kuhn even in his earlier phase, thought of these five elements as possible grounds for comparison, despite incommensurability. See. Kuhn, 1970b, in Lakatos and A Musgrave (ed), 1970a, p 261

1.2.1.2 Later Kuhn (Early 1980s Onwards)

Most of the criticisms against Kuhn, brought out till 1977, may now be softened, in my opinion, as Kuhn published *The Road since Structure*, in 1990. The same phrase is the title of a well-thought out collection of Kuhn's essays produced between 1970 and 1993, published posthumously in 2000. Most of the essays here portray Kuhn in a new outfit, which we call 'Later Kuhn'. The collection also includes an interview with him (in 1995). Further, as Rupert Read points out in his review of *The Road since Structure*, "It (the book) also evidences a wish to be comprehensible (on their own terms) to the 'Analytic' philosophers by whom Kuhn was most harshly criticized (e.g. Davidson)".[82] Thus the Later Kuhn seems to have modified his position. For instance, he suggests that he will omit the issue of incommensurability from any more consideration: "(for) a larger project, the book on which I'm currently at work. ... [A] theory of what I once called incommensurability – will have to be omitted entirely"[83]. Further, "If I were now rewriting", he admits, "*The Structure of Scientific Revolutions*, I would emphasize language change more and the normal/revolutionary [science] distinction less"[84].

From the essays in *The Road since Structure* we learn the four fundamental themes[85] emerging out: **a)** Science is undoubtedly a cognitive empirical investigation of nature, endowed with a special sort of '**progress**'. But this progress is not to be understood as though science moves towards the fullness of truth, but progress in ever-improving technical puzzle-solving ability, functioning under the strict criteria of success and failure; **b)** Science is to be understood as basically **a social enterprise**, where the scientists work within the community and only occasionally they move out of it to find solutions for certain anomalies; **c)** Modifying the earlier notion of scientific development as a series of long period of normal science, occasionally punctuated by short periods of revolution, now Kuhn maintains that **science is period of development within a coherent tradition divided occasionally by periods of 'speciation'** (like the biological evolution of species of Darwin's theory), into two distinct traditions with somewhat different areas of research; and finally, **d)**

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[82] Rupert Read, in his book review of *The Road Since Structure*, in http //www uea ac uk/~j339/ kuhnreviewbjps.htm)
[83] Kuhn, 2000f, in Kuhn 2000a, p 106.
[84] Kuhn, 2000c, in Kuhn 2000a, p 57
[85] The editors have done a good job in identifying the themes in the Introduction of *The Road Since Structure* See: Kuhn, 2000a, pp. 1-9.

distinguishing between commensurable languages (where translation is possible, between two languages, and therefore, what is said in one language can be said in another) and incommensurable languages (where only paraphrasing is possible between the languages!) he gives **a linguistic twist to the understanding of incommensurability.**[86]

1.2.1.2.1 Theory Choice – Without any Actual *Choice*

Kuhn attempts to develop a descriptive (explanatory) account of science, which, at the same time has certain normative or prescriptive characteristics. This renders the account rational. In choosing a theory, scientists do have different levels of liking for various desiderata. Therefore, Kuhn claims that theory choice cannot be settled on the basis of "logic and experiment alone"[87] and he insists that the final outcome of the theory choice is not bound uniquely by rational procedure but by many other factors. The scientific community is vested with the power to decide in the case of conflicting interests. The community shares the same standards and values which are acquired in the process of specialized professional training. He lists a few preferred features of scientific theories. These include *precision, wider scope, better formulation, accuracy, close agreement between theory and empirical data, simplicity, and novel predictions.*

But Kuhn himself is aware that they are vague if considered in isolation and they might contradict one another, if taken together. For instance, the existing theory may have highly

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[86] Kuhn at the second phase prefers to look at incommensurability **metaphorically** With the change of theories not all the terms change in their meaning While most of the meanings remain the same only some of the terms change in their meaning "The terms that preserve their meanings across a theory change", says Kuhn, "provide a sufficient basis for the discussion of differences and for comparisons relevant to theory choice". [Kuhn 2000a, p 36]. Now incommensurability is confined only to the linguistic domain He now distances himself from the non-linguistic aspects of incommensurability Therefore, "Incommensurability thus equals untranslatability" [Kuhn, 1990, p 299] Kuhn highlights two major difficulties in translation and interpretation **Translating interdefined terms** – for example, phlogiston – its full meaning is embedded with other terms used in the theory; therefore not possible to translate into terms of later chemical theory, and the notion of **Conceptual disparity among terms,** (i e terms are conceptually so pertinent and relevant to one particular linguistic system, culture etc), while translating a term into another language one may not find the exact equivalent for a given term For example, the French word, *esprit*, can be replaced by 'spirit', 'aptitude', 'mind', 'intelligence', 'wit', 'attitude', 'judgment' etc according to the context Kuhn clarifies that "these are not cases of ambiguity, but of conceptual disparity between French and English" [Kuhn, 2000c, in Kuhn 2000a, p.48] and therefore every translation has to involve an element of author's intention and that in turn proves that "there can be no perfect translation" [86] [Kuhn 2000c, in Kuhn 2000a, p 49]. Therefore among scientists there is no side-by-side or point-to-point comparison, a scientist has to learn from scratch as a learner of a new language does

[87] Kuhn, 1970c, in Cohen, and R C Buck (eds) 1971, p 144

positive value in any one of the criteria, while the new competitor may have a high score in another criterion. Now the dilemma arises as to which of the criteria to choose. Sometimes the community seems to accept a new theory even without considering any criterion. Kuhn gives the example of the theory of Copernicus. When it was proposed it was not more accurate than Ptolemy's. It gained more accuracy only with Kepler's sixty years' of slogging in radically modifying it. If, for the lack of accuracy, Copernicus' theory had been completely ignored, we would not have remembered him today. Each of the five criteria mentioned above can be understood or interpreted differently by different scientists. Therefore, though two scientists may use the same criteria and yet can reach different conclusions.

Kuhn prefers to call the shared criteria **as values, rather than rules**. Each creative discipline is characterized, among other things, by different sets of shared values. At times two men committed to the same values may choose different theories. Unfortunately these values may prove to be confusing in actual applications. He explains with an example from the traditional proverbs that are contradicting each other. "He who hesitates is lost" and "Look before you leap" or "Many hands make light work" and "Too many cooks spoil the broth". Though contradictory yet these are taught to the children in the school. Treating the shared criteria as values, not as norms, has some advantages. It explains rationally even those aspects of scientific enterprise, which the tradition normally labels as irrational or non-scientific.

As these desiderata assure rationality of science, Kuhn sees the descriptive account of science as normative also. Therefore, in spite of the ambiguity and vagueness in the desiderata Kuhn affirms that science is very rational. He is convinced of rationality in science and argues: "if history or any other empirical discipline leads us to believe that the development of science depends essentially on behaviour that we have previously thought to be irrational, then we should conclude not that science is irrational, but that our notion of rationality needs adjustment here and there'[88]. He emphasizes the same when he comments

[88] Kuhn, 1970c, in Cohen, and R. C Buck (eds.) 1971, p 144.

on the ideas of Lakatos: "Scientific behaviour, taken as a whole, is the best example we have of rationality"[89].

Along with these values there are many personal or subjective criteria shaping theory choice: one's previous experience as a scientist, the duration of his research, extra-scientific persuasions (like philosophical or religious convictions), one's personal preferences. for instance, one may prefer originality to coherence (and therefore ready for risks!), while another may prefer vice versa and end up not taking risks. So Kuhn concludes that the theory choice is a complex procedure, because "every individual choice between competing theories depends on a mixture of objective and subjective factors, or of shared and individual criteria"[90]. Yet he chooses these desiderata "because they are individually important and collectively sufficiently varied to indicate what is at stake"[91].

However, since theory choice is a collective decision of the community and all our observations are theory-dependent, no hypothesis can be purely objective. So there is no objective way of theory-evaluation. Given this view he faces a lot of criticism from different quarters. Lakatos is so strong in his criticism that he labels Kuhn's science as "a matter of mob psychology"[92]. Kuhn declares once again that all these are due to a total wrong reading of his ideas: "Reports of this sort manifest total misunderstanding, and I have occasionally said as much in papers directed primarily to other ends"[93].

A scientist cannot just base her theory choice on a matter of her personal taste. She needs to intelligibly explain her choice to the peers. Even with Einstein it so happened that towards the end of his life he had to remain isolated due to his view towards quantum physics, which he based only on his taste, whereas Bohr was ready to discuss the bases of his claims. The critics accuse Kuhn of subjectivism on the ground that he bases the theory choice on personal likes and dislikes. But Kuhn denies the charge as a misunderstanding. He claims that the theory choice is still objective (though with some limitations!), as it can be analyzed in terms of criteria like accuracy and consistency. Though theory choice is affected by

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[89] Ibid , p. 144.
[90] Kuhn, 2002, p 425.
[91] *Ibid*, p. 422
[92] Lakatos, 1970b, in Lakatos and A Musgrave (eds), 1970a, pp 91-195-
[93] Kuhn, 2002, p. 422.

"idiosyncratic factors dependent on individual biography and personality"[94], there are also shared (or objective) criteria. Thus for Kuhn, "Analysis of theory choice of an individual scientist thus results in two kinds of active values; cognitive values to which the whole community is committed, and individual values varying within the community".[95] The communal cognitive values may grant rational basis; but individually differing values may not give rational base. But not all of the individual values are irrational; professional experience will surely add to better functioning; this consideration may lead to different choice by different scientists; it does not indicate irrationality, "rather, it may be a sign of different information bases used in the decision".[96] Thus an adoption of the new theory cannot be regarded as conscious choice on the part of that person. So declares Kuhn, "*No process quite like choice has occurred,* but they are practicing the new theory nonetheless"[97] (emphasis mine).

1.2.1.2.2 Popper vs. Kuhn

Kuhn, in his paper, "Logic of Discovery or Psychology of Research", compares and contrasts his views with those of Popper. Kuhn enlists a number of claims or attitudes that are common to both of them, like the importance given to the dynamic nature of science, the rejection of cumulative growth of science and so on[98]. Nevertheless there are indeed **many areas where Kuhn and Popper differ**[99] Kuhn argues that a Popperian scientist seems to be

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[94] Kuhn, 2002, p 429
[95] Hoyningen-Huene, 1992, p. 493.
[96] *Ibid.*, 495
[97] Kuhn, 2002, p 436.
[98] It seems that both of them have developed similar ideas about scientific enterprise almost simultaneously. For as Kuhn himself claims he has not read Popper's work until the publication of *The Logic of Discovery* (1959), though he has heard that Popper's ideas are widely discussed For instance **a)** both focus on the dynamic nature of science, rather than the strict logical structure of science, **b)** both give equal importance to facts and the spirit of actual scientific life, for which both turn to the actual history of science and result in similar conclusions; **c)** both emphasize upon the revolutionary process of scientific growth, where the new theory replaces the old one and they focus on the failure of previous theory in facing challenges posed by logic, experiment and observation; **d)** both reject the cumulative growth of science, **e)** both are found in one company in rejecting most of the tenets of logical positivism, and insisting upon an intimate relation between scientific observation and theory; **f)** both of them seriously doubt the possibility of any neutral observation language, **g)** that the aim of scientists is to arrive at explanatory theories is agreed upon by both of them, and finally another significant similarity between Kuhn and Popper is that **h)** both of them give due importance to the concept of tradition in the enterprise of scientific knowledge [See Kuhn, 1977c, in Kuhn 1977b, pp 267-8] As early as 1948 Popper boldly declared, "I do not think that we could ever free ourselves entirely from the bonds of tradition. The so-called freeing is really only a change from one tradition to another" [Popper, 1963, p 122]
[99] Some more areas where **Popper and Kuhn disagree** Kuhn demands a deeper commitment to tradition on the part of a scientist, while Popper would appreciate if the scientist is always geared to refute the tradition'

always anxious to disprove his own theory, as if a dagger dangerously dangles upon his head. A significant disagreement between them is with regard to the idea of demarcation of science and non-science. The notion of 'normal science', which is central to Kuhn, seems to be missing in Popper's framework In the words of Kuhn, "it is normal science, in which Sir. Karl's sort of testing does not occur, rather than extraordinary science which most nearly distinguishes sciences from other enterprises. If a demarcation criterion exists it may lie just in that part of science which Sir Karl ignores"[100]. When one focuses too much on testing of theories one is sure to lose the major part of science, for most part of the actual science lies in the period of normal science. Kuhn laments, therefore, "To rely on testing as the mark of a science is to miss what scientists mostly do and, with it, the most characteristic feature of their enterprise".[101] Popper, therefore, seems to make the exception a rule! Kuhn suggests that "Sir Karl has characterized the entire scientific enterprise in terms that apply only to its occasional revolutionary parts"[102]. A beginner in science is primarily trained to work in normal science not to throw away the existing theories outright! Kuhn has problem with Carnap also, as Carnap and Popper agree on many important aspects of science. [103] Kuhn claims that scientific growth is not cumulative, with no sharp distinction between observation and theory, nor between context of discovery and context of justification There is no particular method used in science and there is not a strict deductive structure in science. Science is very much social and context-bound and therefore essentially historical.

Therefore, The fundamental difference between Popper and Kuhn is that while former views science to be always in constant revolutions as the basic principles are being always put to test, the latter demands a serious commitment to the existing theories (as revolutions or shifts occur only occasionally). Further, a Popperian scientist is always anxious to falsify

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Further, Kuhn is highly unhappy with Popper's demarcation criterion of science and non-science But Kuhn prefers to concentrate on the central region of agreement, in stead of focusing on the disagreements. Though the disagreement over the demarcation is one of high intensity, Kuhn still feels that the disagreements between them must not be blown out of proportion, as the disagreement is not really a disagreement, rather only a difference of viewpoint. Both seem to see the same lines and diagrams on a sheet of paper but interpret them differently. So Kuhn explains, "That is why I call what separates us a gestalt switch rather than a disagreement and also why I am at once perplexed and intrigued about how best to explore the separation" [Kuhn, 1977c, in Kuhn 1977b, p. 269].

[100] Kuhn, 1977c, in Kuhn 1977b, p 272.

[101] Kuhn, 1977c, in Kuhn 1977b, p. 277

[102] *Ibid.*, 272.

[103] For a precise and comprehensive presentation of the similarities and dissimilarities among the views of Carnap and Popper, see: Hacking, 1999, in Klee (ed), 1999, pp 217-220

his/her own theory, whereas a Kuhnian scientist needs to exhibit a deeper commitment to uphold his/her theory.

1.2.2 Paul Feyerabend - Methodology – Not a *Corner Stone* for Science

No other critic of science has meted out such a vigorous attack against the received view of science as Feyerabend has done. He knocks down the whole concept of rationality from the realm of science. He argues that science has been given an undue high pedestal-status on two grounds: the methods of science and the results that it comes out with. For him *what makes science rational is its methodology* and *what makes a methodology special is its aim and results*. And because there is no such special method which is unique to science, to be followed in all the domains of science, he argues, ***there is no rationality in science;*** therefore he claims that science too need not be unique. He propagates this conviction, mainly in his celebrated works: *Against Method* (1975) and *Science in a Free Society* (1978). One can roughly divide, Feyerabend's works, as for instance John Preston does in his *Feyerabend – Philosophy, Science and Society*, into two major sections: ***from early 1950s till 1970*** and ***from 1970 onwards, till his death in 1994***. In the first part he was engrossed in developing an all-embracing model for acquisition of knowledge, while in the second part he lost interest in the above project and became highly critical of rationalism. In this short presentation, I concentrate more on the ideas of the second phase, regarding the rational (or non-rational!) aspects of science.

1.2.2.1 No Method, No Rationality!

Feyerabend identifies *the demand for one single method* (i.e. *methodological monism*) as the core of rationalism. He agues that the rules, which the methodological monists propose are naïve and simplistic, fixed in advance, without any consideration for historical elements. The types of rules that he has in his mind are a) that one must not propose *ad hoc* hypotheses to explain away the noncompliant data; b) one must not yield to hypotheses which go against the hitherto well-accepted experimental outcome; c) one must not accept hypotheses with lesser empirical content compared to the prevalent theories; and d) one must stay away

from introducing hypotheses that are self-contradictory[104]. He claims that these rules can neither be descriptive nor prescriptive and goes on to systematically deny each of those claims.

But history shows that there is no *the* method, suitable for all the domains of science. He brings in the case-study of Galileo to show how the latter systematically went against each of the rules of the methodological monists. This is not to show that Galileo did not follow any method in his science at all, rather, Galileo emerges as a strong sign for the need for *methodological radicalism* and *theoretical pluralism*. Many facts are unearthed only with the availability of alternative theories. To refuse to consider the alternatives leads the scientists to the danger of abolishing the potentially refuting facts. These facts may be capable of showing the absolute inadequacy of the theory in question. [105] By ignoring them the scientists are at loss. They have to go on with the ignorance of holding on to a theory which is, in fact, deficient and incompetent Not even one single rule, however greatly valued and cherished it might have been, does come to stay permanently in science. It is violated at one point or the other. The scientists also ignored the demands of rationality to achieve greater heights in science. They sometimes not just violate the traditional rules they even choose just the opposite rules. Such violations are *factual*, *deliberate* and even *absolutely necessary* for further growth in science. The newly adopted rules could even be *backward looking*. Circumstances may even demand "to introduce, elaborate and defend *ad hoc* hypotheses, or hypotheses which contradict well-established and generally accepted experimental results, or hypotheses whose content is smaller than the content of the existing and empirically adequate alternative, or self-inconsistent hypotheses, and so on"[106]. It is not the case that a new theory has to clarify all the doubts raised by the previous theory and rationally prove its superiority and a far-advanced empirical content before it is used. Theories often obtain clarity only after a prolonged usage. To become empirically successful they need non-rational and non-sensical acceptance in the first place. Such unmethodical push-ups' are needed for the new theories

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[104] Preston, 1997, p.172.
[105] Feyerabend, 1998a, in Curd and J A Cover (eds), 1998, p 937
[106] Feyerabend, 1999, in Klee (ed.), 1999, p.231

Feyerabend employs several instances from History of Science to argue that strictly insisting upon any single prescriptive scientific method is not only impossible and not factual, but also it positively hinders the scientific enterprise. For instance, he elaborates the Copernican Revolution, which is usually taken to be the clear and undeniable instance of rational and systematic growth of science, and which supposedly follows a fixed methodology. But he showed "that all common prescriptive rules of science are violated in such circumstances"[107] and claimed that efforts to blindly follow those prescriptive rules would have even prevented scientific revolutions. Theoretical pluralism is preferable as it does not impose rigid rules on the scientific community and it is necessary for the growth of science, because, "Variety of opinion is necessary for objective knowledge"[108]. Therefore he advocates *methodological pluralism*, which is not only more humanitarian but also more favourable to the growth of science.

1.2.2.1.1 Anarchism – Need not Lead to Chaos!

Anarchism, Feyerabend argues, is a requirement for any intellectual enterprise. It may be objectionable in politics but certainly not in epistemology. Feyerabend is for epistemological anarchism, to liberate science and society from wrong understanding that scientific rationality has a special and superior character. In fact this is the conviction, as he himself declares, that led him to write *Against Method*: "The following essay is written in the conviction that *anarchism*, while perhaps not the most attractive *political* philosophy, is certainly excellent medicine for *epistemology*, and for the *philosophy of science*"[109].

Feyerabend assures that because we don't adhere to fixed rules or methods in an anarchistic science we need not worry that it will land us in chaos. The less stress on strict law and order in science would not lead to anarchism in science, for he believes in the well-ordered nervous system that the humans have developed over the millennia[110]. Therefore he denies strict, unchanging and all-appealing methodological rules in science; he does not encourage a chaos-like situation, in both theoretical pluralism and methodological pluralism. **For what he has in mind is not the non-existence of such rules but their emergence and**

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[107] See: http://paul-feyerabend biography ms/
[108] Feyerabend, 1975, p 46
[109] Feyerabend 1999, p.228
[110] *Ibid.*, p. 230.

dependence only within the given research agenda. As "there are standards, but they come from the research process itself, not from abstract views of rationality"[111], a scientific research need not be capricious and whimsical.

1.2.2.1.2 A Tendency to Follow False Reasoning

True, it is not easy to go against the traditionally well-appreciated practices. For we are generally determined to faithfully follow the *tradition of reason* but actually we fail to realize that what we consider the "'voice of reason' is but a *causal after-effect* of the training"[112] we have received. Only the ignorance of the potentialities of humans and the complexities of the social surroundings make us cling to ".. intellectual security in the form of clarity, precision, 'objectivity', 'truth'..."[113]. Thus, when we dispassionately analyse the intellectual processes in history, there seems to be only one rule that is protected and acceptable under all situations and at all times of human development, and that principle is nothing but "anything goes"[114]. In fact, he says, a rationalist who has a closer study of the historical episodes cannot but throw up his arms in the air and sincerely exclaim that 'any thing goes'.

Feyerabend makes a scathing attack on *the stability thesis* (i.e. taking rationality to be more or less invariant over time). There are no absolute rules in science and, in fact, accepted rules are very often violated and even just the opposite ones are chosen. He does not see any 'rational' basis for choosing Newtonian science over Aristotelian science. **Science prevailed magic, or Newtonian science prevails Aristotelian science, not because of any rational superiority on the part of science**. Of course, science has a sort of rationality but it is not as robust as we think it is; it is one among many forms of rationality. A scientist or an artist is at the same footing in terms of rationality. They don't need, as Feyerabend puts it, "papa methodology or mama rationality to give them security and direction, he can take care of himself, for he is the inventor not only of laws, theories, pictures, plays, forms of music,

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[111] Feyerabend, 1978, p.90.
[112] Feyerabend, 1999, p. 232.
[113] *Ibid.*, p. 234.
[114] *Ibid.*

ways of dealing with his fellow men, institutions, but also of entire world views, he is the inventor of forms of life".[115]

1.2.2.1.3 Falsificationism – Not a Solution!

Feyerabend is also critical of Popper's Falsificationism For, no important theory is ever in harmony with all the relevant facts. But naïve Falsificationism demands that a scientific theory must be rejected if it does not agree with the available, known facts. But theories are kept up and even encouraged for further development with *ad hoc* methods, which are essential to the progress in science. For example, Galileo could not give the necessary optical theories to support his observational claims with telescopes, he and his followers had to use *ad hoc* rules until the field of optics could justify their telescopic claims with an optical theory. He agrees that falsifiability provides a way to replace invalid inductive thinking with deductive, falsifiable reasoning. Nevertheless he argues that doing so is neither necessary for, nor conducive to scientific progress; in fact it hinders it. Thus he argues that science proceeds not by induction, but by *counter-induction.*

In short, **no special methods for science, therefore no special status for science either.** If at all one looks for a universal rule for science, that would be, 'anything goes'. The special status of science, if any, is obtained from the social and physical values of the results of science, rather than its methods. The supremacy of science is just given to it. Science has forcefully pushed itself up! Not by logical arguments, but because of its power it came to occupy the ruling position. As in the middle ages the religious leaders of Christendom imposed rule on their subjects, now scientists use science as power to push their ideologies upon people.

1.2.2.2 Feyerabend's Lenience towards Relativism

In Feyerabend one can trace out two possible routes to relativism, through *methodological pluralism* and *incommensurability*: Firstly, given no fixed method, science has no way of ratifying the choice of one method over another. There seems to be no way of calculating the

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[115] As quoted by: McMullin, 1988b, in 1988a, p 10

merits of the different methods or paradigms. Secondly, since there is incommensurability in terms of truth-content relativism emerges very strongly[116].

In his "Rationalism, Relativism and Scientific Method" (1977) Feyerabend combats against rationalism, He differentiates between naïve and sophisticated versions of 'cosmological', 'institutional' and 'normative' rationalisms. He finally gives his doctrine of relativism that "there is no *one* rationality, there are *many* and it is up to us to choose the one we like most"[117]. In the same paper he presents a crucial problem what has is known as the 'dilemma of ultimate commitment' – i.e. both the rationalists and the irrationalists make a sort of 'leap in faith' in committing themselves to their respective ideology Their choice is beyond rational justification. For he explains: [118] Assume we want to judge action A by standard S. We apply S to A and render our judgment. But the application must also be rational, so there must be standards S` which judge the pair [A,S] and so on *ad infinitum*, unless we admit that at some place we simply act without being able to provide the standards which make this action rational.

With the insistence of anarchism, the privileged position given to reason is displaced. It becomes equally problematic and abstract as the other notions of Obligation, Duty, Morality, Truth and 'their more concrete predecessors, the Gods'. All these notions have been very badly threatening humanity and systematically hampering their freedom and joy in developments of every sort. He argues that for both rationalism and irrationalism there is no rational basis. As it is only a 'leap of faith', the proponents of both rationalism and irrationalism land in relativism.

1.2.2.3 Empiricism – Ineffective in Fulfilling its Promise!

According to Feyerabend, empiricism is not able to fulfill even its fundamental promise. However, empiricism has become so powerful that every intellectual enterprise is keen to take it as its official position. Many look up to empiricism as the only way to escape whimsical speculation and meaningless metaphysics is to rely upon a *thorough*

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[116] Preston, 1997, p. 193
[117] *Ibid.*, p. 194
[118] As quoted by Preston, 1997, p 195.

observational procedure. But unfortunately modern empiricism seems to establish a sort of metaphysical dogmatism, which in fact it aims to oppose. It is ironical to note that empiricism constructs its own position on such an edifice which is not refutable by experimental procedures[119]. ***Empiricism, if it is less and less tolerant of theoretical pluralism then it becomes more and more dogmatic***. If any intellectual enterprise likes to be objective, it must make an essential room for pluralism. It is this pluralism of theories that enables a sharp criticism of the existing theories, however well-accepted they have been in the past. One must not make only the domain of 'observational facts' as the yardstick for evaluating theories, as we don't have any observation, independent of theoretical considerations. Science cannot afford to deny a theory, because it sounds too general or metaphysical. At every stage of science some sort of metaphysics or the other is unavoidable in order to stop science from becoming dogmatic: "A science that is free from *metaphysics* is on the best way to become a *dogmatic* metaphysical system"[120].

Empiricism insists upon two conditions – *Consistency Condition* and *Meaning Invariance*. Feyerabend explains them as follows: [121] "**a)** Only such theories are then admissible in a given domain which either contain the theories already used in the domain, or which are at least consistent with them inside the domain and **b)** Meanings will have to be invariant with respect to scientific progress; that is, all future theories will have to be phrased in such a manner that their use in explanations does not affect what is said by the theories, or factual reports to be explained".

He finds serious fault with both these criteria. Episodes from the history of science show that both these conditions have been violated, especially at those crucial points where great scientific revolutions took place. There are widely know violations of consistency conditions: • between Newton's theory *and* Galileo's law of the free fall and Kepler's laws, • between statistical thermodynamics *and* the second law of the phenomenological theory; and • between wave optics *and* geometrical optics. Similarly, the relativity theory is shown to be violating both the conditions of consistency and meaning invariance. The first criterion, the *consistency condition,* increases the tendency to retain the older theory as one

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[119] Feyerabend, 1998b, in 1998, p 923
[120] *Ibid.*, p. 925
[121] *Ibid.*, p. 926-7.

can retain many cherished assumptions of the past. At times forces us to overlook even the observational evidence in the choice of theories. A theory is rejected, not so much for its counter-evidence at the face of new observational or experimental results, but just because it goes against a well-cherished theory at hand. Here, the age and familiarity become the basis for the theory elimination. So he even wonders: "Had the younger theory been there first, then the consistency condition would have worked in its favour".[122]

Against the condition of 'meaning invariance', Feyerabend maintains that 'contextual theory of meaning', by which, meaning of a term in a theory is determined by the context in which it occurs. A genuine alternative competitive theory must substantially differ from the first theory; must differ in the meanings of all the terms in it; if this difference is not substantial, this is not really the alternative theory but only a variant: The general principles of a theory affect the meaning of every term; when theory changes substantially those principles too change, and with that meaning also changes. However, large part of the theory of the world remains intact; that is why the transition from Newtonian mechanics to general theory of relativity has not altered culture, arts, ordinary language and perception.[123] Incommensurability leads to a strict subjectivity in the realm of theory choice. Since there is no logical way of comparing various theories, we are left only with the "aesthetic judgments, judgments of taste, metaphysical prejudices, religious desires, in short, what remains are *our subjective wishes*"[124]. Thus the notion of incommensurability shakes the claims of rationality in science.

Under this 'blissful ignorance' of the refuting facts, one tends to be mistakenly convinced of the speciality and uniqueness of the current theory and reject any single theory that does not go along with the present theory. From here one automatically moves on to the state of metaphysical dogmatism. Here its success is assumed and artificially created by us. The success is not because it corresponds to the truth and nature, nor because it has been scrutinized under many possible alternative theories. Given such a background, that particular scientific theory becomes a sort of a *myth*, which is kept up for many personal, social, political and religious reasons, like one's dread, unfounded inclinations,

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[122] Feyerabend, 1975, p 36.
[123] *Ibid*, p. 271.
[124] *Ibid.*, p. 285.

preconceived ideas, and religious convictions. Efforts are made to reinforce the *myth*, not necessarily by religious priests but by the custodians of science and Nobel laureates themselves. This *myth* permeates the whole life and it becomes almost impossible to criticize, because the possibility of considering any other "set of equally all-embracing principles... has been excluded from the very beginning"[125] **Therefore the insistence upon consistency and uniformity of theories weakens science by removing its critical power; it seems to lead even to opposite effects.** For, the great power of imaginative and innovative ideas is under a threat. It tells upon the realization of one's deep insights. If such a situation is allowed to prevail for a period of time it will slowly and steadily affect the quality and the vigour of education.

Having presented the seminal ideas of the proponents of the rational and non-rational models of rationality in science, I now move on to the critical evaluation of these ideas in **Chapter 2.**

[125] Feyerabend, 1998b, in Curd and J A Cover (eds), 1998, p 938

CHAPTER 2

ASSESSMENT OF THE 20TH CENTURY THEORIES OF RATIONALITY IN SCIENCE

2.0 Introduction

In this Chapter I assess the views of the proponents of rational and non-rational models of rationality in science. In **Section 1**, I take up the ideas of Hempel and Popper. I attempt to argue that Hempel is in need of 'liberation from goal', as rationality cannot be comfortably confined only to goal-means relationship. After analysing Popper's strong proposal of Falsifiactionism I conclude that he emerges out to be a 'fallible fasificationist'. **Section 2** takes up the critical evaluation of Kuhn's and Feryerabend's views, the proponents of non-rational models of rationality in science. At the end of the analysis of their views, I argue that, due to the difficulties in the desiderata, Kuhn can be correctly taken as a 'rational relativist', while Feyerbabend, as my appraisal would reveal, would be a 'proponent of rationality in science with a human face'.

2.1 ASSESSMENT OF THE RATIONAL MODELS OF RATIONALITY IN SCIENCE

2.1.1 Assessment of Hempelian Account

I begin by summarizing the critiques of Hempel's analysis of rationality by two important thinkers, namely Kuhn and Philip Kitcher, whose critiques I deem to have direct relevance for our purposes here.[126] Then I give a few evaluative remarks of mine about Hempel's ideas.

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[126] Many critiques have a great admiration for Hempel's sincere and honest efforts in philosophizing. As Fetzer puts it, "He [Hempel] cared more about finding the right solutions than whether his solutions were right" [Fetzer (ed.), 2001, xiii.]. Further, Kuhn too expresses similar sentiments when he declares, "In him [Hempel] I learned to recognize the stance of a man who intends philosophical distinctions to advance truth rather than to win debates." [Kuhn 2000b, in Kuhn 2000a, p 208], and similarly W Salmon too admires Hempel's acumen in philosophy, especially in logical empiricism, by saying, "His [Hempel's] writings have uniformly exhibited the kind of clarity, depth, incisiveness, and fairness that ideally suit them to provide a solid basis for understanding the fundamental philosophical issues" [Salmon, 1983, p 555]

2.1.1.1. Hempel's Impossible Dream: Kuhn

Kuhn construes Hempel's attempt as an attempt to construct a purely logical account of scientific rationality. Both Hempel and Kuhn agree that theory choice has to presuppose a prior specification of the goals – say, to make the theory more efficient or better 'puzzle solving'. A theory is more efficient, if, say, there is a better fitness between theoretical predictions and the results of experiment and observation Suppose, given this goal, one chooses a theory which does not provide a better fitness then we can straightaway see that one is irrational. Hempel wants to develop an account of theory choice based upon logic and experiment, whereas Kuhn affirms that logic and experiment alone can't provide one with sufficient grounds for theory choice. Kuhn, as well as several historians and philosophers are of the opinion that this very attempt is basically untenable. However it is good to note, as Salmon clarifies, that "It is not that Kuhn wants to regard science as irrational; instead he would offer a more 'naturalistic' conception of rationality"[127]

Any comprehensive account of scientific rationality, Kuhn is convinced, cannot afford to ignore the actual practice of science. According to him, the traditional methods of verificationism or falsificationism are not compatible with the actual practice of science. Logical positivists derived their methodological rules for the notion of rationality from certain *a priori* models. But there are no *a priori* determinations or norms to which scientific activity is expected to conform. Theory of rationality must be formulated by looking at the actual practice of science. Kuhn also rejected the clear-cut distinction between descriptive and normative accounts. Normative account has to take note of the actual practice of science. As essential functions of science-practices lead science to improvement and progress, so they can be considered as normative. Scientific progress, like Darwinian evolution, "[is] a process driven from behind rather than pulled towards some fixed goal to which it grows ever closer".[128] For Kuhn, all these lines of thinking make one thing very clear, that is, Hempel's efforts to arrive at a logical account of rationality of science will remain always unsuccessful.

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[127] Salmon, 1983, p. 557.
[128] Kuhn, 2000f, in Kuhn 2000a, p 115.

2.1.1.2 Rationality does not always Demand Utility-Maximization - Philip Kitcher

No doubt, Hempel's notion of rationality has two distinct components, namely *normative* (evaluation) and *explanatory* (description) components. Hempel defines, as we have already seen, rationality in terms of the goals of the action and the beliefs available for the agent to accomplish that action. Kitcher calls this as ***'utility- maximization notion of rationality'***. But the problem with this notion of rationality, Kitcher observes, 'success' can be a matter of luck too. One may attain the maximized utility by a mere matter of luck. So a modification in Hempel's account of goal-means relationship is needed to take care of the aspect that the agent does the actions in the most reliable way, not by luck, to maximize the perceived utility.

Kitcher tries to show that utility-maximization of action need not always be counted in a materialistic and numerical way. He gives the example that Charles Darwin, before proposing to his cousin, jotted down all the advantages and disadvantages of proposing to her and marrying her. Weighing the relative strengths of the both the aspects he finally decided to marry. We cannot totally call this approach a rational one. For, this kind of *decision-theoretic approach* to such a phenomenon of choosing one's spouse does not seem to be appropriate. Marriages involve companionship and commitments at deeper levels. One who is aware of this "would question his own ability to make the numerical judgments and would be profoundly skeptical of attempts to compute the 'utility-maximization action"[129].

More studies in psycho-neuro related fields reveal many striking elements with regard to the process of decision making in our ordinary day-to-day lives. Very often we don't make any elaborate cost-and-effect analysis of our actions before we perform them; we need to act almost impulsively having no time for strict rationalization – for example, jumping into the river to save a drowning child, or jumping quickly away at the sound of leaves' rumbling fearing a snake, and later finding out that it is just a noise made by some dry leaves. Decisions can very well result from our emotional responses, like moved by pity and sympathy helping someone, even by going out of one's way even though we don't seem to

[129] Kitcher, 2000, p 252.

like him/her. Kitcher prefers the phrase ***being reasonable*** to ***being rational*** The one who is reasonable gives considerable importance to reason and emotion. Such a person goes far beyond mere decision-theoretic calculation. Such a person goes beyond being rational.

2.1.1.3 Problems in Confining Rationality to Sheer Goal-Means Relationship

It is true that the 'means/end conception of rationality' is very close to common sense. Critics of rationalists cannot deny this means/end conception of rationality. Even those who deny the elements of logicality, objectivity, deliberation, detachment etc can't easily deny this concept of rationality; for to do so will make that person highly irrational or insane; for even the action of denying the concept of rationality in terms of means/end relation has an *end* to be achieved. However, when we investigate into the nature of goals and the multifaceted nature of human actions we understand that it is not all that simple to understand rationality in terms of goal-means relationship.

2.1.1.3.1 The Complex Nature of Goals

Due to the complexity involved in *the nature and formation of the goal itself* it seems to be inadequate to see rationality only in terms of goal-means relationship. According to Hempel, an action can be shown to be rational if it has the highest probability of bringing about the desired end. This view involves knowledge about the desires of the agent. If that is the case, then ***some problems***, subtle though, arise in such a claim: ***First***, there is no unbiased and certain method to learn about or to judge the aims of the agent **a)** A given action may have many goals and one goal may involve many actions; **b)** The person himself/herself is not aware of all that goes on in the mind; **c)** An action may have expressed and unexpressed goals. He/She may be dishonest or may not like to reveal the hidden agenda of her actions. (e.g. It is like doing some charitable activity with the explicit goal of helping the needy, but with the implicit goal of basking in some self glory), and **d)** Emotional factors, religious ideologies, value systems, personal and social commitments play a very big role fixing up one's goals. Without desires, passions there can't be any aim at all in life. Very often the society lacks strict parameters and universal standards to measure them, especially in the grey areas.

Second, since all our goals in life are often inter-dependent it is not easy to fix upon the validity and the quality of a goal in isolation, and this reflects in determining the rationality of the action itself. The end must be coherent with one's other goals in life. A rational action is the one which enhances the prospects of satisfying our central goals in life, rather than interfering with it. So an action can't be taken in isolation to study its means/end relationship. I can think of an example: a youngster wants to have the experience of taking some narcotic drugs. But although that action may fulfil the goal of having such experience the very action does not seem to be alright given the welfare of the whole of life, especially in case she gets addicted to the habit. And ***Third***, if reason requires acting for the best, many other questions arise – What is the best? What things are of value? And not only that, one may further ask Whose best? The agent's? Of the agent's beloved? The society's? All humans? All sentient beings? and so on. All these are not a simple matter to be settled easily. ***And finall,*** as Nathanson[130] points out, limiting rationality to the success of realizing the intended goal would do a big harm to a whole lot of human activities. For, there can be cases where an action can succeed in realizing an agent's goals and ***still be irrational.*** [e.g. Someone wants to check the force of gravity by jumping from the 10th floor without adequate precautions. S(he) may fulfil the goal of the action, but life is seriously endangered]. [131]

2.1.1.3.2 Multi-dimensional Nature of Human Actions

Humans are so multifaceted that their actions can't be limited only to goal-means type of actions. Goal-oriented actions seem to be just one type of actions that humans undertake in their actual life situations. All of human actions, that are multi-dimensional, cannot be squeezed into one category of goal-means relation.[132] For some actions we are not aware of the goals at all. For instance, although one may not know the purpose of some religious

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[130] Nathanson, 1994, pp 105-109

[131] I'll return to Nathanson's ideas once again in discussing the notion of 'Reasonableness' in Chapter 5

[132] Max Weber argues that it is unfortunate that in modern society, in the realms of politics, economics, the law, surprisingly even in interpersonal relations, the means-to-end action seems to be given more predominance He lists four types of human actions ***goal-oriented action*** (where goal and means are rationally chosen); ***value-oriented action*** (where the goal may not be rational itself, but pursued with rational means, e g. like attaining salvation), ***emotional or affective action*** (which is rooted in emotional state of the actor, rather than in the rational evaluation of means and ends, e g like religious or fundamental sects), and ***traditional action*** (which is rooted in customary of thought, e g actions of Orthodox Jewish congregation) [Coser, 1996, pp. 217-218].

rituals yet one will be still performing them It is not rare to find children asking for the purpose of some rituals and the elders telling them to keep quiet and perform them; this is because often the elders themselves don't know the clear purpose (or goals) behind those rituals. The ancestors, of course, might have had some goals for those rituals, but the present elders are not aware of them, yet we consider those actions quite rational.

Some religious goals don't seem to be attained throughout one's life time There is no proof that it has been achieved in other's life as well For instance, having salvation as one's goal! It is, in fact, achieved after one's death.[133] If one confines rationality of an action only to the actual realization, or possible realization, in the case of salvation one does not even know that it is possible to achieve, as no human being has come back from death to tell us about it. So the rationality of the actions that are striving for salvation seems to hang in the air, unsettled this way or that way!

It is true that any action of a human being in normal circumstances will have some goals and that makes her/him rational. Be that as it may, all that I want to show that the account of rationality based on goal-means is not that simple and straight forward. One final example, I think, might capture the difficulty, which I am struggling to explicate here. An elderly gentle man, who receives pension from the State, is expected every year to produce a certificate to declare that he is alive. One particular year he fails to do so. The following year he goes with a said certificate. But to his dismay, there the authorities were demanding another certificate from the pensioner to show that he was alive the previous year. For the present certificate shows that the pensioner is alive now, but that is not the proof for his being alive last year. Now the action of **those officials may sound rational** as they try to fulfil their duty and to achieve their goal of keeping a proof that the man was alive the previous year. However intuitively we seem to know that **it is not reasonable to demand** the second certificate from the man because had he been dead the previous year he would not have been alive this year. Thus, my point is that life involves variety of actions, where goal-means

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[133] In the Indian Traditions the state of liberation (or freedom from all sorts of suffering) has been seen variously, as *mukti*, *apavarga*, *kaivalya* etc It is basically a realization that the self is different from the physical body. They speak of the possibility of attaining liberation (Mukti) while still alive or after death While living in body, the self (soul) attains *jivanmukti*, after the death of its body the liberated self attains what is called *videhamukti*. For instance, the *Sankhya* Philosophy of the Indian Tradition [See Chatterjee and Dhirendramohan Datta, 1984, p 284] I don't intend to go into all those intricacies here, except to note that even there the *videhamukti* seems to be more desirable

view may make an action rational but not reasonable, and what we need in life is, as Philip Kitcher[134] would argue, to be reasonable people rather than rational people

2.1.1.3.3 Goal Vis-à-vis Science

Speaking about goal-means relation in the scientific inquiries, one realizes that goal of science, unlike that of an individual, is to be understood in a much more complex manner, not as an attempt to attain fixed goal. Goal in science is not like the goals of the activities of day-to-day life. Scientific activity can't be seen as something motivated to achieving one particular clearly-articulated goal. It may not be always directed to a specific goal, but that does not mean that it is not rational. History of science shows us that i) Science is not purely a goal-governed activity; usually when the repeated attempts fail to achieve a goal, that action is renounced, but in science on the contrary, they try more hard or try in different methods to attain that goal; ii) Scientific activity is somewhat different from moving towards one fixed goal; the activity itself generates new dimensions and aims for its development. (Galileo, Newton and others replaced the then held practice of explaining reality in terms of occult qualities and adopted a mechanical view of reality But Newton himself, in order to explain gravity had to introduce a sort of occult elements; that is, he relied on some divine powers to explain the action-at-a-distance; thus though he had not renounced the general goal of providing mechanical view of nature, yet he had to shift / change his goal for a specific purpose). The context itself imposes certain requirements or conditions, like the need to abide by the religious principles in vogue that time This shows that the goal of science is constantly modified by the circumstances, in which it has its being and moving.

Even if there is one grand pre-fixed goal for science, at no point of time one can claim the goal of science has been achieved; suppose that goal is achieved one day the activities of other scientists, say of the following generations, seem to be redundant. Down the centuries science shows that it is an on-going activity; it is never able to reach the already one fixed final goal due at least to two reasons: i) one fixed goal is not given to the scientific community; dimensions of goal keep changing in relation to the realms of actual practice; and ii) Goals of scientific inquiry are such that they can't be attained by one or two groups

[134] Kitcher, 2000.

in a specified time-frame. It requires a very long process and it needs the collaboration of diverse groups, from diverse regions for a long period of time. For instance, the Human Genome Project to unravel the mysteries of the genetic make up of humans or the Space Mission to trace out the presence of life in the extra-terrestrial or extra-solar domains, has been going on for several years, with the collaboration of hundreds of experts from the various parts of the globe.[135]

2.1.1.3.4 Goal of the Institution, not of an Individual Activity

Science is not just one single homogenous inquiry, rather it is an institution Since science is an institution (structure) the whole institution as such represents the goal. Max Weber points out that the choice of problems, in both social and natural sciences, is always 'value relevant'. For him, "There is no absolutely 'objective' scientific analysis of culture or... of 'social phenomena' independent of special and 'one-sided' viewpoints according to which – expressly or tacitly, consciously or unconsciously – they are selected, analyzed and organized for expository purposes" [136] He goes on to argue that the difference between the social and natural sciences is not in any of their special methods of investigation inherent to them, but they differ only in the aims and the interests of the scientists. There are lots of similarities between these sciences, like, total explanation is not possible in both sciences, and both involve abstraction from the multidimensional aspects of reality.[137]

To decide upon the rationality of an action mere analysis of goal is not enough, but the conditions/requirements of the institution within which science functions. In a complex activity the failure (or difficulties) to achieve a goal does not imply the activity is irrational. (For instance, a good government, a harmonious society, removal of poverty and various discriminations in the society may not be satisfactorily achieved in a society, but this does not mean that actions with that aim are irrational). Further, some goals are not achievable, not only in practice, but even in principle For instance, justice or equality - which is not possible (not only practically speaking) to attain in its fullness in a political realm; it is

[135] When we include these non-rational features of psycho, socio and political dimensions of the goal of a scientific endeavor, an action may not be rational according to the strict requirements of the Received View, but still it *need not be irrational*, for that action can be *certainly reasonable*, in a Comprehensive Account of Rationality in Science, as I will argue in the Chapter 5.
[136] Shils, and Henry Finch (eds.), 1940, p 72
[137] Coser, 1996, pp. 219-20.

impossible also in principle, because the yardsticks or requirements of justice may change from time to time within political systems and across various political systems Often each activity is seen as rational not with the realization of its goal but whether it sets the step for further practice towards the realization of that goal. Therefore goal-action may not be the right way to address the issue, rather the issue of rationality must focus on the aspects of goal-institution relationships.

2.1.1.4 Hempel – A Bridge between Logical Positivism and Kuhn

Hempel, on the one hand, reformulates logical positivism's account of rationality in order to include socio-cultural elements in the account of rationality, and on the other he tries to correct Kuhn by showing that the considerations of a goal (and the means to achieve it) of the scientific activity lay down restrictions upon the desiderata so as to make them necessary and sufficient norms for scientific rationality. Hempel rightly shows that the accounts of logical positivism and Popper are incompatible with actual practices of sciences. Therefore the normative account has to take note of the actual practice of science. At the same time, he argues that a major lacuna in the Kuhnian position is a result of not making a distinction between the explanation of behaviour of the scientists and the issue of justification. It is true that desiderata are insufficient in theory choice; and these don't provide any algorithmic procedure for science practices. However there are conditions of goal; the goal lays down restrictions upon the scientific procedures and acts as motivating reason or direction. Therefore, for Hempel, science is not an inquiry where 'anything goes'. We need context to reconstruct the rational account of science He comes out with a new account of rationality, which he names as **'objectivist but relaxed rational reconstruction'**, which can be seen as a bridge between logical positivism and Kuhn.

2.1.1.5 'Relaxed but an Objectivist Construal of Rationality' – More Relaxed than Objective?

As Hempel is aware that due to the problem with the nature of desiderata proposed by Kuhn a totally objective account of scientific rationality is not possible, he accepts, 'a relaxed but an objectivist construal of rationality'. For, *till late 1970s,* Hempel maintained a strict list of requirements for scientific rationality For instance, in "Scientific Rationality: Normative vs.

Descriptive Construals,"[138] he demands that scientific procedures are precise to make a theory choice which is unambiguous at all times, and these procedures follow strict and explicit norms and these rules are followed for advancing scientific knowledge. He also believed in the continuous growth of science· "(the new) theory does not simply refute the earlier empirical generalizations in its field; rather, it shows that within a certain limited range defined by qualifying conditions, the generalizations hold true in fairly close approximation"[139]. He views the growth of science a sort of cumulative growth as he believes that the new theory is not only more comprehensive but also the old theory is a derivative of the new one, so much so that the new one is a kind of special manifestation of the old one. However *by the middle of 1980s,* we see a sort of liberalization in his demands, as he maintains that the methodological principles which don't refer to psychological or sociological aspects are not desirable[140] and he adopts a *relaxed objectivist construal* Thus, according to Hempel an ideal rational account of scientific inquiry must involve both the ***descriptive*** (explaining) and ***prescriptive*** (justifying) accounts of scientific enterprise. An account may justify ***why an agent followed certain rules*** to attain a particular goal, but this need not explain ***why the agent chose to act in that way*** So we need an explanation to that effect For him, therefore, "An account which does possess this double aspect of explanation and justification might be called an *ideal rational account*",[141] and he calls it 'explanatory-normative methodology' (E-N methodology). Richard Kitchener also has the same the view, as he argues that "one will not simply *describe* what it (critical philosophy of science) is, what its epistemology, ontology and ethics are .. But neither will one *prescribe*... what it ought to be".[142]

This approach seems to be reasonable. However, according to Fetzer, though Hempel finds some commonalities between the normative and pragmatic methodologies yet he seems to be inclining more towards a normative methodology. So he evaluates Hempel as follows "The most important lessons of Hempel's enduring legacy must be that scientific standards cannot be derived from descriptions of its practice alone".[143] However, I personally seem to think that Hempel's account is more relaxed than normative. Due to the inconclusive nature

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[138] Hempel, 2001a, in Fetzer (ed), 2001
[139] Hempel, 1966, p. 79.
[140] Hempel, 2001b, in Fetzer (ed.), 2001
[141] Hempel, 1998, p 454.
[142] Kitchener, 1992, p. 19
[143] Fetzer, 2001, p. xxxii.

of the desiderata (as pointed out by Kuhn), Hempel argues that the desiderata provide only a relaxed notion of rationality and he claims that the conditions of goal are able to provide an objectivist construal of rationality. But I feel his latter claim is debatable. With all the problems with the goal-means notion of rationality, as we discussed earlier, one can see that the goal-means thesis of Hempel does not seem to do the job what he attributes to it. Therefore I tend to look at his relaxed objectivist construal as something 'more relaxed than objective'.

Having seen some critical remarks on Hempel's ideas we now move on to have a close look at the those of Popper.

2.1.2 Karl Popper: A Fallible Falsificationist!

Popper, due to his well-developed theory of Falsificationism, emerges as a staunch proponent of rational model of science. That theory, for Popper, achieves many things with one shot: it solves the perennial problem of induction; it demarcates between science and non-science; and it gives a strong rational footing to science. But with a bit deeper analysis we find Popper's claims for scientific rationality run into many difficulties.

In this Section I look into some of the limitations of the theory of Falsificaitonism and to assess the viability of Popper's claim to have dissolved the problem of induction.

2.1.2.1 The Limitations of Falsificationism

The theory of Falsificationism might seem to be acceptable at the first sight as it claims to guarantee conclusiveness (in falsifying), unlike verificationism which can give us only probability. However on a closer analysis, one becomes aware that there is an ocean of criticisms from all possible sections. As one commentator puts it, "there are many problems with his (Popper's) account of progress through Falsificationism, (for) ... some kinds of scientific evidence, including probabilistic evidence, are unfalsifiable and... in the lab, scientists often ignore falsification".[144] Newton-Smith sounds rather blunt in branding

[144] Taylor, "Why Science Matters", 2006. See: http://www.sirc org/articles/why_science_matters.shtml

Popper as 'the irrational rationalist'[145]. It is because i) Popper's method of *Conjecture and Refutation* is not able to produce theories with greater *verisimilitude*, in fact, falsification is not only helpless it even "involves a grave distortion of actual scientific practice"[146] and ii) the relationship between the goal of science and the method of science, which is essential to claim rationality in science, can't be established. Let me now consider some of them here:

a) A scientific theory or a statement is a very complex one in reality. So it is not that easy to falsify it. As Duhem-Quine show that a single falsifying instance can't falsify the whole theory, as any theory is a collection of many hypotheses. Not all the theories are as simple as 'All elephants are black', for, theories are interconnected and no theory would be established or disproved in isolation and hence the conclusive falsification is made very difficult. So given a falsifying observation statement it may be the case that one of the auxiliaries or initial conditions is false. The falsity cannot be automatically attributed to the hypothesis in question. So the hypothesis can be retained in spite of a falsifying test by modifying the auxiliaries or the initial conditions. This, in fact, can keep on going and at no point one can strictly falsify a hypothesis. [147]

b) We have many examples in the history of science to show that even after falsification a particular theory is not just discarded They just temporarily shelf it aside and hope for a better explanation in future. After a while it may be revived and gets accepted, tentatively though, by the scientific community. Meanwhile they make *ad hoc* modifications to keep the theory going. Therefore it is not proper to demand an immediate rejection of a theory when it is falsified. As Lakatos quotes the example, Mercury's anomalous perihelion was not taken as a falsifying instance of Newton's theory of our planetary system. As a result Newton's theory was not rejected, rather they kept aside the anomalous instance to be considered later and *ad hoc* solutions were given to save the theory[148].

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[145] Newton-Smith, 1996, 1981, p 44
[146] *Ibid.*, p. 45.
[147] Chalmers, 1992, p. 64.
[148] Lakatos, 1974, p 247.

c) In history, there are many episodes, which can be adequately accounted for, neither by the Inductivists nor by the Falsificationists. For instance, the Copernican Revolution took about 150 long years to be established. In 1543 Copernicus published his helio-centrism theory and it was confirmed by Galileo's telescope only in 1609. Hence the acceptance of the Copernican theory did not take place at one instant of falsification as Popper would have us believe

d) Further, the scope of falsificationism is limited in the sense it cannot be employed in the case of probability statements and analytic statements. For the technical falsifiability seems to be unhelpful in such cases. Popper[149] makes the distinction between *logical Falsificationism* (referring to the logical possibility of falsification in principle) and *technical Falsificationism* (referring to a practical proof of falsity). Probability statements are neither falsifiable nor verifiable in the logical sense. They are not verifiable, for the usual reasons as any other universal generalizations and not falsifiable either, because in a throw of a coin the probability for 'head' is ½, that is, both head and tail have equal frequency. Though we have a series of throw and in all of them we get head; yet the probability of getting tail is not ruled out. So with a finite number of throws of a coin we can't falsify the probabilistic statement. Only infinite sequence of events can contradict a probable estimate and it is not meaningful to speak of infinite number of sequences. However science (Physics) has grown successful in the predictions derived from the hypothetical estimates of probabilities by a method called 'practical falsifiability. That is, though the hypothetical probabilities can't be fully falsified, practical falsification is achievable by a methodological decision to rule out highly improbable events.

e) Problem with having falsifiability as the criterion of demarcation of science and non-science: any statement which is falsifiable need not automatically be scientific. As Putnam[150] gives the example, "if anyone puts a flour sack on their head and raps the table 99 times then a demon will appear' – this statement clearly has epistemological character, logical property and falsifiability too. But it is hardly scientific!

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[149] See: Popper, 1992, p. xxii
[150] Putnam, 1981, p. 197.

f) Falsification does not seem to be very different from verification. Popper shuns verification as it is impossible to conclusively verify a universal theory. The same difficulty seems to arise in the case of falsificationism too. Any theory depends on auxiliary hypotheses and initial conditions. Therefore it is always possible to have alternative assumptions about the initial conditions to 'save' the theory. Only the combination of theory, auxiliary hypotheses and initial conditions can be falsified, but unfortunately, as we saw above (in b), this falsificationism cannot automatically be transferred to the theory at hand! Rom Harre and Michael Krausz clearly bring out the problem of asymmetery between the process of confirmation and falsification, when they analyse Popper's ideas:[151]

> Furthermore it (Popper's ideas) suffers from the general problem of methodological fallibilism that the supposed asymmetry between confirming a hypothesis as true and disconfirming it as false is difficult to defend. While the former seems to depend on the inductive assumptions that the future will be like the past in relevant respects, itself in need of inductive support, the latter seems to depend on a related assumption that the future will not be like the past in relevant respects, an assumption equally in need of inductive support.

Therefore, an in-depth analysis of Falsificationism clearly brings out some of the insoluble problems that plague the Popperian account

2.1.2.2 Problems with Popper's Denial of Induction

Popper ignores inductive reasoning as unnecessary: "There is neither a psychological nor a logical induction. *Only the falsity of the theory can be inferred from empirical evidence, and this inference is a purely deductive one*"[152]. For him science is rational primarily because it is a goal-oriented enterprise and it strictly follows a method to achieve that goal. Nothing but *truth* is the aim of science. But sadly enough the final truth is always beyond its grasp. Any new theory, if it is genuinely a scientific theory, can take us only nearer to truth, called *verisimilitude*. In this process inductive reasoning will not be of any help as it would not lead us to any conclusive truth. The very notion of verisimilitude, which is very dear to

[151] Harre and Michael Krausz, 1996, p 71
[152] Popper, 1963, p. 55.

Popper to affirm that science is rational, progressive and worth the while, itself is in danger without some sort of inductive metaphysics[153]. Lakatos takes pains to elaborate on the disturbing implications of Popper's verisimilitude for the problem of induction. The actual dividing line between classical scepticism and Popper's fallibilism is rather thin So Lakatos observes: "The difference between total scepticism and humble fallibilism is so small that one frequently feels that one is engaged in a mere verbal quibble..."[154]. So it would do well for Popper to realize that some form of inductive process is crucial in the scientific process.

Science needs something more than mere observation and experiments. If it confines itself to the domains of empiricism it cannot justify its very existence. For the very principle of induction, which is supposed to be the backbone of the scientific enterprise, cannot be derived from experience and Hume has to be given the credit, as Bertrand Russell stresses, of bringing this fact to light: "(The principle of induction) must therefore be, or be deduced from, an independent principle not based upon experience. To this extent, Hume has proved that pure empiricism is not a sufficient basis for science"[155].

It is true, inductive reasoning is not without problems either. But going to the extent of effacing inductive reasoning (if at all possible!) from the very enterprise of science will land us in scepticism. Of course scepticism has its own strings of difficulties. Nevertheless without induction it is well nigh impossible to show that there is a growth in science and that science is a rational enterprise. It is highly likely that science would be empty, if inductive reasoning is completely ruled out. It would be even suicidal for science to reject inductive process. As Salmon puts it, ".. that science is inevitably inductive in matters of intellectual curiosity as well as practical prediction. It *may* be possible to excise all inductive ingredients from science, but if the operation were successful, the patient (science), deprived of all predictive import, would die"[156].

Finally, for Popper rationality is critical debate. The core of Popper's philosophical breakthrough is, as Stefano Gattei has it, "rationality requires not foundation, only critical

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[153] By inductive metaphysics I mean a framework of metaphysics where one is allowed to have the inductive reasoning as a valid form of reasoning
[154] Lakatos, 1974, p. 260.
[155] Russell, 1974, p.699.
[156] Salmon, 1998, p. 443.

dialogue: it is the end of foundation philosophy".[157] In the 20th century, the debate over foundationalism plays an important role, people either deny it (and hence scientific knowledge is unjustified and therefore irrational) or hold that scientific knowledge is a justified belief, while weakening the idea of truth as correspondence with reality, or the idea that justification shows that a statement is true. Gattei falls on Socrates, who said that we are living in the twilight zone between knowledge and ignorance, to claim that "the failure of foundationalism does not drag epistemology with it. The twilight zone between knowledge and ignorance is an ideal well worth holding on to"[158]

With Popper's denial of induction and dependence on the scientific community for rational decision, scientific methodology seems to be rendered to be void of rationality altogether. Anderson raises an important query: "Since Popper allegedly has rejected induction and relies on the scientific community to reject and accept basic statements, the scientific methodology inevitably loses its rational component."[159] Nevertheless, though Popper claims to have solved the problem of Induction, in the theory of corroboration it makes a slow and subtle reappearance. There is no obvious difference between the view that a theory depends for justification on the occurrence of confirming instances ***and*** the view that it depends on the failure of the falsifying ones to occur. Hence Popper does not seem to be proper in denying or successful in solving the problem of induction. In fact, science needs inductive reasoning and, of course, it never makes science less rational.[160]

Having seen the critical remarks of the proponents of rational model of science, now in the next section I'll elaborate the critical evaluation of the proponents of non-rational model, namely, Kuhn and Feyerabend.

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[157] Gattei, 2004, p. 464.
[158] *Ibid.*
[159] Soren Bo Anderson, "Relativism". Source. www.phys.port.ac.uk/what/example.htm
[160] In Chapter 5, I take up the issue of inductive reasoning again to argue that it is a happy legacy from the traditional account of rationality in science

2.2 ASSESSMENT OF THE NON-RATIONAL MODELS OF RATIONALITY IN SCIENCE

I evaluate the views of the proponents of the non-rational model of rationality in science, Kuhn and Feyerabend. I focus on those aspects that are relevant to our purpose here.

2.2.1 Thomas Kuhn – A Rational Relativist!

Kuhn's serious and systematic study of History of Science has drastically changed the hitherto held picture of science. Science is now basically seen as a social enterprise. Here I assess his ideas that are directly relevant to our purpose, namely the new picture of science, the notion of paradigm and the issue of theory choice.

2.2.1.1 Science – As a Social Enterprise: Kuhn's New Picture of Science

Issues of rationality and those of reality, though not unrelated, are the main pre-occupation of the contemporary philosophy of science According to Hacking, Kuhn's book, *The Structure of Scientific Revolutions,* "produced a decisive transformation and unintentionally inspired a crisis of rationality".[161] Before Kuhn, the prevalent idea of science was that each new theory in the successive periods was better than the older one, adding more to the knowledge content. As the latter theories were more comprehensive the scientific growth was a continuous one. The goal of science was to arrive at the whole truth, whatever it might have meant: "Each successive theory's explanation was closer to the truth than the theory before. It was the truth, and the prediction and control that came with it that was the goal of logical-empirical science".[162] But for Kuhn it is not so. Arriving at Truth, whether full or partial, is not the goal of science. Truth does not pull science forward but only the puzzles push it ahead. Puzzle- solving is the goal of science, as noted earlier.

For Kuhn the subject of science is the community of the scientists, committed to values, whereas for logical positivism and critical rationalism, the subject of science is the

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[161] Hacking, 1999, p.217.
[162] David J Voelker, "Thomas Kuhn Revolution against Scientific Realism" In· http·//history.hanover.edu/hhr/94/hhr94_4.html

individuals following rules (algorithms). For the latter theory choice is done with well-defined rules; so anyone pursuing it rationally will eventually come to the same decision; it is a rational decision. For Kuhn the theory choice is not strictly rule-governed, rather "the decisions are influenced by the cognitive values to which the respective community is committed. The important point here is that a decision which is *influenced* by values is not necessarily *determined* by them This implies that different individuals influenced by the *same* values may come to *different* decisions" [163] He was probably the first one to being out the interconnectedness and the interdependence of Philosophy, History and Sociology of Science in a very emphatic manner. They need one another for mutual enrichment. The processes within a scientific community, which finally results in an authoritative consensus is termed as 'negotiation' and "Negotiations in science, like those in politics, diplomacy, business, and many other aspects of societal life, were widely said – especially by sociologists and political scientists – to be governed by interest, their outcome determined by considerations of authority and power".[164]

2.2.1.2 Kuhn – In the Eyes of His Critics

Alexander Bird[165] presents a much precise and balanced evaluation of Kuhn's ideas. The very cyclic understanding of science, as normal science – crisis - revolution – normal science, is disproved by history. If normal science and revolutionary science are taken as the two extremes, most of science is in between, neither normal nor revolutionary. Most of the revolutionary sciences did not involve any bloody-fight; for instance, perhaps we can cite Crick's unraveling of the DNA structure as a bloodless coup Many of Kuhn's critics, like Hoyningen-Huene[166], find fault with Kuhn that he does not give any explicit theory of meaning in his *Structure*. Others[167] have tried to present Kuhn's philosophy in broader philosophical angles and evaluate his positions with respect to a large range of philosophical concerns. Moreover, Suppe[168] opines that Kuhn loses his influence in contemporary philosophy of science due to many reasons: such as, Kuhn's modifications and clarifications of his positions seem to exhibit his inclinations towards a sort of neo-positivistic view; the

[163]Hoyningen-Huene, 1992), p. 492
[164] Kuhn, 2000f, in Kuhn 2000a, p 8
[165] Bird, 2000
[166] Hoyningen-Huene, 1993
[167] For example, Horwich, 1993
[168] Suppe, 1977a, p 647-8.

limited role for rationality in his understanding of science, his distinction between normal science and revolutionary science seems to be increasingly becoming more and more untenable; and above all his epistemological and ontological outlook sadly reduces scientific knowledge to nothing more than just a collective beliefs of a given scientific community.

2.2.1.3 Paradigm - Still Problematic

After about 15 years of the publication of *SSR*, Kuhn seems to have realized that the concept of paradigm grew out of his control. He agrees, paradigms were supposed to be held just as exemplary problem solutions, "but they expanded their empire to include, first, the classic books in which these accepted examples initially appeared and, finally, the entire global set of commitments shared by the members of a particular scientific community."[169] All such expansions in the limits of the notion of paradigm led to lots of confusion. To avoid many such misunderstanding of the notion of paradigm, Kuhn proposed the idea of *disciplinary matrix*. But unfortunately, the analysis of such new proposals shows that, though some of the earlier misgivings were solved, many of the puzzles regarding paradigms were left untouched[170]. For instance, Carl Matheson opines that many interpretations of Kuhn's ideas, very divergent at that, are possible, perhaps "because the internal consistency of Kuhn's positions still stands in some doubt"[171]. Kuhn's distinction of normal science and revolutionary science is not so problematic as the description of the transition from one paradigm to another. The way he deciphers the transition projects him to be non-rational, if not irrational! The transition is not something which is rationally deliberately chosen, rather a sort of conversion experience. As Carl Matheson puts it, "the transition between paradigms is best explained sociologically, in terms of institutional might, polemics and perhaps generational replacement" [172].

Kuhn claims that a paradigm is not rejected unless another paradigm is simultaneously accepted by the scientific community. He argues that when a paradigm is rejected it is in fact

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[169] Kuhn, 1977d, in Kuhn 1977b, p xix

[170] For instance, Shapere comes out with a sharp criticism against Kuhn's attempts to solve the problems of 'paradigm'. See: Shapere, 1972, pp 706-709

[171] Matheson , "Historicist Theories of Rationality" In http //plato stanford edu/entreis/rationality-historicist/

[172] *Ibid.*

a decision to accept another.[173] However Mark A. Stone[174] points out that this is not the case; Stone differentiates three types of discoveries: spontaneous, implicit and directed and argues to show that Kuhn's claim may be true for the first two types of discoveries, but not for the directed ones. He shows Kuhn's own example of Copernican Revolution does not subscribe to this claim, because, by Kuhn's own admission, Copernicus has rejected the existing paradigm even without any successor at hand.

Thus the notion of paradigm, the transition between paradigms and the extent of its influence on the respective scientific community are not clear even with the later Kuhn.

2.2.1.4 Theory Choice – Not a Cake-Walk!

Kuhn's insistence upon theory-ladenness of observation and meaning variance thesis had naturally led him to view knowledge as a matter of shared judgment of a given community. In his own words, "I regard scientific knowledge as intrinsically a product of a congeries of specialists' communities"[175]. Because of this many authors[176] accused him of making science a totally irrational enterprise. In the enlarged edition of *Structure*,[177] he tries to soften his doctrine of theory-ladenness of meanings, whereby he maintains that disciplinary matrix is that which determines the meanings of terms in such a way some shared interpretation of some of the terms found in both theories is made possible.

The desiderata of Kuhn, namely, *accuracy, consistency, scope, simplicity, fruitfulness of the theory, etc*,[178], as he himself, as noted earlier, was aware of their limitations and ambiguities, don't also seem to make the theory choice completely smooth and rational. Kuhn's proposal to take the desiderata as shared values did not solve their inadequacies. For, as Paul Hoyningen-Huene puts it:[179]

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[173] Kuhn, 1970a, p. 77 and p. 79
[174] Stone, 1991, pp. 177-85.
[175] Kuhn, 1970b, in Lakatos and Musgrave (ed), 1970a, p 253
[176] For instance, Schefler, 1982; Shapere, 1964a, 1964b and 1972).
[177] Kuhn, 1970a.
[178] Kuhn, 2002, p. 422.
[179] Hoyningen-Huene, 1992, p 493

> Each of these values can be interpreted somewhat differently by different members of the same scientific community. For example, what simplicity means exactly and which aspects of a theory are primarily meant is not uniquely fixed by the commitment of a community to this value... two cognitive values, can, in their application, contradict each other which makes relative weighing necessary. But their relative weight is, again, not determined by the commitment of the community to the list of values.

Hempel too finds the desiderata to be problematic in many ways; for instance, the taste and priorities of scientists vary with regard to the items in the desiderata. So "commitment to those norms does not ensure a uniform decision as to which of two theories outranks the other, by way of satisfying the entire set of desiderata"[180].

Due to this subjective element playing a big role, Kuhn, unfortunately, is accused of making theory choice (scientific enterprise) an irrational enterprise. Therefore, for Kuhn, science is largely shaped by powerful propaganda, personal conversions and the demise of opposing voices. One is not able to see any objective and precise evaluation of the achievements or claims of scientific theories.[181] But Kuhn argues that this is not a weakness for science and one need not remove this; any theory- choice will always be a risk; when the full implications, both positive and negative, are not fully known, it is vital for scientists to give a try; different scientists must try different theories, so this disagreement among them is very significant for the growth of science. The individuals may disagree but **the consensus is based on the collective system of cognitive values**, but finally the 'the community of specialists' ensures the choice of a theory over another. [182] Therefore, for Kuhn, the **question of rationality of theory choice** must be raised in the context of the community, and not in the context of individual scientist. Thus the role of the community is very important in arriving at consensus, especially in modern scientific research.[183]

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[180] Hempel, 1998, p.457
[181] Hoyningen-Huene, 1992, p. 494
[182] Kuhn, 1970a, p 200
[183] In Chapter 5, while discussing my notion of Comprehensive Understanding of Rationality of Science, I take up this consensus of the scientific community, as one of the features of Reasonableness in science I have an elaborate presentation on this showing, for instance, how the community plays a role in deciding what an observation is in modern science.

2.2.1.5 Kuhn – A Rational Relativist!

Kuhn[184] lists and discusses in some detail desirable values for theories, like accuracy, consistency, scope, simplicity, and fruitfulness. The five criteria are at work both at normal and revolutionary periods. These criteria, which are used to evaluate scientific theories and structured lexicons, are constitutive of science and scientific rationality. These criteria enable one to differentiate two paradigms to see which is better. Therefore the **threat of relativism** is removed: "For me, therefore, scientific development is, like biological evolution, unidirectional and irreversible. One scientific theory is not as good as another for doing what scientists normally do. *In that sense I am not a relativist*".[185] He is aware that those criteria may not guarantee full agreement; yet they help for a better judgment of a theory[186].

However, though he claims that he is not a relativist but due to the problems in theory choice relativism is not fully ruled out; at the same breath we need to add that the desiderata and the consensus in the scientific community prevent him to be totally irrational either. Therefore, it is more fitting to see him as ***a rational relativist!***

2.2.2 Feyerabend: An Advocate of Rationality in Science with a Human Face!

Feyerabend is one of the most influential critics of science who made ripples in both the scientific and humanist circles. In this section I devote some time to see how he is kept at the extremes, by his critics, of high appreciation or depreciation. Then I asses his challenging claim that there is no methodology in science.

2.2.2.1 Mixed Reactions over Feyerabend's Contributions

Feyerabend anticipated strong reactions for his thought-provoking work, *Against Method* (*AM*), from different quarters. He, in fact, was criticized as cheating people, misapprehending Galileo, making false assurances and even making himself stupid in the

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[184] Kuhn, 1970a, p. 158, 199, 262, Kuhn 1977e, in Kuhn 1977b, 321-2
[185] Kuhn, 1970a, p. 264. Stress mine
[186] Kuhn, 2000f, in Kuhn 2000a, p. 105

eyes of the intellectuals. He himself was aware of some inadequacies of that book. In his own words, "*Against Method* is not a book, it is a collage. It contains descriptions, analyses, arguments that I have published, in almost the same words, ten, fifteen, even twenty years earlier"[187]. As he expected there were strong, but mixed, reactions over his ideas.

Gonzalo Mune'var gladly declares that Feyerabend is the most important thinker of the 20th century, especially as humanity seems to look back to evaluate all that has gone in that century. In introducing the volume on *Beyond Reason*, Mune'var says that for some Feyerabend is a clown and for the others a great philosopher; but he is "decidedly of the second opinion that is becoming general around the world as this century comes to an end and history begins to cast its appraising eye upon the intellectual harvest of our era".[188] Science can no more be treated as a body of rational disembodied knowledge. That is why, a decade back, Elzinga and others strongly realized that "in the future, graduate programmes as well as undergraduate curricula will have to devote more time to ethical topics, and also to enlighten the students on the ways that political interest intervenes into science"[189]. The gender issues in science, the concerns of the environment, the apprehensions involved in biogenetic technologies and many other such domains highlight the moral responsibilities of scientists as social agents, who are supposed to be accountable, not only for the present but also the future generations! All these elements were clearly and powerfully brought out by Feyerabend even in 1970s.[190]

Some, on the other hand, are very tough in attacking Feyerabend to call him a childish thinker, who is not serious about his own claims. For instance Herbert Schnädelbach thinks Feyerabend is a playful man; he quotes Feyerabend to have diluted the claim about 'Anything goes', as it was never meant to be a principle, but only "a somewhat joking portrayal of the situation of the rationalist who wishes to have universal principles but who

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[187] Feyerabend 1995, p 139 He, in fact, regretted greatly for having written that book He even thought that he had been sick when he wrote the book His personal life was in a very bad shape That book made him totally defenceless (p.147)

[188] Mune'var (ed.), 1991, p. ix In fact it is a very good collection of 25 essays on Feyerabend's contributions, it ranges from glorifying him as a rarest of the rare thinkers of the 20th century and accusing him to be the most dangerous man of humanity For example, Vine Deloria, in "Perceptions and Maturity: Reflections on Feyerabend's Point of View", acclaims that Feyerabend reveres all the peoples of the globe with dignity Whereas on the other hand Jospeh Agassi, in "As You Like It", goes even to make a scathing personal attack on him accusing him of supporting the Nazi ideology

[189] Elzinga, et al., (eds), 1990, p 9 As quoted in S Richard Jennings, 1992

[190] Feyerabend, 1978

has to increasingly empty them of all contents when faced by the material I offer. 'Anything goes' is all that remains".[191] Feyerabend is projected to be a staunch proponent of irrationality in science, or at least he is made to declare that science is not guided by any rational element but power, propaganda, prejudice.

2.2.2.2 Feyerabend in a New Light!

Now there are efforts among the scholars to remove the erroneous understanding about Feyerabend, by reconstructing his arguments to show that Feyerabend (at least the later one!) is not against rationality in science. He argues for rationality in science based on certain values. Robert Farrell is one among such sympathizers of Feyerabend, who try to show that Feyerabend's rationality is to have a fine balance among the competing (even incompatible!) methodological demands. He projects Feyerabend to have a 'tightrope-walking rationality'. For, **though Feyerabend denied any universal 'rules' of rationality yet he recognized temporal values that are universal, like comprehensiveness, empirical accuracy, fruitfulness and testability**. Therefore, Farrell argues: "The ultimate practical necessity of rationality is to attempt to balance the irreconcilable demands of the values of rationality, hence the title: *Tightrope-Walking Rationality*"[192]. Further, Rationality involves something more than mere adherence to rules; rationality is often identified by a rationalist with always acting in compatibility with certain strict rules and regulations. But Herbert Schnädelbach wonders that if 'adhering to strict rules' is what makes one rational, then computers, trained bats, and even washing machines cannot be excluded from being rational[193].

Feyerabend is against only the strict traditional understanding of rationality; in a strict rationalist point of view, science must fulfil at least one of these three theses[194]: the logical thesis, the factual-foundational thesis and the methodological thesis. These theses would not

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[191] Feyerabend, *Erkenntnis fur freie Menschen* (Suhrkamp: Frankfurt, 1979), p. 87. As quoted by Herbert Schnädelbach, 1991, p. 434.
[192] Farrell, 2003, p. 3.
[193] Schnädelbach, 1991, p. 435
[194] Logical thesis claims that all our thinking must conform to logic in providing the structure of our knowledge; the factual-foundational thesis demands that there are indubitable sources of our knowledge and they exist; and the methodological thesis maintains that a scientific research must be performed according to the rules of an unchanging scientific method.

allow any room for subjective or rhetorical elements (like judgement, emotions, intuitions, reasonableness etc.) in scientific progress, as these would be considered 'irrational'. But Feyerabend's notion of scientific progress does have room for all these elements. Nevertheless science can still (and still) be rational. He was always trying to show that rationalism would have to be rejected by its own standards

2.2.2.3 Science Needs a Sort of Metaphysics

It is encouraging to see Feyerabend not ruling out metaphysics outright as meaningless. His understanding of empiricism, which attacks the traditional inconsistency condition and meaning invariance condition, does make room for metaphysics and ideologies. He makes it clear not only that our observational claims involve non-observational background elements but also no part of observations is free from it. As Newton-smith has it, " .. it is not that our observational judgments may have an ideological component, our observational judgments have no components that are not ideological"[195]. Therefore, Feyerabend is very well aware that without some metaphysical elements science would not be what it is today. In his framework of empiricism, we have a different understanding of metaphysics. Metaphysical systems can be looked as scientific theories in the making. Metaphysics, as an alternative, is desirable for a better criticism. If a metaphysical claim goes against a well-established scientific claim, the former can be taken as a new criticism of the given scientific claim. Alternative claims are very important for the purpose of criticism[196] Therefore, if whole of metaphysics is mercilessly ruled out it is very likely that the scientific theories themselves may transform into dogmas. It is not enough that an empiricist checks the knowledge claims only on the basis of observational evidence, rather she has to create many alternative theories, including metaphysical ones, to evaluate the original theory. So in short, "*a good empiricist must be a critical metaphysician*"[197].

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[195] Newton-Smith, 1996, p. 139
[196] Feyerabend, 1998b, in Curd and J A Cover (eds), 1998, p 942
[197] *Ibid* , p.944; emphasis mine.

2.2.2.4 Does / Can *Anything* Really Go?

Feyerabend seems to be doing the mistake of throwing the baby with the bath water! Yes, no fool-proof certainty is available with science and no universally accepted ahistorical single methodology is to be applied, but that does not certainly imply *anything goes*! One might even see a sort of rashness in jumping to a conclusion that anything goes! The failure of the inductive methodology and that of even of Popper's deductive methodology seem to have made him largely disheartened. He is in search of a method or a set of rules without any exception, but because he is not able to come across one, he turns out to be highly sceptical to declare 'any thing goes!' He is angry with the society which gives undue importance to science and makes science 'everything' for the society. So as a reaction to such a society he goes to the extent of denying any rationality to science at all.

No moderate rationalist would deny that some methodological rules have failed at some time or the other. We are not omniscient. We don't have any direct access to truths of reality other than the tools that are available with us. We need to somehow judge the achievements of science by the comparison of rules and methods available at hand. A historical analysis may find fault with one particular methodological rule but that does not justify denouncing all the rules. A historical investigation of science may "take up a single plank of the ship of methodology while the rest remain, for the moment at least firmly in place. An attack on a particular aspect of method presupposes method"[198].

2.2.2.5 No Methodology, No Rationality?

It is quite common among philosophers to think that scientific methodologies are theories of scientific rationality; for example, we can cite Lakatos, Musgrave, Worrall and so on[199]. Methodology is identified with rationality. Therefore one tends to impose one's understanding of methodology to evaluate the rationality of the past. But Curtis cautions that a historian must not use one's own modern methodology to evaluate the rationality of the

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[198] Newton-Smith, 1996, p. 134

[199] For instance, Kulka thinks that for Lakatos, methodology provides a rationality theory (See. Kulka, 1977, 325-43); Musgrave argues that various methodologies provide cannons of rationality (See Musgrave, 1976, pp. 181-208); and in Worrall's understanding a methodology has a direct relevance upon rationality or irrationality (See: Worrall, 1976, 107-79)

research programmes of the scientists of the past.. One needs to consider the scientists of the yester years in their own intellectual milieu. The methodology that the present historian arrives at now is the product of the intellectual contribution of the long generations of the bygone era. He makes an elaborate study on Darwin's understanding of methodology and rationality and concludes that we can consider the overthrow of creationism by Darwin and his "overthrow of the requirement for proven causes itself" as rational, "only if we decline to use our own methodologies by which we appraise the rationality and correctness of the revolution as a whole. We can see this only if we take into account the rationally changing methodologies of the participants themselves".[200]

Those who argue against any universal methodology in science, as Polanyi, Quine, Hesse, Kuhn, Wittgenstein and so on, put forward two sorts of arguments; *either* the principles of (non-universal) methodologies thoroughly underdetermine theory choice, and thus making the principle impotent; or they are so indistinct and confusing that they permit anything and every thing.[201] Similarly, Feyerabend also claims that very important scientists have produced very important theories by violating the well-cherished rules of their times. True, no one claims that all scientists are rational at all the times in all the matters. But only a few that too the trend-setters of modern science fit Feyerabend's description; as Laudan says, "It is not scientific charlatans he is describing; rather... the figures he is writing about have always been considered as the folk heroes of our scientific culture" [202], like Kepler, Copernicus, Galileo and Einstein who come across as persistent 'cheaters' in the game of science, as they always seem to go counter-inductively, just not bothering about even the glaring falsifying evidence. It is true, they all went against, or even modern progress would not have been possible had not they done so, but to make this exception a rule, that science always progresses, or has to progress this way, is a bit too much.

Further, some authors strongly feel that the historical case studies that Feyerabend undertakes are not historically accurate[203]. Even if one assumes that they all be true, still Laudan is convinced that Feyerabendian conclusions can't be justified. A serious study into his conclusions will easily reveal his confusions over the nature of methodological rules.

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[200] Curtis, 1986, p. 158.
[201] Laudan, 1989, p. 299.
[202] *Ibid*, p. 302.
[203] For example, see: Machamer, 1973), and McEvoy, 1975

Laudan proceeds further to analyse the situation: A legitimate methodological rule is that which optimizes the opportunities of achieving some cognitive aims. Therefore it can be criticized on two grounds; either **a)** a rule chronically fails to promote a certain goal, or **b)** it is less efficient than other rules. All that Feyerabend case studies show is that certain scientists at certain times promote the goals of science though they violated the given rules[204]. Further, a methodological rule is proposed to obtain a particular end.

Sometimes it may happen that the end is achieved by violating the rule. Laudan clarifies that when scientists support a given rule they are in no way claiming that all sciences must follow only that rule in all their endeavours, rather they are convinced that that rule ensures the achievement of goals than the violation of it[205]. In such violations we can only say that said rule is not the best for the desired end; or that rule may never work out to get the intended end. Only from a few successful rule-breaking events by a few scientists no universal conclusion can be drawn against methodology itself. Laudan wonders that Feyerabend's position is like that of some one decrying any treatment for cancer, just because a few cases of cancer spontaneously got cured without any medications. He raises a very strong objection to Feyerabend: "To move from the alleged failure of two of three methodological rules to the presumption that all methodologies are hopeless is *to engage in just that sort of naïve inductivism about which he is otherwise so abusive*" [206]

Feyerabend not only claims that great scientists have broken the well-accepted rules and methods to develop science and behaved in a way what modern philosophers would call irrational, but also that the rules ***had to be broken*** to attain scientific progress. Powerful scientists make up their own rules and standards as they proceed; it is because there is no over-arching rules about how to compare and evaluate scientific theories; so much so that scientists progress well "because they did not permit themselves to be bound by 'laws of reason', 'standards of rationality', or 'immutable laws of nature'".[207] Granted, the prevalent methods may be faulty; they may not be efficient; and one method may not be answering the questions of different disciplines. But science is always in need of new methods and not abolition of all methods. For as Herbert Schnädelbach explains science does need a method

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[204] Laudan, 1989, p. 303
[205] *Ibid.*, p. 304.
[206] *Ibid.*, p. 305 & 306. Emphasis mine.
[207] Feyerabend, 1975, 190-191.

to subject it to the members of the free society; just because a few philosophers have the illusion that methodologies can be demolished one can't decry the methods permanently.[208]

2.2.2.6 Science – Not a Custodian of Rationality

In the normal parlance *science* is seen as the epitome of rationality, because science uses a special and unique methodology: therefore, to be scientific or to be an expert is to be rational. If any one comes out with a theory or a kind of new invention or a discovery, it is expected to look for its scientific basis. That is why, nowadays every discipline likes to claim its statements or principles are scientific in order to make it more acceptable to the people. The scientific character of the traditional natural sciences, like Physics and Chemistry, is appropriated not only by the Study of Politics and Society, but also by the Study of Historical Materialism, Administration and Library and the like; that is why today we also have, as C. Trusedell lists out, "Library Science, Administrative Science, Speech Science, Forest Science, Dairy Science, Meat and Animal Science, and even Mortuary Science"[209].

But such a received view of science and its methodology are being questioned in the recent decades. Still many top level scientists are convinced that they, as scientists, are the custodians of rationality. Daniel P. Moloney points out, "Stephen Jay Gould, Richard Dawkins, E. O. Wilson, Stephen Pinker, Daniel Dennett - all these have, in recent years, tried to leverage their credentials as scientists into positions as guardians of public rationality"[210] and since science is close to answering all questions, if any one is anti-science, she will be branded outright as 'irrational'.

Feyerabend's caution against absolutizing rationality is appreciable and meaningful. It is true and correct that scientists are not that rational and objective as the popular picture of

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[208] Schnädelbach, 1991, p. 438
[209] As quoted by Chalmers, 1992, p xvi
85. Moloney, "Questioning Everything?", in http.//www leaderu com/ftissus/ft9811/opinion/moloney.html
86 *Ibid.*
87. *Ibid.*
88. Feyerabend, 1975, p. 295.

science makes us believe. We need to realize that the 'questioning-everything' attitude is not always at work in the scientific enterprise. It is not true to say that science arrives at every theory or inference through a process of scepticism. So, if one thinks that a scientific theory must be without any Cartesian scepticism and there must not be any logically possible alternative, "then there might not be a single meaningful scientific conclusion that we can call rational"[211]. Scientists do act upon many assumptions and suppositions, which cannot be put into a scrutiny of Cartesian methodological scepticism. Nevertheless this in no way makes science and scientists irrational, rather it only teaches us that logical certainty is not possible in scientific enterprise. Scientists also make as many assumptions, if not more, as any one else. Their assumptions often do go wrong, "especially when, like Feynman, they assume they know more than they do".[212]

Feyerabend maintains that the scientific activities are so varied that no common rules can be abstracted. The theories are so incommensurable that the preference of one theory over another is only a question of subjective ideologies and personal orientation. As long as the *accepting and rejecting of ideologies should be left to the individual*[213] it totally depends on one's ideology and not on any rational basis. He seems to accept that inconsistency can be one of the criteria to objectively decide that a theory is deficient. Therefore at least there is one factor which is not bound by one's ideology. However he does not have any problem with inconsistency, as inconsistent theories have brought progress in many cases. But Newton-Smith objects that "the fact that inconsistent theories have brought progress is not reason to revise logic by dropping the law of non-contradiction. Inconsistent theories have brought progress through their development into consistent theories"[214]

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[214] Newton-Smith, 1996, p. 128

2.2.2.7 Need for a 'Method' to attack Methods!

One cannot afford to deny the role of reason or method completely, neither in practical life, nor in science. Feyerabend is right in opposing scientism; but he goes to the extent of denying any dint of rationality in science. He says, "...those who admire science and are also slaves of reason. They have now to make a choice. They can keep science; they can keep reason; they cannot keep both".[215] Thus, unfortunately he places science as something opposed to reason. A reasonable rationalist would allow a certain degree of incommensurability between two theories, belonging to two different paradigms. True, comparison between two rival theories may sometimes be logically impossible. Further, to a certain extent a scientist is influenced in theory choice by the elements, which Feyerabend has mentioned, and some other external factors like desire for name and fame, the financial aids for the given research. But, as Chalmers points out, one need not think that this would make science opposed to rational arguments. For, by checking in terms of serious inconsistencies or by showing some consequences that the individual scientist may detest we can have a rational backing for the particular theory choice[216]

Again, methodological pluralism does not imply the absence of rules and norms in science. Rather, it implies that there are different sets of rules for different sciences. The methodological monists seem to have been misled by the examples taken only from physics of the last few centuries. Actually it is not even conceivable that the physicists, neurophysiologists, geologists and astronomers use the same method(s) in their respective investigations. But radical rationalists are reluctant to agree with this fact, for methodological monism is the bedrock for them. For them, perhaps as they give undue importance to the view of methodological monism, if there is no fixed methodology there is no guarantee for a rational process in science: "If no principles of evaluation are fixed, there is no 'objective view-point' from which we can show that progress has occurred and we can say only that progress has occurred *relative to the standards that we happen to accept now*"[217]. Reasonable rationalists will surely make room for the fact that the methodological rules need not be absolutely immune to changes.

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[215] Feyerabend, 1978, p 16.
[216] Chalmers, 1992, p. 138
[217] Worral, 1988, p.274

2.2.2.8 Rationality in Science – but with a Human Face

One cannot afford to ignore science or reason; we need traditions as a spring board for diving deeper, or soaring higher into the explorations of reality. Newton seems to have said, 'Only when I stand on the shoulders on the giants of the past, I am able to see farther'. As Herbert Schnädelbach explains that it is reasonable to follow the traditions and we constantly ask ourselves in each and every case whether it is rational to follow them. At no stage humanity can afford to ignore reason, nor science, and much less reason in science. However limited and problematic the rational approach may be in facing our life-problems, humanity does not have any other better way of proceeding.[218] Nevertheless, this rational or scientific approach needs to be enriched by human and social factors of life.

Due to an undue admiration for science the society mistakenly concentrates only upon the scientific developments investing lots of time and energy, money and human power. We need to concentrate on the totality of human welfare. The State has to focus first on the making safe drinking water, sanitation, employment and other basic facilities available for all its citizens. This demands at least as equal, if not more, attention as science gets. Any one who is genuinely interested in the total welfare of humanity will certainly demand that the State puts all humans *right* on the earth first, before it plans to put a man *right* there in the moon. Clarity in priority is required. At the global scenario thousands of times more money is spent for weaponry than for peaceful and holistic development projects. Realizing all these Feyerabend demanded for liberation of the society from science.

Feyerabend, till his end, voiced out throughout his life his deep concerns for humanity and liberty, in all the realms like politics, science and intellectual pursuits. That is why, in spite of all his great contributions in the intellectual world, finally he wanted the world to remember him basically as a simple and ordinary human being, who values love the most. A couple of weeks before he breathed his last on 11 February, 1994, he wrote in his touching autobiography: "My concern is that after my departure something remains of me, *not* papers, *not* final philosophical declarations, but love... That is what I would like to happen, not

[218] Schnädelbach, 1991, p. 446

intellectual survival but the survival of love"[219]. Considering the whole analysis and the last words of his life, one can, in my opinion, get the picture of Feyerabend as someone who is certainly for rationality in science, but not at the cost of humanity.[220]

Now I move on to consider the salient features of Dudley Shapere in **Chapter 3.**

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[219] Feyerabend, 1995, p 181

[220] In Chapter 5, when I evolve my account of rationality in science, I argue for the need for some of the human elements, like judgment, role of the agent, common sense etc., which would make science reasonable, if not rational.

CHAPTER 3

SHAPERE – A CONTINGENT INTERACTIONAL EMPIRICIST

3.0 Introduction

Among the contemporary philosophers of science, I choose the ideas of Dudley Shapere to be dealt with in detail. It is because I think his ideas of science and philosophy of science sound very enlightening and well founded. In my opinion, Shapere succeeds to a very large extent in demonstrating that science is neither divine, implying that it is not beyond corrections and changes, nor too shallow, to allow anything to go, in an irrational way, being led by the forces of mob-psychology. His position frees the human thought process from the unconscious compulsion of having *a priori* absolutes. At the same time, it would not lead to relativism or skepticism. His treatment of the notion of background information in science and the detailed study of neutrino experiments have helped me in understanding the issue at hand.

Therefore, after providing a brief look at the most important theories of rationality in science of the 20th century, I now devote this chapter to delve into Shapere's contributions. This chapter has two sections: ***Section A*** deals with Shapere's critiques of the major trends of the 20th century; namely Logical Positivism and Karl Popper, in what he calls 'the Classical Era', and Kuhn and Feyerabend in 'the Post-Classical Era' In ***Section B***, I look into some major aspects (that are relevant to our purpose) of his contribution to philosophy of science.

Shapere's contribution is quite vast. His important ideas like methodology, observation, meaning and incommensurability in science, the notions of domain, goal, success and the absence of specific doubt in science, the role of 'given' in experiments, his idea of reality, truth and knowledge etc. – all seem to be a well-connected web, as though they are different nodes in fishing net. I intend to focus only on the ideas that are directly relevant to my purpose: his understanding of background information, the notion of observation as a concept schema and the idea of reason in science. At the end, I shall show how he projects

himself to be ***a contingent interactional empiricist*** and in the next Chapter I shall assess his views.

3.1 SHAPERE'S CRITIQUE OF 20TH CENTURY'S THEORIES OF RATIONALITY IN SCIENCE

3.1.1 Critique of Scientific Theories of the 20th Century – Classical Era

Shapere considers the first half of the 20th century as the Classical Era of the 20th century. Now I spell out his critiques of Logical Positivism and Karl Popper.

3.1.1.1 Against Logical Positivism's Observation-Theory (O-T) Distinction

Shapere does recognize the constructive contributions of Logical Positivism. For instance, it has raised, he acknowledges, many problems regarding the interpretation of science; the answers to those problems may not be perfect, but gave considerable insight and illumination to the problem. However he criticizes the logical positivists from various angles.[221] Here I take up one of the important criticisms, namely the criticism against the Positivists' famous *Observation-Theory (O-T) distinction.*

Logical Positivism attempted to show science to be the most objective enterprise, as it is based on pure, unadulterated observation and verifying (or falsifying) experiments. However, by 1950s, this view had to be rejected and it was realized that there was no brute, undeniable 'given' at the bottom of observational facts. It was also realized that observations, contrary to the popular expectations, were theory-infected. Shapere argues that in science even observation terms are not theory-free. In science things are not always as simple as the claim 'cat-is-on-the-mat'; it is also not simply a presentation of sense data or

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[221] Shapere's another major criticism against Logical Positivism is about their *logical orientation in understanding science* They misconceived the scientific enterprise in a very fundamental way. They saw philosophy of science as logic of science and therefore philosophy of science was supposed to be concerned only with the logical form and not with the contents of science They were blind to the central 'nature' of science. They actually diverted from the original aim of the Vienna Circle, that is, to examine closely the then radically new scientific developments in areas like relativity and quantum theories [For more details on this, see: "Logic and the Philosophical Interpretation of Science," in Weingartner (ed), 2004, 41-54, "Post-Positivistic Interpretation of Science, I, 102-119; and "Post-Positivistic Interpretation of Science, II, 352-382", in *Reason and the Search for Knowledge,* 1984a)

phenomenalisitic analysis of observation; and it is not just an investigation of pointer-readings or graphs. Science involves a great deal of interpretation even in the so-called simple observations. Theory-ladeness affects the relevance of observation, what counts as observation and the very interpretation and meaning of observation terms Therefore, "All 'observation terms' in science are, in this view, at least to some extent 'theory dependent' or 'theory laden' ... Data are not 'raw'; there are no 'brute facts'"[222]. Shapere explicates this notion of theory-ladenness further in the context of neutrino experiment, as we shall see in the next section.

Given the complex nature of modern science, Shapere proposes yet another sort of distinction to meaningfully speak about the existence and the interpretation of theoretical concepts, which reflects the actual practice of modern physics clearly. In scientific reasoning often situations demand that scientists make a distinction, what Shapere calls, between two types of concepts: existence concepts (or terms) and idealization concepts (or terms). This distinction is necessitated to deal with certain types of problems at hand. Of course it is not that all concepts in physics come under these two categories. Some entities are thought to 'exist' though there are no compelling reasons to think so. Shapere elaborates the 'idealization concepts' with some examples[223]; I would like to focus on one such example, the 'notion of electron'.

Lorentz theory of electron claims that electron cannot be a geometrical point with no radius. It must have some radius. For treating it as 'a point particle' with no radius creates some serious problems. For, the electrostatic energy of a charged sphere of radius 'r' and charge 'e', is e^2/r. If $r = 0$, energy will be infinite; and if we apply it to $E=MC^2$, then the rest mass will be infinite. But the electron does not have any of these infinities. However, for certain purposes and problems it is more convenient and simpler to treat electron as a point particle. The theory of relativity requires that electrons have a zero radius, while Lorentz's theory denied that idea. Lorentz's concept of non-zero radius for electrons had also a problem – how is that the electron is kept at equilibrium without constituent parts of this negative

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[222] Shapere, 1984b, in 1984a, p. 106.
[223] Shapere, 1984c, in 1984a, pp 352-365 Another example he discusses here is the notion of 'rigid body', both in the classical and post-classical periods of science.

charge repelling one another? For this Poincare[224] proposed a mysterious power; he introduced cohesive forces (which are not electromagnetic in nature) that counterbalance the coloumb negative repulsive forces of the electron on itself and maintain the equilibrium. Such inconsistency between the theory of relativity and the classical electrodynamics is not merely due to idealization or characteristic of 'formal structure' of the system; but it shows the inadequacy of any theory as an account of nature. The distinction made between idealization and the way the things really are, is made on scientific grounds, and it has a definite use in physics. Whether science treats electron as dimensionless point or as a particle, it is all for some genuine scientific reasons. Thus though an electron in reality cannot be a dimensionless point, yet it is convenient to treat it, for genuine scientific reasons, as if it had no dimension. As Panofsky and Phillips note, "The idealizations of real charges as points, lines, and surfaces not only permit great mathematical simplicity, they also give rise to convenient physical concepts for the description and representing of actual fields"[225].

Shapere further analyses what it means for an entity to exist in physics. A distinction is made in science between the way in which an entity can/not exist and the way in which it is convenient to 'idealize' that entity. For instance, the notion of Electron as a point-particle is physically impossible, but in certain cases it is assumed to be so. Certain entities can be said to be existing or non-existing or probably existing. What is important here is not the 'terms' used, but their 'uses'. The context of uses will tell us that the terms used here refer to idealization, and not directly to electron itself; some purported entities (at some time claimed to have existed), but do not exist now (like ether, phlogiston); some entities whose existence is claimed by good theorists, but not yet established (quarks); there are even borderline cases. All these point out "the fact that it is not terminology of 'entities', 'idealizations' etc., which is important; what is important is the logic of the scientific usage of the terms so classified" and the entity terms need to be understood in terms of convenience of employment, "in order to call attention to certain features of the cases discussed".[226]

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[224] Poincaré, "Sur la dynamique de l'électron," *Rend Palermo*, 21 (1906) 129 As quoted by Pauli, 1958, pp. 184-6.
[225] As quoted by Shapere, 1984c, in 1984a, p. 358
[226] Shapere, 1984c, in 1984a, p. 367.

The relations between 'entities' and 'idealizations' are very important. The entities involved may be held not to exist, not because their existence would conflict with some theoretical concepts, but it may be because that such entities are not found (e.g. Vulcan, fifth force of nature), or their existence is abandoned (e.g. ether). However some entities, which were once abandoned, may still have some utility value (e.g. particle theory of light was abandoned in 19th century, but even today it is used in ray optics under certain circumstances). Over the years, it is possible for entities to have a shift in their status, from 'entity terms' to 'idealization terms'. Such shifts are normal precisely because the treatment of these entities as 'entity terms' or 'idealization terms' depends on actual physical grounds, rather than logical, or metaphysical, or linguistic ones.[227] All these considerations so far about the existence / properties are not in a metaphysical sense; rather it is very much within scientific realms. Thus Shapere has shown the serious difficulties with the O-T distinction of Logical Positivism in the context of modern science.

3.1.1.2 Popper's Notion of Background Knowledge – Too Temporary and Alarmingly Broad!

Shapere argues that Popper did not give a clear and systematic presentation of background knowledge and its functions, though he gave a few examples of such functions. Here the intuition is that such background knowledge is already well-accepted and it is therefore easy to choose or reject a proposition on the basis of such background knowledge. Popper always attributes only a temporary character to the background knowledge; he says, it is "for the time being," "for the discussion of this particular problem" [228] and so on. He goes on to make it clear that a fallibilist "does not accept this background knowledge; neither as established nor as fairly certain, nor yet as probable. He knows that even its tentative acceptance is risky, and stresses that every bit of it is open to criticism, even though only in a piecemeal way."[229] It sounds too temporary to be taken as knowledge. Besides, he

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[227] Shapere further elaborates on the implications in Physics when we assert that 'A exists' It implies that other existing particles can interact with A, and A can affect and be affected by them, It implies that it has some properties that have not been discovered yet, that what we consider as fundamental properties may not be really so fundamental or vice versa, or (though rare) we may be wrong in thinking that the entity has the property at all; and It implies that it has some properties that have not been discovered yet, that what we consider as fundamental properties may not be really so fundamental or vice versa, or (though rare) we may be wrong in thinking that the entity has the property at all [See Shapere, 1984c, in 1984a, p 370-372]

[228] Popper, 1962, p 239.

[229] *Ibid*, p. 238.

conceives background knowledge to be consisting of also 'myths'[230] and 'common sense'[231]. This implies that it is alarmingly wide so that anything can be used as background knowledge, and there is no reason to consider any particular belief better than other beliefs in the background knowledge.

Shapere further points out that Popper never seemed to have recognized that "many of our scientific beliefs about the universe have come to be accepted more securely than that, at least until we have found specific reason to doubt and reject them"[232]. He further argues that if what Popper says is correct, then how is that a piece of background knowledge is used again and again? The position of the background knowledge is not as temporal and tentative as Popper thinks; it is more lasting and secure than he conceives it of. If so tentative, why does he call it knowledge at all? It cannot be used in the pursuit of further knowledge, nor as guiding reasons for carrying further the work of science, and for more practical purpose. If that is the status of the background knowledge, Shapere wonders, why to take such background knowledge very seriously and why it is accepted in a more lasting and reliable sense and not just tentatively. Popper seems to have no answer for this.

3.1.2 Post-Classical Philosophers of Science of the 20th Century

In the post-classical era, starting roughly from late 1960's, the trends in philosophy of science did recognize the need for background knowledge in science. They took the role of background information in science very seriously; they all held that some kind of presupposition or background information to be playing a big role in understanding the problem at hand, to interpret facts, even to determine what 'facts' are at all in science. Without all these background support, they claim, scientific theories are hardly meaningful.

Shapere[233] recognizes three common theses among all of the post-classical philosophers: a) ***A presupposition theory of meaning*** – meaning of all scientific terms are determined by theory / paradigm / ideal natural order in which we find them. Therefore, they are against the distinctions drawn, according to Received View between Observation-Theory and meaningfulness and meaninglessness; b) ***A presupposition theory of problems***, which helps

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[230] Popper, 1972, p. 181.
[231] *Ibid.*, p 33.
[232] Shapere, 1999.
[233] Shapere, 1984d, in 1984a, p. 66-67

define the domain of scientific inquiry, and decide what can be a scientific explanation in answer to the problem; and c) ***A presupposition theory of the relevance of facts to theory, of the degree of relevance and generally of the relative acceptability of different scientific conclusions.*** Let us consider his critiques of the two major philosophers of science in this era: i) Thomas Kuhn and ii) Paul Feyerabend

3.1.2.1 Thomas S. Kuhn

I focus on two important critiques of Shapere against Kuhn, namely, i) the Paradigm and Background Information and ii) Denial of O-T distinction leading to Incommensurability.

3.1.2.1.1 The Revised Notion of Paradigms – Still Problematic

Shapere was one of the early critiques[234] of Kuhn when the *Structure* was published. Shapere did not accept the idea of an 'absolutistic and monolithic view of paradigms'. For, an absolutised view of paradigm naturally leads into strong relativism, "in which not only substantive theories, but also what count as reasons, legitimate theories, explanations, and even the meaning of words, could differ in an 'incommensurable' way from what counts so in another paradigm-tradition"[235]. Further, it becomes impossible to speak about the progress of science in the context of totally compartmentalized paradigms; and since there are no 'paradigm transcendent' elements, how to judge two paradigms and how to rationally choose one over the other – and therefore how to understand even the very notion 'progress'? It becomes impossible to see whether a theory has any advance of the over the theory of the past. [236].

Correcting some misunderstanding and removing ambiguities over the notion of paradigm, Kuhn attempted at a modified picture of paradigm in the second edition of *Structures*[237]. In its *postscript* he tried to answer these objections by proposing an analysis of 'disciplinary matrix', with four components, namely, 'symbolic generalizations', metaphysical paradigms', 'values', and 'exemplars'. Earlier he had focused on the unity of the community

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[234] Shapere, 1964b.
[235] Shapere, 2004, p 46.
[236] Shapere, 2001a, in Hoyningen-Huene and H Sankey (eds), 2001, p 193
[237] Kuhn, 1970.

or paradigm; but now on the diversities of a paradigm. Yet he insists upon 'unity', a sociological one (not monolithic internal or intellectual, as treated in the previous one), whose members might disagree on what are appropriate 'symbolic generalizations' and so on. In fact, thus he encounters an 'essential tension' between the fundamental unity - a thread of intellectual unity - among scientific traditions / communities *and* healthy diversities among the members. Modern science teaches us that background information consists, not only of various types of theories, narrow or broad, playing different kinds of roles, but also specific facts and practical knowledge.[238] But Shapere points out that there are many exemplars to be followed; science has to rely on a combination of diverse background theories; there might emerge some types of classification of background information and their functions, even some thread of unity... but tracing out that kind of unity need not be the aim of philosophy of science. Further, the search for such unity, which does not exist, is not only unnecessary but also a distraction from the efforts of understanding what real science is and how to build on what we already know.

Further, Kuhn's explanation of disciplinary matrix (the four components mentioned above) does not clearly capture the actual variety of components of actual science. It is not enough to fit in or squeeze in various aspects of background information into the above mentioned four components. For example, in the neutrino experiment – how to clean the tank-fluid that captures neutrinos? Why to bury the experiment to avoid contamination by cosmic muon decays? – Where to classify all these information under those four components? Thus, "Background information is too diverse, applied too many ways, for too many purposes, for a simplistic classification into four fundamental types to be truly illuminating"[239].

3.1.2.1.2 Denial of O-T Distinction Leading to Incommensurability

The notion of incommensurability is common to both Kuhn[240] and Feyerabend[241] as both are staunch proponents of the view of theory-ladenness. There cannot be clear-cut distinction between observation terms and theoretical terms. The meanings of the observation terms are fully contextual. The terms in a theory don't have meaning in isolation. While logical

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[238] Shapere, 2001a, in Hoyningen-Huene and H Sankey (eds.), 2001, p.196.
[239] Shapere, 2001a, in Hoyningen-Huene and H Sankey (eds), 2001, p 195
[240] Khun, 1970
[241] See: Feyerabend, 1965.

positivism has been advocating that only observation sentences are meaningful and all theories are meaningful only in as much as they rely on observational sentences for their interpretation, Kuhn and Feyerabend claim just the contrary – observational statements have to depend on theories to be meaningful, and therefore it is the observation sentences that are in need of interpretation and not the theory.

However, with the denial of the O-T distinction even the fundamental theories were rendered to be incommensurable. Because of no observational vocabulary independent of theory and no common element among theories, and above all due to the theory-ladenness of observation, the issue of comparability becomes very crucial. Problem of relativism thus emerges very powerfully. This makes the whole of scientific enterprise to be non-objective, non-progressive and relative to background information and therefore, immune to rational criticism. While the logical positivists insist upon the independence of observational terms from any theoretical influence, these relativists argue that the meaning of observational term is permeated by the theoretical context and is relevant to the theory in question. Thus both stand at the extremes.

3.1.2.2 Paul Feyerabend

Among other criticisms of Shapere against Feyerabend, I highlight only two important ones: Problems with Feyerabend's denial of two basic theories of contemporary philosophical empiricism and the problems with his notion of incommensurability and theory choice.

3.1.2.2.1 Problems with the Denial of Consistency and Meaning Invariance Conditions

Feyerabend[242] focuses on two important conditions, which are said to be the corner stones of contemporary philosophical empiricism, ***the consistency condition and the condition of meaning invariance***. He denies both of them and argues for inconsistency of scientific theories with one another and contextual dependence of meaning of scientific theories, including the so-called observational terms. In fact the meaning of observation terms depends on the theoretical terms and not the other way about. Shapere challenges that if both

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[242] *Ibid.*

these conditions are denied one would be led to relativism; a certain amount of consistency and meaning invariance (in a qualified sense) are necessary to see science as a rational enterprise. For, how is it possible to reject both these conditions? For if two theories are to contradict each other one must be the denial of the other; this contradiction demands that theories must have some common ground of comparison. Even the theories that are seemingly very different have some common elements; for instance, geological theories and physical theories of waves and their transmission – how earthquake waves are transmitted through different kinds of material is a common element for both the theories. One may argue that this comes as a part of the background information, and then the same old problem arises, 'what is a part of theory?' It is still persisting.

Further, Feyerabend claims that even a slightest change in the theoretical context will change the meaning of every term. Does every change result in a change of meaning? Does every change constitute a change of theory? Do mere extensions / applications of a theory make a difference to the theoretical context? Do the different ways of axiomatizing the same theory give us different theoretical contexts? When a theory is changed, do the logical terms, like 'and', 'if-then' change their meanings too? Similarly, his statements about relationship between change of meaning and change of theory are not clear. Similarly, can all these, namely, an addition of an epicycle in a theory; a change in the value of a constant; a shift from circular to elliptical orbit; ascribing a new property to some entity – be treated as a change of a theory? He may say that these are changes ***in*** a theory, ***not of*** a theory; that is, when these changes become strong enough they affect the meanings of the terms; or he would say that the mere difference constitutes a change of meaning, which, as Shapere fears would may end up in a tautology: "the mere difference itself constitutes a change of meaning of all terms in the theory – so that the doctrine that 'meanings change with change of context' becomes a tautology"[243].

Thus Feyerabend fails to give a detailed and adequate account of: **a)** what counts as a part of 'meaning' of a term; **b)** what counts as a 'change of meaning'; and thus in turn, **c)** what counts as a part of a 'theory' and **d)** what counts as a 'change of theory'. His idea of a theory seems to include everything; it is not clear as what to include in it – they include ordinary

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[243] Shapere, 1984a, p 71.

beliefs of day-to-day lives, religious myths, strong commitments to methodologies and even quasi-metaphysical principles[244]. It is not sure whether Feyerabend and Kuhn would be happy to include Kepler's mysticism as an integral part of the theories proposed, and Newton's idea of absolute space is part of his theory.

3.1.2.2.2 Problems with Incommensurability and Theory Choice

In order to overcome the objection that incommensurability leads to a serious problem of theory choice in science, Feyerabend proposes *three requirements*, which help in judging between two competing theories:[245] **a)** Invention of a new metatheory, which is more general in describing a common background that defines test statements acceptable to both the theories. But, Shapere points out a problem: any term in the metatheory will have a context will be radically different from the context in which a corresponding term occurred in one of the two original theories Thus, the problem of comparing the terms in the original theories, in stead of being solved, has been just pushed to the level of comparing the terms in the metatheories[246]; **b)** Feyerabend invites us to do an internal examination of theories. One theory may establish more direct connection to observation and may have a more direct interpretation of observational results. But the problem here would be, if a theory defines its own facts / experience, then what could be more direct than this?; and **c)** Feyerabend introduces the notion of 'the pragmatic theory of observation' to help in theory-choice. Here the criterion to decide upon an observational statement is not in terms of meaning but by the circumstances of its production. However, this introduction of 'pragmatic theory of observation' too did not succeed much. For, if all the meanings are dependent on some theories, and theories can be formulated as one wills and further if any observational evidence can be given to support any given theory, then "it follows that the role of experience and experiment in science becomes a farce"[247]. This analysis seems to agree that there is something which is theory-independent and with which we can determine the choice: that is 'human experience as an actually existing process' – which makes the observer utter some sequence of noises – only when we consider their meaning theoretical

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[244] Feyerabend, Colodny (ed.), p. 219
[245] *Ibid.*, pp. 216-217.
[246] Shapere, in 1984d, in 1984a, p. 74.
[247] *Ibid.*, p. 81.

considerations come in. Hence, not the reference to their meaning is important but the domain of 'features of experiences' which they are concerned to imitate.

Shapere spells out the ***problematic similarities between Feyerabend and Kuhn***: **a)** Feyerabend's notion of 'high-level theory'[248] and Kuhn's notion of 'Paradigm'[249] – both are too general and one is at a loss about what to include or not under that notion!; **b)** Both of them don't give what counts as a part of meaning of term and what counts as a change of meaning, though both these issues are central to their philosophies; **c)** Both of them lead to relativism, as they demand for complete replacements of theories / paradigms, which in turn bring in utter incompatibilities. For Kuhn, the standards to decide problems, facts, concepts, explanations – all depend upon paradigm; and for Feyerabend, all these depend upon theories; and d) Both of them fail in providing extra-theoretical basis to compare / judge theories; and therefore the choice depends on the basis of arbitrary decision.

All these problems[250] are, Shapere is convinced, due to the wrong turn in understanding the 'meaning'; these are the logical consequences of their narrow understanding of what 'meaning' is. Now can we provide a middle ground by altering their rigid notion of meaning? He gives a way out by suggesting that we can have meanings similar, and yet different in some respects. By this view he hopes to avoid extremes of positivism and relativism, and yet includes the Positivists' meaning invariance and the relativists' incommensurability. He suggests that 'reference to meaning' need not be the fundamental tool for dealing with the problem of theory choice. He claims to *(dis)*solve the problem

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[248] Feyerabend, 1965.

[249] Kuhn, 1962, p. 40 ff.

[250] Shapere further argues that both the classical and post-classical philosophies of science of 20th century fail in a particular aspect. The actual motivation of the Vienna Circle (VC), at the beginning of 20th century, was to understand the then revolutionary changes in physics of the 20th century. Due to their exaggeration of the need and the role of logic in science, the content of science was thought to be irrelevant and dangerously misleading Logical empiricism, the offspring of the VC imbibed the Platonic-Aristotelian quest for essences. if one wants to understand science must know the essence of science, which all sciences have in common (not any individual theory) and so the original motto of studying the relativity and quantum theories was lost, it is the fundamental failure to ignore the specifics of particular scientific theories In a similar vein, the post-classical trends too seem to have gone off the track they began criticizing logical empiricism and presented a new program to correct the deficiencies inherent in that movement; but the post classical philosophers of science, Kuhn and the cohort, like Toulmin, Hanson, Feyerabend, who were rooted in history of science paid too much attention to historical content, even to the extent of not finding any trans-historical elements to judge the progress of science. Therefore for the postclassical philosophers of science, "major scientific change, scientific revolution, was left as mysterious, even unanalysable, now, in the absence of anything that could count as a paradigm-transcendent reason, as it had been for their logical empiricist predecessors, who had denied that reasoning (a 'logic of discovery') was involved in arriving at new scientific ideas" [Shapere, 2004, p. 47].

ofincommensurability and theory choice with the concept of 'chain-of-reasoning connections' between the usage of terms at successive stages in history.

Having discussed Shapere's criticisms of the Classical and Post-Classical trends of 20th century, I concentrate, in the next section, upon his own contribution to philosophy of science.

3.2 SHAPERE'S MAJOR CONTRIBUTIONS TO PHILOSOPHY OF SCIENCE

This section focuses on the salient features of Shapere's philosophy of science, relevant to our discussion: namely, the Notion of Background Information, Observation as a Concept Schema, Reason in Science, and Rational Descendent of Empiricism.

3.2.1 Background Information and Science

3.2.1.1 The Notion of background Information

Content of science at a given period serves as background information of science for that period. In science there is always a set of beliefs, and never a vacuum. There are varieties of sets of background information, where different items play a different role in different problem-situations. Background information has not only factual and theoretical beliefs, but also "vocabulary by which we describe and delineate the subject-matters of our inquiry, the methods we employ in the search for knowledge, the normative standards by which we conduct our inquiry and set its goals"[251]. Logical empiricists, insisting upon experience as the starting point of the scientific enterprise, did not appreciate any role for background information. But the contemporary historians of science, like Kuhn and Alexandre Koyrè, have made the philosophers aware of the need of history of science for philosophy of science. Feyerabend[252], N.R. Hanson[253], Robert Palter[254], Stephen Toulmin[255] and many others realized that science would not take place in a 'vacuum' and it would certainly need

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[251] Shapere, 2001a, in Hoyningen-Huene and H Sankey (eds), 2001, p 200
[252] For instance, Feyerabend, 1962 and 1981a
[253] Hanson, 1958.
[254] Palter, 1956.
[255] Toulmin, 1953.

prior beliefs and theories. There is no paradigmatic unity or single background theory, as Kuhn would like us to believe. Specifiable background beliefs are used with specific roles in conception, performance and interpretation of the research. [256]

3.2.1.2 Criteria to be a Component in Background Information

The background comes from the past of science; it has proved powerful, successful in its own way. Therefore *previous success* (in accounting for a body of information, for which they are held responsible) and *present coherence* (under certain conditions) with other beliefs with which they are expected to cohere are *major criteria* to be a member of the background information. Based on these two, a sort of demarcation line is gradually drawn. This demarcation line between background information and non-background information is only *incomplete unfinished, and contingent* as it is based on the considerations internal and external to science[257]. We need to be critical of what we take to be background information; and this pool of background information is not discovered by logic; it is based on earlier knowledge, and thus can reach back to the deepest levels of evolutionary history. It is not to belittle the role of logic in science; logical inference plays an important role in science; but it is not all that that is there for scientific reasoning and it is not even the central part of science; logic is concerned with all possible worlds, but it cannot tell much about why we have come to believe certain things about our particular world.[258] One day science may become totally autonomous and then we may have to introduce a new logic. But we cannot predict the outcome of science in advance, and the inquiry has to be guided by the content of what we have learned. But as of now, we must admit that we can only be guided by prior knowledge, which may be inadequate for the tasks to which it is applied.

3.2.1.3 Evolutionary Aspect of Background Information

One more important feature of that background information is the fact that it has evolved over the years, just as how we have evolved; that is, over the past centuries we have departed from those primitive middle-sized views and we have transcended those

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[256] Shapere, 1989a, p.433
[257] *Ibid.*
[258] Shapere, 2004, p. 52.

experiences in modern science. The limits of everyday world have gone beyond the middle-sized domains, to the smallest and the largest ones. In spite of the gaps and uncertainties we could draw a large picture of the universe, from the beginnings of evolution in the past, into the far distant future; and this is being tried in evolving 'the theory of everything'. It has altered our concepts of explanation, the idea of the universe and even the very idea of reason. All these "have been radically transformed, in ways that could not have been anticipated by any *a priori* considerations"[259].

An individual element is accepted into or rejected from background information for excellent and compelling reasons. However these reasons are not known *a priori* or transhistorical absolutes, rather its legitimacy is proved or disproved by the actual functioning of science in course of time. For instance, in the case of neutrino experiment, "Nuclear physics, weak interaction theory, the theory of stellar structure – those qualify" to be background information, while "witchcraft, Aristotelian mechanics, and religious creation myths do not"[260]. **The significant role that the background information plays in the scientific enterprise, the mode of accepting something as legitimate member in the pool of background information, and how it enlarges in course of time – all these become clear with the example of 'neutrino experiment' in the following pages.**

3.2.2 Concept Schema

To understand the recent sophisticated science it is better that one treats the important concepts employed in it as a 'concept schema', instead of individual concepts. For, the meanings of these concepts are not given once and for all as one individual concept; rather they develop over the years, with all related aspects. He prefers to discuss the notions of observation, meaning, reality, truth, knowledge, and so on as 'concept schema'.[261] Philosophers have failed to arrive at the exact meaning of many concepts and that can be evidence that there is no such exact meaning. Their meanings can be made up only by a chain of ideas, linked by reasons: "that is what we consider to be a 'concept or meaning specified by a set of necessary conditions is really a concept schema. I argue that many other

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[259] Shapere, 1989a, p. 436
[260] Shapere, 1988b, p. 308
[261] Shapere reiterates his preference to address them as concept schema, rather than concepts, in his forthcoming book, *The Rational Dynamics of Scientific Inquiry*

'concepts', including 'explanation' cannot be given precise meaning except in terms of the CONTENT of background information."[262] Thus a concept schema means[263]: **a)** A concept schema is formulated in terms of a 'framework' that remains reasonably stable over a significant period of time, or over contemporaneous areas of inquiry; **b)** The usage of the *content terms*[264] depends on accepted scientific beliefs, which are the elements of the background information; **c)** The accepted background information can and does often change from one epoch to the next, and therefore the usage of the content terms of the concept schema (e.g. what is to be observational) also changes. Thus the usage or application of the content terms can vary over the period during which the framework is otherwise stable. (Later we see, the framework itself can be changed); **d)** The usage of the content terms is changed in the light of new scientific beliefs, which count as reasons for making changes. Thus there is a *chain-of-reasoning connection*[265] between the successive usages of the concept schema; **e)** A concept schema is treated as part of 'an approach to inquiry' and the interpretation of its results. There can be many rival approaches to an inquiry; one is accepted and the others are rejected. The selection of a given approach is based on legitimate reasons. The approach involving concept schemata is also contingent;

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[262] Shapere, over e-mail communication, 30 Sept, 2003.

[263] Shapere, *The Rational Dynamics of Scientific Inquiry*, Chapter II, p 8-9, (Forthcoming).

[264] By content terms Shapere means those terms which refer to the content of the accepted scientific beliefs These terms are contrasted with meaning-terms and reference-terms

[265] Though the usage of a term differs, and the background context differs at successive stages, the usages can be compared due to, what Shapere calls, 'the chain-of-reasoning connection' between those usages At successive stages some properties or the other of the terms are dropped or added for specific reasons. Let U_l and U_k are two usages that determined by theoretical contexts, T_l and T_k There is a chain of reasoning which helps us to understand why certain properties ascribed in usage U_l and its successors up to and including U_k were deserted, modified, or replaced; the same chain-of-reasoning explains the possibility of comparing the two usages and their theoretical contexts even though the last stage U_k involves very few or even no features in common with the first usage U_l [Shapere, 2001, p. 199]. Shapere explains with an example of usage of electron over centuries: After a rethink upon Faraday's electrolysis experiment Stoney concluded that electron was an indivisible unit of charge (and not matter), later Thomson added the property of mass to electrons and electrons became classical particles, with mass, position and velocity, and negative charge But the recent quantum mechanics abandoned simultaneous attribution of position and momentum, and added another property of spin to electron. In the further evolution of quantum field theory, electrons are seen as a variety of leptons Like all particles, electrons are also seen excitations of a quantum field, possessing a range of quantum numbers. All these developments were even unimaginable to Stoney and Thomson in those days However, we know all these properties are about electrons, not because we ascribed essential properties to electron, or some sort of necessary and sufficient conditions of applications of the term We understand the term refers to electrons also not because of an irreducible assertion that we 'refer to electron' The continuity and comparability of the usage is not due to some common descriptions or common reference, rather, "the rationale for saying that we have referred to the same thing all along is given by the linkage of reasons which gives continuity to the history" [Shapere, 1989a, p 429] **The historical usages of electrons are extremely different, if not radically incommensurable, yet they are not incomparable due to chain-of-reasoning connection. Therefore, to understand the nature of science and its development, we must look in the process of reasoning employed in science and not in philosophy of language.**

and **f)** A particular schema is used to a sequence of specific usages, not just to a single set of specifications. The members of the sequence are linked by a chain-of-reasoning connection. I now elaborate one of the most important, and relevant to my purpose, concept schema, observation[266].

3.2.2.1 Observation as a Concept Schema

Shapere prefers to see, for the reasons explained above, observation as a schema, rather than a concept. In the process of discussing salient features of observation Shapere undertakes the following four *important tasks*: a) What is it to be a scientific observation, in the light of the recent particle physics and cosmology?; b) What is the distinction between the legitimate and wild speculation in science (this he thinks that the traditional empiricism failed to do)?; c) How to justify the appeal to the unobservable in science as something legitimate? and d) How to show that science is still empirical, though going beyond unobservability? He points out a major misconception of equating observation with sense perception. He argues that the empiricists' doctrines of observations are in need of correction.

Both the major methodologies of science, the Inductive Method and the Hypothetico-Deductive Method, suffer from the same deficiency: both the methods don't tell us what an observation is. Classical Empiricism insists that all our ideas are based on observation. 20th century Logical Empiricists give logical basis for construction of ideas, not psychological basis. Since they are interested in science, they speak of 'observation', and not 'impression'. Due to their linguistic interests, they speak of 'observation-terms', intensifying its distinction from 'theoretical-term'. Except a few, like C. G. Hempel, (for whom observation includes not only direct observation by sense, but also sensation and introspection), for almost all empiricists, **observation means sense perception.** By sense perception they mean only the direct sense-observation, while scientists have a wider notion of it; the scientists rather include in the realm of sense perception what we get by means of instruments, designed to get information about what we don't and can't perceive directly through our senses.

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[266] I choose to elaborate on the concept schema of observation because in the last chapter I take up the notion of observation (in the context of Gravitational Wave Experiments) to show how the consensus in the scientific community assumes great importance in modern science. This notion of consensus, I hope to show, is very significant feature of the holistic understanding of rationality (reasonableness!) in science

May be, it was alright during the period from the 16th to 18th centuries to interpret scientific concepts as being exhaustively interpretable in terms of sense perception. But as science developed many features and elements were encountered which were not directly perceivable (e.g. force, inertia, space, electromagnetic radiation etc.). By the 19th and 20th centuries, what is selected to be observed, how to be observed, how it is to be described, how it is to be interpreted – all such exercises departed from the strict adherence of sensory perceptibility.

Even if all our knowledge were shown to be ultimately based on sense perception still we would not know or understand knowledge fully We need something more than that to understand knowledge. For our sense perception covers only a limited section in the whole range of Electro Magnetic (EM) spectrum and ***more importantly***, classical empiricism is not only insufficient to understand science and its problems, but also it is largely irrelevant and even positively obstructing the process. For now we learn that the EM spectrum consists of a wide range of rays and with vastly differing wavelengths. It ranges from short wavelength gamma rays through X-rays, Ultra Violet (UV) rays, visible light, Infra Red (IR) rays to long wavelength Radio waves. The normal light, which is visible to our human eyes, is just one portion of the vast spectrum. Gamma rays (with extremely high frequency and wavelength as short as a billionth of wavelength of the visible light) are at the one end and at the other end are the radio waves, with trillion times higher wavelength of the visible light. "The eye" therefore, "comes to be regarded as a particular sort of electromagnetic receptor, capable of 'detecting' electromagnetic waves of the 'blue' to 'red' wavelengths, there being other sorts of receptors capable of detecting other ranges of that spectrum. This *generalized notion of a receptor or detector* thus includes the eye as one type"[267].

Shapere highlights three fundamental doctrines of empiricism (regarding observation) and shows why all the three need to be rejected given the present developments in philosophy and science: **a)** In order to decide what is to be considered as a sense-perception, a clear distinction is to be made between purely 'given' in sense perception, which is therefore free of any interpretation; and all 'other ideas' that are based on the interpretation of the 'given'. All these beliefs and concepts go beyond the 'given'; **b)** All our knowledge-claims are either

[267] Shapere, 1982c, p. 505.

directly or indirectly traced to observation. When science uses unobservable or theoretical terms they get their meaningfulness only by tracing its origin or relevance to some observational aspects; and **c)** Observation has two aspects: evidential and perceptual. Both are identical and therefore what is evidential is perceptual. So what counts as evidence is what is given in sense-perception. It is perceptual, because it is free of any interpretation, having no need of any background information.

From the recent advancements in the knowledge of history of science and the actual practice of scientists, it can be shown that all the three doctrines mentioned above are extremely problematic: **a)*** No clear-cut distinction can be made between the 'given' and the 'interpretations' of them. There is no pristine or brute 'given' that is ever found. Observation is based on selection. Interpretation of the 'given' is a construction with many presuppositions. The actual situation is: $T_x = f\,[g(O_x)]$.[268] Logical empiricism claims that a theoretical term (T_x) can be shown to be meaningful as a function of an observational term (O_x). But they don't seem to realize that (O_x) itself is not the 'pure given' but coloured with the presuppositions (g). So pure observation is not possible; **b)*** The second is a natural effect of the denial of the first. Because the 'basis' itself is not purely objective, then all other beliefs might be infected with presuppositions and interpretations. Even if something is taken to be the basis (e.g. unanalysable sense-data), it is not clear how other non-basic terms are based on the 'given'. and **c)*** Modern science has separated these two, evidential and perceptual, and "the focus of modern science is on observation as evidence, not on observation as perception"[269]. It is primarily because sense perception is often unreliable (seeing the half-immersed stick as bent!) and incapable (in the areas of too small or too big in size or with the objects too near or too far!). Since perceptions are often erroneous we bring in instruments to record exactly; evidence is collected by the detectors without any perceptual bias involved. Now these results are to be interpreted.

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[268] For Logical Positivists it would be $T_x = f\,(O_x)$ They stop with this and don't seem to realize that observation is not a 'pure' observation but a function of some presupposition (s)

[269] Shapere, 2000.

3.2.2.2 Conditions for Observation

There are certain elements which can never be observed. For instance, as science develops one may observe Jupiter from a close range, but one can never perceive directly the particles in the cloud chamber; one can only observe only the track of the particle. Further, even if we assume that pure observation is possible, which requires no interpretation, and even if we grant that all scientific concepts are presuppositions ultimately based on sense- perception, we need to realize that the central body of reasoning by which scientific ideas are arrived at in modern science would have been ignored. Observation is not mere sense perception, it needs a specific receptor and it needs interpretation. Therefore, the conditions for something to be observed (observable) are· "**a)** information is received by appropriate receptor; **b)** that information is transmitted directly, without any interference, to the receptor from the entity".[270] Further, whatever is grasped by the receptor needs to be transformed into humanly accessible form for interpreting the results. Therefore, Shapere proposes the third condition: "**c)** The information is transformed by appropriate devices into humanly-accessible information which is (eventually) perceived (and used appropriately as information) by a human being"[271]. These conditions will be explicated with the help of the Neutrino Experiment discussed below.

3.2.2.3 An Elaboration of the Neutrino Experiment

Here I briefly explain the neutrino experiment, raising the question at the end, whether, according to the scientists, neutrino is observed or inferred. I also outline the need and the components of the background information with regard to this experiment. I show how, as Shapere claims, the understanding of the background information in this experiment differs from that of presuppositionists.

Shapere undertakes this case-study of neutrino experiment[272] to undercut the traditional claims about observation in science, by showing logical empiricism's basic tenet of 'pure and interpretationless' observations is a farce. Nuclear Physics arrived on the scene of modern science in the 1930's. Bethe-von Weizssacker proposed that nuclear reactions are

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[270] Shapere, 1988b, p. 308.
[271] Shapere, 1982c, p. 509.
[272] See: Shapere, 1982c.

the source of the energy produced by the sun. But there was a problem in testing these nuclear reactions. The sunlight (energy) that we receive from the sun is produced due to the nuclear reactions, at the central core of the sun, at very high temperature and pressure. Four hydrogen atoms join together to produce one Helium atom and lot of energy (photons or EM particles) and neutrinos are also released: $4\ {}^{1}H \rightarrow {}^{4}He + 2\ e^{+} + 2\nu_e$ (superscript is the atomic number; along with Helium two positrons and two electro neutrinos are released). When the photons reach the surface of the sun, after a long journey of 400,000 miles from its core, taking 10^5 to 10^6 years to reach the surface of the sun, they lose much of their energy, due to interaction with other particles. From the earlier knowledge about the photon-interactions and the theories about the states inside the sun, we learn that the information carried by the photons from the core of the sun is greatly distorted in the long journey through the passage of energy from its production-point. So actually speaking, the photons that are released at the sun's surface are not the same photons that had been produced at the center of the sun. Hence it was considered to be an *indirect* observation of the core of the sun.

However, neutrinos, which are weak in interactions, reach the surface from the core of the sun without any interaction with any kind of particles. Further, when they reach the earth too they are intact without any modification, while other EM particles undergo lots of changes, already before reaching the surface of the sun, and also later while reaching the surface of earth. The neutrinos reach the earth exactly as they were created at the core. Hence in order to learn about the core of the sun more *directly*, the study of neutrinos is essential. They carry the 'pure' information of the solar core, as they are not tampered or interfered with on their long journey.

Later in the 20th century 'direct test was proposed', by studying those weakly-interacting particles, neutrinos. The world of Physics was already aware of the four fundamental forces in nature: The *Strong Force* (which holds the nucleus together), the *Gravitational Force* (the weakest of the four), the *Electromagnetic Force* (manifested in the EM spectrum) and the *Weak Force* (responsible for radioactivity and more importantly for the conversion of one chemical element into another). Based on this knowledge and the knowledge of the 'Theory of the Source of Stellar Energy,' (of 1930s), the 'Theory of Stellar Structure', and, and the

'Theory of Nuclear Reactions', Neutrino experiment was conceived to 'observe' the core of the sun and to find out how they produce the heat energy (light). To make a study on these neutrinos, we need first to capture them in an appropriate container, making sure that that process doesn't alter the nature of the neutrinos. They are received in a chlorine filled tanker to produce radioactive argon, with a half-life of roughly 35 days. Neutrino detector is a tank with 400,000 liters (610 tons) of cleaning fluid (Perchloroethylene, C2Cl4), which is kept at a deep mine of about one mile underground. When the neutrinos reach this tank radioactive argon is produced and this has to be removed before it is decayed. $^{37}Cl + \nu_e \rightarrow {}^{37}Ar + e^-$. This is done by sending helium into the tank. Then a proportional counter is set up to register the number of neutrinos captured and that is compared with the theoretical predictions.

Can one claim that the core of the sun has been observed? One might argue that the core of the sun is not observed, for what is actually observed here is only absorptions of neutrinos produced at the center of the sun and not the sun itself; one may even say only the decay of radioactive argon, or just the sense-data, like the clicks, in the consciousness of the perceiver; all the remaining details are the result of inference[273]. Nevertheless scientists claim that this experiment gives us direct information about the core of the sun and that those neutrinos enable us to 'see' the interior of the sun. They don't just say it in a metaphorical language. Their usage is somehow related to some aspects of ordinary and philosophical uses. It is not totally eccentric, rather, "it is an extension of such uses, in part a generalization thereof, in part a departure there from, made on the basis of reasons, and designed to make the most of the epistemic role of observation" [274]

Even some philosophers may not be ready to consider this as observation, arguing that this is a far-fetched notion of observation, or the misuse of that term. For them observation must be 'without inference' and since the experiment here involves inference profusely, it cannot be an observation for them. But Shapere argues that philosophers, being mesmerized by the strict logical rules of inference treat neutrino experiment as a result of inference. He makes ***the distinction between inference and non-inference in terms of 'specific reasons to doubt'***. And he distinguishes between inferential and non-inferential conclusions – the

[273] Shapere, 1982c, p. 487.
[274] *Ibid.*, p. 522.

former would be those having specific reasons to doubt ("but which we are nevertheless still able to use to a certain extent and for some epistemic purposes") and the latter would be those having no such specific reasons to doubt, "and upon which we can build confidently"[275]. One can find an answer with Einstein too:[276]

> It is the theory which decides what we can observe. You must appreciate that observation is a very complicated process. The phenomenon under observation produces certain events in our measuring apparatus, which eventually and by complicated paths produce sense impressions and help us to fix the effects in our consciousness. Along this whole path – from the phenomenon to its fixation in our consciousness – we must be able to tell how nature functions, must know the natural laws at least in practical terms, before we can claim to have observed anything at all... When we claim that we can observe something new, we ought really to be saying that, although we are about to formulate new natural laws that do not agree with the old ones, we nevertheless assume that the existing laws – covering the whole path from the phenomenon to our consciousness - function in such a way that we can rely upon them and hence speak of "observations".

From the above words of Einstein, two points are clear: **a)** besides the single applicable theory, other knowledge may be brought to bear in deciding what we can observe; and **b)** by 'theory' he does not mean something doubtful but something on which we can 'rely'. Further such doubting philosophers need to realize that there is no epistemically relevant case where one can have an observational component "which is in some absolute way free of any inference in the logical sense, that is, which does not require any antecedent belief in order to be useful in the quest for knowledge?" [277]. For instance, as simple as noticing a glittering speck in the night sky and recognizing it as a star, involves lots of theories in the process or seeing the clock-dial to say what time is.

The whole experiment is quite complicated. We need to study all the relevant previous theories. One needs to learn about the appropriate target substance and the interpretation of the results. A lot of background information is needed for the *conception*, *execution* and *interpretation* of the experiment. So without the background beliefs the experiment wouldn't have been executable, and without further background information the results would not

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[275] *Ibid.*, p 517.
[276] As quoted by, Shapere, 1978, p. 993-4
[277] Shapere, 1982c, p. 518.

have been interpreted. In formulating theories of transmission and of receptor, a lot more background theories and knowledge are at work: they have to utilize theories of nuclear reactions, experimental determination of reaction rates, cosmic ray physics, the chemistry of noble gases, the properties of cleaning fluid, information about the radioactive content of the rock walls of the cave which holds the receptor, technological information as to how, and why, to air-proof the apparatus, technological information about the capabilities of radioactive-decay counters and many other similar information are needed.[278] Thus Shapere argues that "science builds on what it already knows, even where its observational capabilities are concerned. It *learns how to observe* nature, and its ability to observe increases with increasing knowledge (or decreases when it learns that it was mistaken in some piece of background information it employed)"[279].

In addition, the background information needs the following major components as well:[280] **a)** various theoretical and experimental results regarding specific nuclear reactions; **b)** information about the opacity about the sun to photons and neutrinos and the factors that affect it; **c)** the appropriate substance to use as a material to capture or detect the relevant neutrinos; **d)** the knowledge about the proper place where to deposit the material (in a deep mine in order to protect it from cosmic contamination); **e)** the information how to clean up the receptor tanks of neutrinos and so on; **f)** What counts as an 'appropriate receptor'; **g)** What counts as 'information'; **h)** What kinds of information there are available so far; **i)** What counts as an appropriate 'source' of the information; **j)** The ways in which information of the various types is transmitted and received, and **k)** The character and types of interference and the circumstances under which and the frequency with which any interference occurs.

Though the background information includes variety of beliefs and theories, and this information may be modified or magnified during the process of the experiment, yet it is not that anything can be included in the body of background information. There are **reasons to**

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[278] Shapere, 1982c, p. 506.
[279] *Ibid.*, p. 514. italics his.
[280] Shapere, *The Rational Dynamics of Scientific Inquiry*, Chapter II, p 4, (Forthcoming)

choose some as relevant and reject others as irrelevant beliefs There are reasons to check, like *success* and *coherence*. [281]

The neutrino experiment and its interpretation may sound analogous to the position of 'presuppositionists'[282], in scientific problem-situations. They have identified the need for background beliefs by the phrase 'theory-ladenness' of perception, but it has distorted many real issues: **a)** The term 'loading' implies the loss of objectivity and thereby the presence of epistemological relativism; **b)** Unlike Kuhn, Shapere claims that there is no *one* basic paradigm available for all the experiments; rather different pieces of information in the background information are used for different experiments; so background information is not to be considered as one single unit; **c)** Against Feyerabend, Shapere rejects the theory of 'anything goes' – because, the items employed in a given research / experiment must be specifically relevant to that situation at hand; **d)** Unlike Hanson, Shapere affirms that background information-ladenness does not remove the objectivity; because, only beliefs which have been established are eligible to serve as background information; and **e)** Shapere[283] differs from the presuppositionists also in criticizing the traditional empiricism.

3.2.2.4 The Role and the Scientific Status of Unobservable in Modern Science

With such a renewed understanding of observation we can now look at the role and the scientific status of Unobservables in the Contemporary Science afresh. We need to revise their nature and the ontological status too. Now it is believed that the universe is infinite. But our horizons of possible investigation are limited. The part of the universe, as cosmology and physics teach us, will not be observable by us unless it enters our horizon, and "if the universe is infinite, that, at any given time, there will always be regions which are unobservable"[284]. Many ideas in Particle Physics and modern cosmology deal with

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[281] Shapere, 2001a, in Hoyningen-Huene and H. Sankey (eds.), 2001, p 185-6

[282] According to presuppositionists' theory, "there is something, of the sort that can serve as standard or set of standards or criteria for scientific rationality and progress, which is immune to the vicissitudes below, and which serves as the ultimate arbiter of those lower-level scientific disputes," says Shapere (1982d, p 451.)

[283] For instance, Shapere holds that * The theory-ladenness of observation does not make it arbitrary, for it is not that just anything can be in the background beliefs but needs to be qualified like the fact of their success in the past, * From the background information, only those elements which are directly relevant to the situation are used in the interpretation, and there are no vague and imaginative appeals, even implicit, to anything like 'social context'; and * The 'given' in the experiment plays a better and more significant role here. The critics of the traditional empiricism tend to either deny any such 'given' or make it powerless to confirm or deny, to choose or reject, any from the rival knowledge-claims [See· Shapere, 2000, p 157-8]

[284] Shapere, 2000, p. 159.

unobservables, unobservable not only in practice, but even in principle. In this context new questions emerge: What is it for something to be observable in science? Is unobservable admissible in science? Going a step further, we need to ask whether empiricism itself can be an account of the scientific enterprise.

Recent Particle Physics and cosmology encounter problems and theories for which observational or experimental tests appear impossible. Those theories are not testable even in principle. Shapere mentions a couple of phenomena with such difficulties, like Theory of Superstrings, Inflationary Theories and Theories about Black Holes[285]. As one may rightly expect classical empiricism would deny / ignore all such entities and theories about such unobservables as unscientific because they turn out to be untestable and they seem to be entering the region of metaphysics, exceeding the bounds of good scientific reasoning. Classical empiricism holds that over the period scientific content changes, but not the scientific methods by which the contents are determined. But now it is clear that we know method also changes along with content. What is observable / unobservable is determined by a number of factors, like: the instrumentation used; the theoretical knowledge which tells us the nature of interactions; the theoretical possibilities of detection of particular interactions, and how the particular interactions give information about its sources. With the growth in the scientific content the notion of (un)observable also departs form the philosophical and common sense. e.g. - the discovery of UV, IR radiations marked the departure from the notion of identifying observation with sense experience.

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[285] ***Theory of Superstrings*** – aims at unified picture of the universe, to unify the gravitational forces and the standard model of elementary particles and forces). They deal with energies on a scale of 10^{19} GeV There is no imaginable technology to test such a high voltage Science is said to have reached a stage where only the universe itself can be the testing laboratory ***Inflationary Theories*** – claim that our presently observable universe is only one domain of the whole universe In the different regions of the universe constants of nature will differ. Some theories speak about the other unobservable regions, even other universes Science considers such entities as legitimate objects of scientific study, though they are unobservable in principle, and ***Theories about black holes*** – though now scientists like Stephen Hawkins opine that black holes are not that black after all, because light can emit from them, we can still say that the centre core of the black holes is largely unobservable. These theories are not just speculative. In the present cosmology, new regions which were previously unobservable are now entering our horizon Similarly, the present unobservable domains may one day enter our horizon, may be 10^{100} years From this one can't argue that this is observable in principle, which would be a mockery of it. In any case, according to our present understanding the universe is infinite, and therefore, as long as it is infinite, there will always be regions unobservable. [See: Shapere, 2000, pp 158-160].

Therefore, whether something is observable or not, is a contingent matter of fact, resting on what we have best reason to think we have learned; it depends on the scientific beliefs currently accepted, the instruments used, and the theoretical knowledge about the nature and the detection of a given interaction, and how these interactions give information regarding their sources[286].

3.2.2.5 A Demarcation between Legitimate and Wild Speculations

One need not think that any bizarre and strange items can be accepted as legitimate entities in the domain of modern science. To avoid any such misgiving Shapere proposes some elementary *guidelines to distinguish between legitimate and wild / loose speculation in accepting something unobservable in science*: [287] **a)** If that entity is logically and mathematically implied by something that is already observable or has observable consequences; **b)** If it is needed for consistency considerations, even though it is not implied by the observable parts of the theory; and **c)** If it provides answers to problems concerning the observable parts of the theory with which no other solution deals successfully. These guidelines of course are to be taken in spirit, not in letters. The very fact that we don't know everything, i.e. our background information is vague, incomplete, even subject to contradictions – implies there will be border-line cases. And because the background itself can be revised, we need to liberalize the restrictions. However, despite the liberality, it is by no means the case that 'anything goes'.

3.2.2.6 Limitedness of Human Observ'*ability*'

In relating with nature, humans experience many dimensions that are inaccessible to logical proofs or sense perception. We need to rely on our ***intuition*** and trust our common sense and human nature. Some are *unobservable due to the limitations in human sensory capacity*; for instance, our eyes cannot see something too small or too big; our sense of touch cannot differentiate minute changes in temperature or pressure. Whereas many animals are equipped to do all these: for instance, a dog can differentiate forty types of smell; sharks can

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[286] Shapere, 2000, p. 158
[287] Shapere, 2000, p. 159.

observe the electric fields around the body of their prey, but we cannot observe. Similarly some are *unobservable by law of nature*; for instance, what lies outside our light cone, as the speed of light is finite, no signal can reach us from there; the core of the sun, quarks etc. As Bas van Fraassen succinctly puts it, "The human organism is, from the point of view of physics, a certain kind of measuring apparatus. As such it has certain inherent limitations... It is these limitations to which the 'able' in 'observable' refers – our limitations, *qua* human beings"[288]. Perhaps that is why, now it has become normal and essential for science too, to speak about the existences of entities, states and events, which are not accessible to human senses (eyes).

In sum, there is no doubt that "All our knowledge of the world rests on observation", but one must hasten to add that "observation is not equatable with sense perception. It is interaction with the world, in the light of background information we have gleaned about what sort of interactions there are in nature"[289]. In science 'observation' is not limited to 'perception with naked eye or by any other senses'. Still the sophisticated science speaks of making 'observations' though what is 'observed' is beyond naked or telescopically-aided eyes. Neutrino experiment teaches us that "what counts as observed or observable is a function of the current state of physical knowledge, and can change with changes in the knowledge"[290]. Thus the concept of observation is not a single notion to be captured by a logical or *a priroi* analysis. It is a concept schema evolving over the years, intertwined with the methodology and background knowledge.

3.2.3 Reason (Rationality) in Science

3.2.3.1 The Emergence of What Counts as 'Reason'

Shapere, in his earlier papers, gives three factors as the constituents of 'reason' in science. When a belief fulfils all the three together its rationality is obtained. In his words, "a 'reason' in science consists of a belief (a) which has proved successful, (b) concerning which there is no specific reason for doubt, and (c) which has been shown to be relevant to

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[288] van Fraassen, 1999, p. 43
[289] Shapere, 1988b, p.309.
[290] Shapere, 1978, p. 992

the specific domain in which it is being applied as a 'reason'".[291] However he concedes that it is enough, practically speaking, to accept beliefs as rational which are shown to be unambiguously successful or free from doubt. Later in order to correct the over-enthusiasm of the historically-oriented philosophers, who seem to overstress on the fact of context-determination of scientific beliefs, Shapere highlighted the element of 'given' (which is unaffected by the theoretical presuppositions) in the scientific inquiry. However, he cautions that "This is not the 'given' of traditional empiricism, a 'given' of pure perception"[292] and goes on to give his understanding of 'given'.

Shapere, going along with the post-classical thinkers, holds that not only what is internal and external to science, and what is scientific and non-scientific but also what counts as reason are not given once and for all, rather emerges along with science. However, he shows that this position does not lead to relativism or subjectivism, as there are sufficient mechanisms to safeguard the objectivity of rationality in science. The guiding principles and the standards for further research, which guarantee the rationality in science, are **The Principle of Domain Success, the Principle of Explanatory Coherence** and these two put together lead to **the Principle of Goal Success.** The fourth requirement is **the absence of a specific doubt**. These principles are learnt, and not given as *a priori*.

3.2.3.2 Domain success

Domain success refers to the ability to fulfill the promise of arriving at explanation of individual domain. The notion of success changes, as the 'goal' changes. For instance, during the Chemical Revolution in 18th century, there was a shift in goal of matter study, i.e. it was from 'to bring matter to perfection' to 'understand matter in terms of its essentials'. There are ***no transcending, unchanging criteria for success***. The criteria for success change

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[291] Shapere, 1982d, p. 458.

[292] Shapere, 1989a, p. 435 The sense of 'the given' is not in the traditional empiricists' sense as 'pure perception' nor is it a result of single effort or a look, nor that once recognized it will automatically give us the character of the world by which it is given; but in a different sense, ***'the given'*** is also permeated and influenced by the background ideas and it ***is to be understood in the following three aspects:*** a selective aspect, having been marked out as significant by our best available background ideas, a descriptive aspect, having been appropriately described in terms of those background ideas, and an access-enabling aspect, having been made accessible by application of background ideas, the scientific character or value we find it to have is independent of – not determined by - those background ideas. [Shapere, *The Rational Dynamics of Scientific Inquiry*, Chapter II, p. 7, (Forthcoming)]. In this book he also elaborates on success, coherence, and doubt, which serve to justify the rationality of scientific belief

as science advances. The *piecemeal approach*[293] to the study of reality is more successful than its rival methods, like holism, mysticism, myth, rationalism etc. It is because:[294] **a)** The piecemeal approach could achieve what it promised to do, i.e. it could achieve domain descriptions and explanations; **b)** Through the piecemeal approach one could obtain results, whose relevance, possibility or conceivability was denied by the rival approaches. For instance, *holistic approach* could not see a piece of knowledge as a separate piece for the sake of study, rather always as a part of inseparable whole. *Rationalistic approaches* rejected any possibility that detailed empirical study of particular domain could lead to significant understanding of those domains; and *mystical approaches* often maintained that only revelation was relevant to their goals, whereas knowledge of specific domains was irrelevant. Results, proved to be impossible by its rivals, could be obtained with the piecemeal approach; and **c)** Through the piecemeal approach and its critical standards, it was shown * that it was possible to modify beliefs in such ways that an increasing number of specific beliefs were found satisfying those standards, * that it was possible to build further inquiry on those beliefs, and * that it was possible gradually to supplement the piecemeal approach itself, in an increasing unification of accounts of different domains, with al the consequences of that transformation.

3.2.3.3 Explanatory Coherence

A theory can be judged not only in terms of its success in accounting for its domains, but also in terms of ***compatibility or coherence*** with theories of other domains. A theory must have not only the domain success but also it needs to cohere with other domains. A theory is, of course, tested only within limited experimental situations, yet this cannot be a reason to doubt it. The ability to cohere with other domains is taken as one of the elements of rationality in science and coherence is elevated to be the 'aim' of science and counted as a

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[293] The piecemeal approach, as opposed to holistic or mythical approaches and so on, *demarcates different domains* of specific areas of research It approaches reality in a piecemeal manner, it tries to comprehend it in compartmentalized areas of experience, as moving bodies, gases, salts [Shapere, 1995b, in Leplin (ed), 1995]. Light, electricity, magnetism, heat are some more examples for domains of science Domain expands, and it is constructed increasingly as science develops, on the basis of available background information. Further, the description of domains and their constituent items, the formulation of problems, lines of research, and possible solutions regarding them, all these get reshaped and reformed as science develops There can be broad domains such as electromagnetism, genetics, organic chemistry etc. or even narrow domains like the interests of specialized individual research workers.

[294] Shapere, *The Rational Dynamics of Scientific Inquiry*, Ch. VI, p.39-40, forthcoming

reason for accepting (or lack of it, for rejecting) a new idea. Coherence paves the way for unification of domains, which in turn is the clear indication of the growth and development of science. Coherence in terms of unification of the explanatory accounts given by separate domains was given importance in due course. Some examples for unifications are: terrestrial and celestial physics (Newton), electricity and magnetism (Faraday) the incorporation of light into the resulting electromagnetic theory of light (Maxwell), the unified treatment of matter (Chemistry) and light in quantum mechanics, and the unification of Big-Bang cosmology and the particle physics of he Standard Model and beyond.

3.2.3.4 Goal Success

One may raise a question with regard to these two principles, the Principle of Domain Success and the Principle of Explanatory Coherence: whether they need any justification and if so, what is the character of that justification? The fact that domain success is achieved in many instances encourages achieving it in other domains as well. The goal of science becomes the effort to obtain domain success and coherence with other domains. In other words, **the Principle of Goal Success consists of the Principle of Domain Success and the Principle of Explanatory Coherence**. This Principle of Goal Success can be looked at two levels: *at the top level* it consists of * the achievement of what the inquiry promised; * the inability of the rival approaches to fulfill those achievements and * the accomplishment of successive extensions to other domains. At *the bottom level*, the principle of goal success consists of * the Principle of Explanatory Coherence and * the Principle of Domain Success (succeeding in explaining domains). The range of success is not a matter of working from 'top to bottom' – but from 'bottom to top'; judging successes first in explaining domains, then moving on to showing their coherence with explanations of other domains and finally checking whether the specific things what the inquiry had promised are achieved or not. Therefore it is a 'bottom-up' rationality rather than the top-down' rationality as it is usually thought of.

3.2.3.5 Absence of a Specific Doubt

The absence of a specific doubt is the fourth important element in the notion of rationality in science. For, as we have pointed out, the elements in background information, which is the

locus of the emergence of what counts as reason, can always be doubted because it is only contingent that we count that information as 'information' or 'reasons' Shapere contrasts, 'specific reason for doubt' with 'universal or philosophical reasons for doubt'. The latter, like 'A demon may be deceiving me', or 'I may be dreaming', can be applied indiscriminately to any claim whatever. Shapere claims that "such philosophical doubts play no role in the scientific or knowledge-seeking enterprise"[295]. He proceeds further to show that the fear about doubt is applicable to the negation too: "In principle possibility that doubt may always arise with regard to any of our beliefs – a possibility of doubt that applies *equally* to *every* belief, including its negation – is not itself a reason for doubt."[296] The element of doubt seems to be always present in every realm of science. For instance, in spite of all great advancements in cosmology today, the physicists, chemists and biologists don't accept the views of the universe as something dogmatic, but open for correction. But to doubt a theory, just because there is the possibility of doubting (Cartesian doubting!), is useless and meaningless[297]. We need to distinguish between specific (actual, genuine) doubts vs. Cartesian (universal) doubts.

Therefore, there is no harm in treating an item as a piece of genuine knowledge as long as there is no specific doubt against it.[298] In sum, Shapere's fundamental claim is that "what counts as a reason in science is not determined by the logical form of the reasoning, but by the content of science at a particular epoch "[299] What is counted or rejected as a reason is done on the basis of background knowledge. Components of the background information are included in for specific reasons. Thus there is no arbitrariness in selecting the constituents of the background information (as against the view of deconstructionists, postmodernists, proponents of mythic approaches and so on).

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[295] Shapere, 1982d, p 458
[296] Shapere, 2001a, in Hoyningen-Huene and H Sankey (eds), 2001, p. 201
[297] Shapere, 1986a, p. 6, italics in original
[298] Shapere, 1995b, in Leplin (ed.), 1995, p 19
[299] Shapere, *Rational Dynamics of Scientific Inquiry*, Ch VI, p 37, forthcoming

3.2.4 Rational Descendent of Classical Empiricism: Transcending Traditional Rationalism and Empiricism

According to Shapere, the question regarding the contributions of the investigator in the process of acquiring knowledge is a persistent issue in epistemology. For him, following are the burning questions in the knowledge-seeking enterprise: What does one actually investigate? - Is it one's own sense-experience or nature or the universe at large? Is knowledge obtained by direct observation or does the investigator bring his or her own aspects into it? If so, what is the nature of such contribution and is it necessary for the process of obtaining knowledge? Or is it not at all necessary, as one can deduce all knowledge from observation? Or is there any middle way possible, i.e. some knowledge can be deduced without any investigation and some knowledge can be obtained only through the investigation of nature?[300] Traditionally two major epistemological groups, ***Empiricism*** and ***Rationalism***, have tried to answer these questions in their own way. Both the groups have some deep insights, while they go wrong in some other aspects.

3.2.4.1 Two Rival Doctrines: Empiricism and Rationalism

While empiricism maintains that all the pieces of knowledge (concepts & beliefs), even if they don't have the character of knowledge, are rooted in experience, for their source and justification, rationalism argues that at least some knowledge is attainable by reason, independently of experience, without any interaction with the reality outside. But **two major criticisms against empiricism** are that it failed to clearly clarify what is meant by pure observation, which does not need any interpretation, and to show how all the other nonobservational beliefs are rooted in observation. Empiricism failed to realize that sense experience (which is the only possible way of having direct contact with the universe) always involves inference, as there is no pure 'given' available. If the importance of the 'given' in experience is stretched too far, one would land in 'solipsism', as one cannot justify believing in anything beyond one's own experiences; one can't speak of past or future, which are basically inferential in nature, going beyond the 'given' of here and now.

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[300] Shapere, 2006b, p. 732.

Hence Shapere is sure, that "empiricism, in its classical version, slid down the slippery slope to the skepticism that lay at the pit of the epistemological enterprise."[301]

Kant attempted to have a balanced view of empiricism and rationalism, by proposing that 'reason' gives us the ***form*** of inquiry (namely, the twelve categories including space, time, principle of causality etc.), and the sense-experiences give us the ***content*** of the inquiry; thereby he claimed to show that some aspects of knowledge had basis in both rationalism and empiricism as well. Unfortunately lots of problems arose with this proposal. Shapere highlights two major lacunae with Kant's idea: **a)** ***The idea of the absolute space and time as basic categories*** - The data coming from senses are not just passive reception; sensation takes place due to a positive decision to pay attention. Recent developments in mathematics, like non-Eucledian geometry, Reinmanian geometry, have disproved Kant's idea of absolute space. The successive mathematical concepts of 'space' undercut the allegations that there was anything 'essential' to space, in terms of which we must inescapably think. In contemporary physics space-time itself has to be explained in more fundamental terms. Quantum fluctuations seem to be of more fundamental importance than the ideas of space. Quantum field theory has come to show that space-time itself is a product of the breaking of the original symmetry of all four fundamental forces and therefore space and time themselves have been derived from other more fundamental elements. So space and time are not necessary forms of intuition Shapere argues that "even if this idea should not turn out to be viable, the very possibility of its conception betrays the Kantian philosophy"[302]; and **b)** ***The categorical status of the principle of causality***[303] – The principle of causality claims that every event, object, and properties of objects must be predictable from some previously existing conditions through scientific laws. But the quantum theories have strongly questioned this claim. Not all properties of an object can be determined at every moment of its existence. For the *Bell inequalities*, the *Aspect experiments*, *non-locality of quantum theories* – all reject the spatial localization of objects. The discontinuities, which are pervasive in quantum theories, reject that an object implies spatiotemporal continuity of the

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[301] Shapere, 1988b, p 301

[302] *Ibid.*, p. 303.

[303] Here it seems that Shapere treats causality and determination as one and the same But one can show that certain events / processes that cannot be determined, can still be shown / conceived to have been caused, and the causes may be unknown.

object and its behaviour. Thus the so called rational truths have been radically questioned and rejected.

3.2.4.2 An Objection against Empiricism - Never Clarified!

Shapere points out an objection against empiricism, which he thinks that other critiques of empiricism ignore. Classical empiricism never answered the following objection about its central claim: 'all our knowledge is based on sense experience' – is this declaration itself analytic (a matter of definition)? Or empirical (a matter of fact)? In both cases it would be highly problematic: "if analytic, it can, on its own principles, tell us nothing about the matters of fact with which it seems to be concerned; but if it is empirical, it cannot be established with absolute certainty."[304] Therefore empiricism itself (like its conclusion) is an empirical doctrine, and so it can bring itself to a stage at which it outgrows itself. Further, if the character of empiricism as a methodology is thus contingent, why it has been *de facto* key to so much knowledge? In retrospect, we can now see that empiricism has been a powerful methodology, not because it is a logically necessary methodology, but because of the way we and our particular universe happen to be (i.e. all our knowledge has to start with some interactions with the world).

3.2.4.3 Moving towards *Interactional Empiricism*

Shapere comes out with a renewed understanding of empiricism. Neither science nor philosophy can tell us on *a priori* grounds what method must be used in studying nature, how to learn about it, and much less about how nature must operate or reveal itself to us! Empiricism is useful at the beginning stage of our knowledge-seeking inquiry, but should we hang on to it at the later stages too? That is yet to be answered. Classical empiricism would deny or ignore many of the contemporary cosmological theories of Superstring, Inflationary theories[305] and so on as unscientific, as they are untestable in the traditional

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[304] Shapere, 2000, p 161.

[305] Shapere argues that for this Interactional empiricism mathematics is very essential Until 19th century mathematics was seen just a tool in science. But now Modern cosmology and quantum theory show that Mathematics plays a constitutive role in science **We need Mathematics to think in weird terms and to go beyond the medium sized-world to extremely small or big world.** All these conceptual thinking was (is) possible because of the power of mathematics of the 19th and 20th centuries We thus go beyond our earlier

manner. As they enter the region of metaphysics they are said to be exceeding the limits of good scientific reasoning. Empiricists will have to classify such theories and concepts of the modern simply as ''theoretical' (i.e. all nonobservational entities). For, the tools of logical positivism (verification theory of meaning and justification), logical empiricism (theory-independent observation-language) and Popperianism (falsifiability) don't seem to be sufficient and capable to test the theories of the modern science.[306]

Shapere argues that even if classical empiricism has fulfilled its explicit aims, and even if those aims were not wrong in principle, it would ***not*** have given an account of how science proceeds, because concrete scientific reasoning (as in the solar neutrino experiment) consists of far more than what is exhausted by saying that 'all our knowledge (or beliefs) rest on sense perception'. For, empiricism made a fundamentally wrong turn: "The assumption of classical empiricism was that reflection on what could be constructed on the basis of sense-perception was both necessary and sufficient for understanding what happens in scientific investigation. It is neither."[307] For, sense perception is ***not sufficient*** because in whatever way one may interpret sense perception, its analysis would not be enough to understand the knowledge-seeking process completely, the nature of knowledge, the implications of the existence of knowledge etc. Sense perception plays only a minor role in this process of getting information. Moreover, in many cases sense perception has been shown to be untrustworthy. Similarly, sense perception is ***not necessary*** because it has been pushed to the periphery in the modern science. Instruments have replaced the need of direct sense perception and it is needed only at the last stage when the data is transformed into humanly-accessible form.[308] So from perceptual empiricism (classical/logical/constructive), we move on **towards Interactional Empiricism**; from the notion of necessary reliance on observation we move on to **focus on observation as relevant only in a certain domain or stage of the investigation;** and from the equation of sense perception = observation, we move on **to show that both are separate and distinct**.

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modes of thought, to transcend the preoccupation with the practical and the local to think of something which is hitherto unthought-of. [See. Shapere 1998b, in Pin (ed), 1998]

[306] Shapere, 2000, p. 154.

[307] Shapere, 2006a, p. 527 (15).

[308] Shapere, 1982c, p. 508.

3.2.4.4 Knowledge-Seeking Process as Rational Descendent of Classical Empiricism

Shapere views the knowledge-seeking process[309] (science) as ***Rational Descendant of Classical Empiricism***[310]: it is empiricism, because we have to interact with the world to learn about it; and it is rational descendant as well, because we have to learn what it is to interact; with the help of the background information we have to learn to how to learn. All our knowledge (or beliefs) rest on interactions with the world. But what counts as an interaction, at least at sophisticated levels of inquiry, is determined by what we already have good reason to consider as background information. It is a ***generalization of classical empiricism*** (for sense perception is relevant only with one minor region of electromagnetic spectrum, a manifestation of one of four fundamental forces with nature); and at the same time it is a ***departure from classical empiricism*** (for we have to learn to go beyond the dictates of sense perception).[311]

Shapere's viewpoint, thus, "***is neither an aprioristic rationalism not a sensory empiricism***", though it takes certain important aspects from both of them into consideration: namely, we bring some background information to interpret the data available, however that background information is changeable for specific reasons; "***it is neither relativist nor foundationalist,***" due to the fact that the observation–situation is infused with background information and there is 'the given' in the whole of inquiry; "***it is both historical... and rational***", because even what counts as 'reason' too emerges over the periods of history, and finally "***it is far more concerned with content than with logical form*** (though the later is not excluded)"[312] as after all the actual science is more interested in the contents rather than the formal frameworks and thus this view is faithful to the actual practice of science.[313]

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[309] This knowledge-seeking process, for Shapere, practically means Science, as science is the best available process.

[310] Shapere criticizes not only empiricism but also rationalism Rationalism, he argues, could not establish any substantive truths about reality, totally independent of any connection with the senses He attacks even the compromise proposed by Kant to synthesize both empiricism and rationalism Kant's *a priori* intuitive forms of Space-time category and the Principle of Causality have been seriously questioned by the contemporary physics. [See· Shapere, 1988b].

[311] Shapere, "Observation," 2006a

[312] Shapere, 1995b, in Leplin (ed), 1995, pp. 25-26

[313] One may be reminded of the idea of 'constructive empiricism'. But this idea does not commit itself to realistic understanding of theoretical entities. Since this view considers 'perceptual' as relevant to scientific realism, it is not making any commitment to realistic claims. Its proponents distinguish between perceptible and nonperceptible. For instance, Fraassen differentiates observing Jupiter (if not now, later!) from inferring the particles in a cloud chamber, where the latter is only an inference, as we do with a jet trail in the sky [van

In sum, Shapere's view of science as knowledge-seeking process, which ***transcends both empiricism and rationalism***, consists of the following elements: **a)** In the inquiry of knowledge (in dealing with experience) we must employ some prior set of ideas, which is a half truth of rationalism; **b)** there is no unique set of such prior ideas (concepts or propositions), which we have to bring to our inquiries (as against the classical rationalism's claim that there is such a unique set of ideas) and **c)** There are many (even infinite number of) alternative concepts or propositions that will serve equally well in dealing with experience or the universe. Here one might perceive the danger of relativism and to avoid that, **d)** There are at least better and worse concepts that can be brought to bear in dealing with experience, and whose betterness or worseness can be decided upon specific reasons and to select those items which we bring to the investigation; and it may in at least some circumstances be the case that there is only one best set of such concepts or propositions. Thus "all our knowledge does indeed depend on observation... but we bring to our inquiries prior beliefs for the selection, description, and access of what to observe; and that is... the legitimate residue of the rationalist tradition in the theory of knowledge."[314]

Having given a fair presentation of Shapere's major contributions, I turn to some of his major critiques and Shapere's response to them in the next Chapter. I end that Chapter with my own assessment of some of Shapere's ideas.

Fraassen, 1980, p. 16-17]. However Shapere argues that it is the evidential, not the perceptual, which is relevant to realism in the world of science. Scientists meaningfully talk about 'observing' the unobservables (e.g the neutrino experiment). "Thus, if the question of observation is relevant to the question of realism, the latter must be resolved not by considering what is perceptible to the senses but by examining the evidential aspects of observation." [Shapere, 2006a, (p. 21)] Scientists are justified in speaking about the unobservables in a realistic manner because of the practical success they get in employing those ideas

[314] Shapere, 1998b, p 311.

CHAPTER 4

ASSESSMENT OF SHAPERE'S VIEWS

4.0 Introduction

Shapere by and large evokes a lot of reactions from philosophers and philosophers of science, probably because he attempts at a balanced view between the positivists and the historicists. In this Chapter I assess Shapere's ideas. There are three sections in this Chapter. ***Section 1*** deals with some of the major critics of Shapere, while his response to them is given in ***Section 2.*** I come up with my evaluative remarks of his ideas in ***Section 3*** Recapitulating in a nutshell his notion of rationality in science, I spell out some of the implications of such a notion.

4.1 MAJOR CRITIQUES OF SHAPERE

4.1.1 Jarret Leplin: Circular and Dogmatic Nature of Shapere's Views

Leplin[315] has critiqued Shapere's notions of scientific aims, goals, rationale of scientific change, the relations between science and philosophy of science and the methods of philosophy of science. He criticizes that Shapere has no regard for the sceptical inductive argument[316] (i.e. the scientific theories have failed in the past, so will it be in the future!). I just mention two of the major critical discrepancies that he points out in the views of Shapere, namely, that Shapere's views on rationality involve a sort of circularity and that Shapere views theory change in science as a dogma.

Leplin argues that Shapere's view of rationality of science is plagued with vicious circularity. This is because Leplin construes Shapere's views in the following way: "The rationality of science in the long run is self-certifying because it is legitimate to criticize something in science only on the basis of something else in science. The rationality and epistemic warrant of science are determined by concepts themselves constituted by science

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[315] Leplin, 1984b in Leplin (ed.), 1984a, 1987, 1988a and 1988b
[316] Leplin, 1984b, in Leplin (ed.), 1984a, p. 199

(compare Shapere 1985)".[317] Leplin sees no rational connection, as against the demands of Shapere, among scientific developments. He gives an example to show that Shapere's view does not work: Pre-Daltonian and contemporary tokens of 'atom' or the 19th century and contemporary tokens of 'electron'[318] – there is no connection or resemblance between the usages of these two terms at these two epochs.

Shapere, according to Leplin, seems to hold that theory change in science as dogma, with no proper distinction made between rational and non-rational: "It is nothing short of a dogma in Shapere ... that virtually *all* scientific change is rational".[319] Leplin also views Shapere treating both the notion of background information and the chain-of-reasoning as dogma. These connections make the link practically with everything that is taking place in science with everything outside science.

4.1.2 John Losee: Problems with Shapere's Non-presuppositionist Philosophy of Science

Shapere has proposed a non-presuppositionist Philosophy of Science, which is normative and yet avoids inviolable principles. His non-presuppositionist account, in Losee's understanding,[320] demands that:

a) There is no supra-historical evaluative standpoint and what counts as 'rational' is also subject to change, over the history of science. The criteria of acceptability, rules of procedure, epistemological and metaphysical assumptions – all change over history. One does not have any supra-historical evaluative standpoint and therefore there is no 'inviolability thesis'.

b) It is possible to obtain knowledge in science, and philosophy of science has to show how it is done. A theory replacement in the course of the developments of science is a clear indication of a gain in knowledge. For Shapere, "x knows that T, if and only if, x believes that T and T has been applied successfully over

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[317] Leplin, 1988a, p. 509.
[318] *Ibid.*, p 508
[319] *Ibid.*, p. 509
[320] Losse, 1986.

a period of time and no one has a specific doubt about T"[321]. For him the general doubt that any time a piece of knowledge may be discarded is irrelevant to the issues about knowledge.

c) An account of Philosophy of Science must preserve the objectivity and rationality of science. As science is not a subjective and irrational enterprise and philosophy of science must exhibit objectivity and rationality very clearly.

But John Losee[322] lists out the requirements of a normative account of philosophy of science:

a) A normative account of philosophy of science must contain at least one evaluative standard, 'S', which is applicable to evaluative problems of confirmation-status of hypothesis, comparative acceptability of theories or the adequacy of explanation etc.

b) At a given time, at least one application of 'S' to a present evaluative situation in science determines the correctness of a particular judgment in that situation; and

c) Apply 'S' to evaluate that situation.

These evaluative standards too are subjected to justification. Aristotle, Whewell, Mill, Hempel, Nagel – all acknowledged the need for justification of evaluative standards, and advanced justificatory arguments to justify the evaluative standards they use. Therefore, a last requirement,

d) The question about the adequacy of evaluative standards and particular application of these standards are to be held relevant. Among those evaluative standards, there is at least one S, which has a justificatory argument.

Thus, Losee argues, against Shapere, that a normative account of philosophy of science is not possible without at least one inviolable principle. Shapere claims that all standards of evaluation are also subject to change. But if there is no justificatory argument is available

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[321] Shapere, 1980b, in Nickles 1980, pp 83-4.
[322] Losse, 1986.

then the transition from one stage to another is arbitrary. Such an account of philosophy of science is merely a succession of unrelated evaluative standards and, in fact, there can't be any overarching philosophy of science. If we have evaluative justification S_k at one stage t_1, and another justification S_j at t_2, how to talk about the transition stage? Given that there is no inviolable principle, we need to have a meta-level principle (which stipulates that comparative justification of evaluative standards is to be determined by appeal to present day standards of rationality). If the criterion of rationality also changes at a given time, one displacing another, on what basis can one choose one over the other? One can't be discarded just like that without any proper justificatory argument.

Methodologists want to know whether a standard S can be applied in a given situation, whereas a nonpresuppositionist would say, "yes certainly, if it *works*"; but that can be known only after it has worked out well. So, if the correctness of the evaluative practice can be decided only after the 'fact', then the normative judgments are actually historical judgments. If so, Losee points out, Shapere has two options: either "to pursue the nonpresuppositionist program under weak strictures on prescriptive status, and accept the consequent incorporation of philosophy of science into the history of science; or to stipulate within PS (Philosophy of Science) at least one principle held to be inviolable".[323]

4.1.3 Gerald Doppelt: Shapere's Views in Need of Clarification

Here I focus on Doppelt's criticisms against Shapere's notions of theory change, success, and epistemic gain/loss. He argues that Shapere needs some universal standards, though Shapere denies them, in order to make Shapere's notion of science viable. Finally I highlight how he charges Shapere of (moderate) relativism.

4.1.3.1 Problems with Shapere and Other Post-Kuhnians

Doppelt argues that post-Kuhnian trends, which include diverse thinkers like, Feyerabend, Hanson, Toulmin, Lakatos, Hesse, Laudan, Shapere and so on, pay more attention to history of science, at the cost of due attention to the content of science. The historicist standards

[323] Losee, 1987, p. 70-71.

make a clear division between post-Kuhnian programme of science and, its rival, logical empiricism. But among all these historicists there is a lack of consensus in the notion of rationality. All these historicists ignore the philosophical requirements that ought to be satisfied by any completely adequate conception of scientific rationality. **The problem with them in general is that they want, on the one hand, to give importance to history of science and on the other try to develop a non-relativistic conception of scientific rationality.** However they lack 'philosophical clarity' in their efforts to achieve these two goals. They seem to fail to give the properties which an epistemological conception of science must have.

4.1.3.2 Shapere's Notion of Success – Unsuccessful

The notion of success is very important in Shapere's framework. When a scientific belief fulfils the requirements of success, coherence and the lack of any specific doubt it is accepted as rational.[324] The rationality of theory choice also depends on the empirical success of the theory. But he does not seem to give a clear account of the notions of *success* or *specific doubts*. If these standards are specific to domains, Doppelt argues, how can the scientists of the other domains will judge the given theory? This presupposes or necessitates some common notion of success across various domains.[325] Shapere denies that there is any such universally valid standard to measure empirical success or the shifts in such standards. He asks, therefore, "... what better 'standards' or 'criteria' could we employ... than those beliefs, methods, and so forth that proved successful and have not been faced with specific doubt!..."[326]. Doppelt argues that Shapere's such words involve a kind of circularity, even a paradox: for, there are only shifting, contingently acceptable standards of success; and yet it presupposes some rationality of shifts in these standards which rest on some more fundamental universal sense of success. So a pertinent question arises: "How could philosophy of science judge the rationality of the scientific corpus of beliefs at time T_2 as more successful that its predecessor at T_1, if the success of each is exclusively judged relative to its own special standards(s) of success?".[327]

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[324] Shapere, 1982d, p. 458.
[325] Doppelt, 1988, p. 116.
[326] Shapere, 1984d, in 1984a, pp 226-7.
[327] Doppelt, 1988, p. 118.

4.1.3.3 The Need for Some Universal Standards – Against Shapere's Demands

A sort of *Canon of consistency* can be formulated from Shapere's view: "The rational credibility of the scientific corpus at a time T_1 depends (other things being equal) on the degree of consistency of (a) the theories that scientists accept (and judge as rationally acceptable) at T_1 with (b) the aims and standards governing theory acceptance that they accept at T_1"[328] Without the assumption of such a canon Shapere can't show why it was rational for modern physicists to adopt a standard legitimizing unobservables (free quarks)... But it is very clear that Shapere[329] has denied that consistency is a universal requirement of scientific rationality and therefore it is rational in science sometimes to accept a particular inconsistency. Doppelt opines that Shapere's idea of scientific rationality actually presupposes some sort of universal aims, methods and standards, which run through the entire development of science and he strongly argues further that minus these important assumptions "(Shapere's) examples and account of rational change would involve a completely question-begging, irrelevant, ultimately empty appeal to 'success' in science."[330] To avoid this lacuna Shapere needs to agree with some universal standards. For instance, Doppelt argues, Shapere has to necessarily adopt a sort of universal notion of success. It may be, for instance, that the ultimate aim of all science is to maximize the over-all rational credibility of the corpus of scientific beliefs – this is actually a presupposition of universal notion of successful science; and the method would be to initiate changes of scientific beliefs that eliminate or reduce tensions, inconsistencies, shortfalls etc. This conception also presupposes a universal standard(s) of scientific rationality, i.e general canons of scientific reasoning to govern the degree of mutual epistemic support, consistency and over all credibility exhibited by the scientific corpus of beliefs at a given time.

4.1.3.4 The Notion of Epistemic Gains – Ignoring the Epistemic Losses

Shapere argues that the epistemic gains constitute the reasons for readjustment in aims, standards etc. of science and he does not mention anything about the epistemic losses and also not about the epistemic gains which would have occurred, if other readjustments had

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[328] *Ibid.*, p. 119.
[329] Shapere, 1984h, in 1984a, p 235-7
[330] Doppelt, 1988, p. 120.

been chosen. While epistemic gains constitute good reasons to accept the change rationally, the losses may equally justify the rejection of that change and the preservation of existing standards. It is only a possibility of epistemic losses in the abstract poses any real problem for Shapere. But, in fact, Shapere argues that philosophy of science must not rest content only with a study of what actually happened in science but also must consider what 'could have' and 'should have happened'.[331] For him a change in scientific standards is rational if and only if it enhances the over all 'success' or epistemic credibility of the scientific corpus at that time; that is, "against moderate relativism, can Shapere's conception show that a change to some new scientific standard B was more rational than continued adherence to its predecessor A and that the change was motivated on this basis...?"[332] To overcome this challenge Shapere has to show: either those epistemic losses are not genuine losses or the epistemic gains outweigh those losses (with the acceptance of new standards and therefore it is rational to change). However, he is not giving any elaboration on this, no example in actual history, or any philosophical argument; it is formidable without any universal standards of aims, methods, evidence etc. Shapere must elaborate the notion of enhancing the success or credibility to deal with the problems of epistemological loss / gains; or moderate relativism emerges! If his account does not show that new scientific standards were more rational to accept than their predecessors, then the way is open for non-cognitive (sociological etc.) considerations of these choice and further cognitive relativism too is not very far.

4.1.3.5 Shapere – A Moderate Relativist!

Doppelt argues that Shpaere's position lands him, at least, in a moderate relativistic position, as Shapere himself seems to be interested in avoiding only extreme relativism. For, Shapere declares, all that is important in philosophy of science is avoiding 'extreme relativism' (which says science is largely irrational or non-rational)[333]. However, Shapere's claims about science made elsewhere in his writings, force him to have a conception of science, that has to overcome *even* moderate relativism: for instance, Shapere says, a) Philosophy of science must show that modern science is 'better' than its predecessors, which had 'wrong'

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[331] Shapere, 1984i, in 1984a, pp. 194-5
[332] Doppelt, 1988, p. 121.
[333] Shapere, 1984j, in 1984a, p. 330; 1984k, in 1984a, p. 415

(not just worse) aims, standards, methods etc.[334]; b) Science generates 'increasingly' well-founded and reliable beliefs; its cognitive achievements are cumulative and steadily increase in history of science.[335]; c) He wants to give an account of scientific change that avoids non-cognitive, sociological, economical, psychological explanations of rational scientific development; thus it is clear that he values the avoidance of sociological relativism[336]; and d) He prefers a realistic interpretation of science on which science achieves discoveries, knowledge, truth, 'discovery of the way the things are'.[337] Apart from this discrepancy in Shapere's claims, Doppelt points out that the reasons for a theory change must be more rationally compelling than those earlier reasons, which favoured A over B in the past. The good reasons for preferring B now must actually motivate the historical proponents of A to reconsider their choice. This would avoid **even moderate relativism,** that is, one does not have equally good reasons to adhere to older theory. This overcomes the relativism concerning the gap between rational scientific theories and irrationally / non-rationally motivated scientific beliefs.[338]

Shapere's account of scientific rationality fails to satisfy his own pictures of science. This shortfall is due to "a failure to appreciate the distinct anti-relativist requirements and relativist challenges at issue in a completely adequate account of scientific rationality"[339] and by just giving 'good' reasons for the scientific change, one may avoid extreme relativism, but still the challenges from moderate relativism remain. All trends of post-Kuhnian era will do well if it realizes the mistake of taking "any account that overcomes extreme relativism" to also overcome "moderate, sociological, and cognitive relativism."[340]

No doubt, Doppelt does recognize the great achievements of Shapere and other post-Kuhnians as they have efficiently challenged the thesis of extreme relativism and radical incommensurability. But the relativist challenges to scientific rationality are subtle; it needs to be tackled by them and other philosophers of science in the post-Kuhnian trends as well.

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[334] Shapere 1984h, in 1984a, p. 211.
[335] *Ibid.*, pp. 205, 228-231.
[336] Shapere, 1984l, in 1984a, p 306.
[337] Shapere, 1984h, in 1984a, p. 227
[338] Doppelt, 1988, pp. 105-107.
[339] *Ibid.*, 132.
[340] Doppelt, 1988, p 132

4.1.4 Toby Linden: Shapere's Problematic Views on Observation

4.1.4.1 Objections over the Notion of Observation

Shapere analyses the concept of observation with examples to show what it is to be directly observable (observed).[341] But Linden[342] shows a contradiction by arguing that these two experiments are probabilistic in nature while the analysis is absolute.

Shapere gives many examples of famous astrophysicists, who agree that the core of the sun, which is at enormous high pressure and heat, is directly observable, though it has 400,000 miles of opaque material form the surface of the sun, which is normally said to be beyond our direct access for ever. Shapere cites two ways of getting information about the core of the sun: **a)** by studying the electromagnetic radiation (light photons) that is emitted from the core of the sun, and **b)** by collecting the neutrinos coming from the sun. Here the former is said to be the 'indirect' method, as the photons get scattered, absorbed, or radiated, and thus any information that we are able to arrive at by studying these photons will be 'indirect'. On the other hand, neutrinos have less probability of interacting with other particles on their way to the surface from the core, and therefore it is direct. From these, Shapere concludes: "X is directly observed (observable) if **a)** information is received (can be received) by an appropriate receptor, and **b)** that information is (can be) transmitted directly, i.e., without interference, to the receptor from the entity x (which is the source of the information)".[343]

Linden's Objections: **a)** Shapere points out that the only contrast between these two experiments is that the neutrinos have less probability for interfering with other particles, while such probability of photons is quite high. But from such probability considerations one cannot derive an absolute condition: "No interference is possible if direct observation is to take place"[344]; and **b)** The level of probability of interference cannot be the key element in analysis. It may give us only an account of what it is for something to be observable. "The

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[341] Shapere, 1985.
[342] Linden, 1992.
[343] Shapere, 1982c, p 492. For more details on this, see **3.2.2.3.**
[344] Linden, 1992, p. 294.

likelihood of the interference (alteration) is not relevant to whether an observation has taken place on a particular occasion"[345].

Linden's Analysis of the Neutrino Experiment

The features of the examples can be pointed out as the basis of what it is for something to be directly observable (observed): * the probability of interference, * the magnitude of interference with radiation and * the magnitude of alteration to the information carried by the radiation.

a) In the case of photons, Shapere claims, due to radiation, the information is altered and in that of neutrinos it is not altered. His analysis seems to ignore the difference between the *interference with radiation* and the *alteration to the information carried by radiation.* Objects may be interfered with but the information carried by them need not be. The probability of interference cannot do the work that Shapere wants his analysis to do.

b) The magnitude of interference with the radiation does not seem to be so crucial as Shapere shows it to be. For, with regard to photons the interference with radiation is so severe that the actual radiation is changed, while he is not explaining how it is that the neutrinos are not affected by the radiation; further he talks only about *the transmission of the information* and not about *the character of radiation*; and most importantly, Shapere focuses only on the interference between the source and the receptor and ignores the interference that occurs after the radiation reaches the receptor. He may subsume all such details under 'background information' yet one must check whether or not interference takes place after the radiation reaches the receptor.

Human elements are essential for something called 'observation' to take place. As Shapere puts it, "whatever information is received through the 'appropriate receptor' must be

[345] Linden, 1992, p. 294.

transformed... into humanly-accessible form"[346]; nevertheless he further states that a human perceiver need not be there "for years. Yet it still counts as observational"[347]. This is a bit far-fetched, as we cannot claim the process of detecting the far-away galaxies observational, if somehow humans don't enter in the long process.

Shapere suggests that the reliability of the experiments depends on the background beliefs of neutrinos and photons. If the background beliefs are doubtful then the reliability is less. In the case of neutrinos the probability of interference (and therefore the alteration in the information) is less; that is there is no specific reason to doubt the background beliefs, whereas in the case of photons such probability is high because there are the specific reasons to doubt its background beliefs. But in future if the background beliefs of photons have overcome all doubts, then photons too can be used to observe the core of the sun. Thus, as of now, he claims that the observation (of the core of the sun) based on photons is inferential (therefore *indirect observation*) and while that based on neutrinos is non-inferential (therefore *direct observation*). But he frequently uses 'directly observe' and 'observe' interchangeably.

4.1.4.2 Modification of Shapere's Definition of Observation

Linden points out that Shapere is not consistent in using the terms 'directly observe' and 'observe' as he uses both the expressions interchangeably. More crucially, the neutrinos, as Shapere himself is aware, do not carry the information as to where they come from. In science it only means that the receptor is pointed in the direction of the source to be observed. But Shapere decides that we can safely conclude that the neutrinos come from the centre of the Sun, because those from other (possible) sources are below the capacity of the apparatus to capture them. It must be noticed, as Linden argues, that "it is the theory of the source and transmission, not the directionality of the receptor that permits us to say that we have made an observation. Shapere is explicit that he intends his analysis only to provide sufficient and not both necessary and sufficient conditions for observation" [348]. Linden is sure that Shapere's view is in need of some focusing, without which Shapere's view will not

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[346] Shapere, 1982c, p 508.
[347] *Ibid.*, p. 509.
[348] Linden, 1992, p 299. Linden quotes from Shapere, 1982c, p. 510

even be sufficient. With these considerations, Linden proposes a correction in the definition of 'observable' proposed by Shapere: "X is observed (observable) if: i) information is received (can be received) by an appropriate receptor, from an entity x (which is the source of information); and ii) that information is (can be) transmitted *reliably* (not *directly* as Shapere worded it), i.e., there are no specific reasons for doubting that any interference to the radiation is accounted (accountable) for"[349].

Having seen some of the major critics of Shapere I now proceed to the next Section to see what Shapere has as a response to these critiques.

4.2 SHAPERE'S RESPONSE

Here first let me focus on the two important papers in which Shapere explicitly answers the objections raised by Doppelt and Leplin. Then I turn to the discussions that I had personally with him.

4.2.1 "Doppelt Crossed"

As Shapere understands, Doppelt critique can be grouped under three groups:[350] a)Regarding the concept of 'success' (no analysis is provided, and therefore the concept of 'reason' unexplained; in need of some universal criterion); b) Regarding the role of standards/criteria in science (how they are related with the substantive beliefs, the possibility of rejecting them); and c) Regarding his becoming a prey to the challenges of (moderate) relativism (underdetermination of beliefs; problem of loss in scientific change).

Doppelt charges Shapere that the notion of 'Success', which plays a primary role in Shapere's account of rational scientific change, is not defined properly. But Shapere points out Doppelt's oversight in this regard, as there are papers which elaborately discuss the notion of success. For instance, "Objectivity, Rationality and Scientific Change"[351] explains that a theory is successful if it is able to account for its domain and "Method in Philosophy

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[349] Shapere, 1982c, p. 492.
[350] Shapere, 1988a
[351] Shapere, 1984g, in Asquith and P Kitcher, 1984

of Science"[352] provides other characteristic of success, namely, the absence of any specific doubt in giving that account for the domain. So, that which is successful and free from these doubts becomes a part of the 'background information'. Similarly Doppelt mistakenly equates the idea of what counts as reason in science only with the criterion of 'success'. It is better that he is aware of the other factors[353], namely coherence with other domains and the element of 'given', which make up rationality in science.

Doppelt claims that since there are many approaches available to decide upon the idea of success, one needs a universal standard of criterion, apart from the process itself. Shapere agrees that there are many approaches available and the piecemeal approach is one among them (the others approaches are mythic, holistic, rationalistic etc); However the *piecemeal was favoured finally because of the following considerations*: i) what that approach promised could be done really could be done, ii) through that approach, it turned out that results could be obtained whose relevance, possibility, or conceivability was denied by rival approaches, and iii) that approach and the critical standards it carried with it, it could refine / alter beliefs in such ways that an increasing number of specific beliefs were found satisfying those standards, that it was possible to build further inquiries on those beliefs, and that approach was able to unify accounts of different domains. These don't refer to another surreptitious application of more basic 'criterion'... 'Being able to do something which other approaches said could not be done' – is not a criterion; to hold it as one of the presuppositions that lay down standards with specific content is to invite a confusion of a philosophically dangerous sort. "The victory of a standard of success, like that of the piecemeal approach to inquiry, need not presuppose some more fundamental criterion (in the sense of a specific theoretical presupposition) of success"[354].

Doppelt thinks that since there are many ways of resolving conflicts and tensions in scientific framework the danger of relativism looms large again. However Shapere reiterates: "the fact that there are typically many ways of resolving problems in science does not necessarily imply relativism".[355] For instance, in 1905, to resolve photoelectric-effect

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[352] Shapere 1986b, in Nersessian (ed), 1986.
[353] Shapere 1984g, in Asquith and P. Kitcher (eds.), 1984, pp 656-657.
[354] Shapere, 1988a, p. 136.
[355] *Ibid.*, p. 137.

problem, many proposals,[356] besides Einstein's were available; yet, finally it was decided in favour of quantum theory. Though the alternatives are logically consistent there can be other criteria for selecting. Just because the alternatives are logically consistent one cannot decide that there is no other criterion to choose one among them; for, "logic by its very nature cannot say anything about the *content* of the alternatives in question, and so says nothing about whether there are contentual criteria by which some, or even all but one, might be ruled out."[357] Thus, when conflicts are examined, in many cases, except may be a few, there are good reasons available to choose an alternative. One can also give a 'defensible account' with good reasons to justify that particular choice.[358]

Doppelt blames Shapere that he ignores the problem of 'epistemic losses', as gains justify the theoretical changes, the losses may justify the preservation of old theory. Shapere does not deny the fact of the epistemic losses but the mere possibility does not imply they do actually exist; it does not mean that we cannot recognize and deal with any losses that actually occur; and further, it does not mean that always there must be losses, and losses need not be equal in weight with regard to the epistemological gains, which justify theory change. It would do well to realize that an initial gain may turn out not to be a loss at the end; science is not all-at-once process; because a theory may be proposed first as a hypothesis, and may not achieve as the old theory did; they may realize that nothing was lost from earlier views Moreover, the transition from A to B can be a gradual one, not that all the standards of the new theory have to be clearly formulated at an initial stage. In the beginning it may be proposed as a 'working hypothesis' and may not have clear idea about its standards, whether it will be borne out or not in course of time. Doppelt points out that when there are good reasons to favour B over A, and there may be equally good reasons for adhering to the old theory, then how to settle, in other words, the problem of: "Underdetermination of scientific changes by good reasons". Shapere asks in return, 'Does it mean that there are never *better* reasons for one alternative over another?' Such a view would be an exaggeration and would be as immoderate as extreme relativism as well. There are cases where better (if not conclusive) reasons available. History of science shows that there are some cases, where there is such *better* reason.

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[356] See: Steuwer, 1975, Chapter 2.
[357] Shapere, 1988a, p. 137.
[358] *Ibid.*, Shapere, p. 138.

4.2.2 "Leplin on Essentialism"

Shapere in his paper, "Leplin on Essentialism,"[359] refutes most of the charges levied against him by Leplin. He strongly disagrees with Leplin regarding the accusation that Shapere's concept of rationality in science is self-certifying. In "Objectivity, Rationality and Scientific Change"[360] and many other papers Shapere has demonstrated how the notion of scientific change is not self-certifying: **a)** a vast, vague competing variety of way of classifying elements of experiences, conceiving problems related to them, how to understand and to explain them, to answer them etc. were suggested by every day experience; **b)** the piecemeal approach carried with it a standard according to which explanations were required to account for an isolated domain of purported facts; **c)** that approach gradually proves its capability to give such accounts, and more generally of doing what it promised it could do; **d)** that approach gradually triumphed over competing conceptions of what counted as a reason and how to learn about the world; and **e)** accounts of separated domains frequently proved coherent, identical, or unifiable with one another, so that a further standard of reasoning, the coherence of accounts of different domains, arose, and that gradually, again as a matter of contingent fact, the piecemeal approach itself began to be transcended in an increasing unification of science[361].

Regarding Leplin's charge that Shapere's view of chain-of-reasoning does not solve the problem of incommensurability, Shapere points out that the very example that Leplin provides (notion of electron) has been used in many of his papers[362], to show how there is a rational progress along the developments in science. Therefore Shapere explains that "those ends appear to be incommensurable only when viewed in abstraction form the intervening chains of reasoning".[363]

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[359] Shapere, 1991c.
[360] Shapere, 1984g, in Asquith and P. Kitcher (eds.), 1984
[361] Shapere, 1991c, p. 658
[362] See: Shapere, 1984j, in 1984a and 1984 (Chapter 15), and 1989a.
[363] Shapere, 1991c, p. 663. Here I like to point out that though Leplin rejects Shapere's idea of overcoming incommensurability as untenable, Leplin himself reflects Shapere's position for rejecting the idea of incommensurability: Incommensurability is nothing "but an artefact of a particular program in the theory of meaning... [which] is best resisted not by ambitious philosophical analyses of scientific rationality, but by disowning that program's model and reference". [Leplin, 1988a, p. 508]. But this is precisely what Shapere has been arguing over the years on the thesis of incommensurability. [Shapere, 1964b, 1982a; 1982b, in Hacking 1982; 1982c; 1988a; and 1989a]

Leplin sees that Shapere's view cannot help constitute knowledge, due to the ever-present possibility of scientific change. But for Shapere, though the possibility of doubt is possible in principle, yet, the conclusion does constitute knowledge. Therefore he asserts, "I hold that there is such commitment so long as we have no significant reasons for doubting a successful scientific claim, which they count as knowledge."[364] Commenting on Shapere's position Leplin charges that "it is impossible to regard conceptual diversity as a rational development".[365] Shapere rejects this as yet another misunderstanding by Leplin. For, background information is never a monolithic body, it provides conceptual sources to understand what the problems are and to provide answers to those problems. This fact expresses the incompleteness of science, containing gaps, inconsistencies, ambiguities and other sorts of problems. Heterogeneous background of ideas which are 'internal' to science provides such variety. Hence it is wrong to say that reasoned diversity is impossible and it is not that the only possible source of conceptual diversity in science is external influence.

Regarding Leplin's campaign for the H-D method to be the method of science, Shapere argues that Leplin seems to be unaware of the problems involved in the H-D method. In addition to the defects with the 'deductive' aspect, it (H-D method) also fails to acknowledge the extent to which new hypotheses are built in the light of prior knowledge; further "it fails to recognize that, when science has reached a high level of sophistication, it only rarely, if ever, needs to appeal to external considerations".[366] The new hypothesis in 'some sense' relies on the 'free creativity' on mind. But science is based on or derived from the best science available. It guides further investigation, the formation of hypothesis etc. At the same time, it is not true that science allows anything in the name of 'free creation' on mind. Science does not stop any abstract speculation outright. However, unless there is a serious reason, it won't take up any hypothesis for genuine consideration[367]. Thus, though, Shapere agrees with Leplin in saying that the history of science does not vouch for inductive method, yet he disagrees with Leplin in upholding H-D method. In fact, the weakness and the strength of the H-D and inductive methodologies can be mutually complementary, so as the weakness of the one is the strength of the other.

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[364] Shapere, 1991c, p.662.
[365] Leplin, 1988a, p. 509.
[366] Shapere, 1991c, p. 672.
[367] *Ibid.*, p. 673.

Shapere does not agree with Leplin in saying that there is no positive evidence to prefer one method over the other; for "we do in fact have powerful and convincing evidence to that our construction of theories should be constrained by consideration stemming from science itself"[368]. We always need something to work on. Though we don't rely on naïve induction, we need something to begin with, to derive from: "In an important sense, there was no first philosopher, no first scientist, no first observer; no one starts out with nothing in terms of which to conceive and interpret, to raise questions, to provide expectations, and to inquire critically".[369] Human experiences provide the background from which inquiry has departed. Thus it is not correct to say that there is no evidence, no reasons for preference to a particular methodology.

Many objections were clarified by Shapere himself during my **personal interviews** that I had with him, on several occasions from July till October, 2006. Some of the major points that came up in our discussion are given below.

4.2.3 Toby Linden's Objections on Observation

While analyzing the neutrino experiment Linden charges Shapere that there is no distinction made between *the interference with radiation* and *the alteration to the information carried by radiation* **(4.1.4.1)**. But Shapere clarifies, again in the same personal interview that "the information *is* the state of photon, and it is not to be treated as something added to photon, as if photon is carrying the information on its back, and hence the distinction that Linden points out is meaningless".[370] Similarly, he points out that Linden does not seem to realize that the radiation is information, and hence one cannot speak of *the transmission of the information* and *the character of radiation* as two different aspects (refer no. iv above). Shapere affirms the preference to use neutrinos, rather than photons, in the experiment, because neutrinos are weak in interactions with the other particles during its journey to the surface of the sun and to the receptor, whereas photons in their long journey of 100,000 years to get out of the sun they bump against other particles at every millisecond and that is

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[368] *Ibid.*, p. 675.
[369] *Ibid.*, p. 673.
[370] Regarding Linden's objection that Shapere wrongly derives an absolute condition based on probability considerations Shapere sharply reacted in the personal interview on 15th Sep, 2006. He just said· "It is a stupid idea to call it probability consideration".

called interference. And finally, Shapere finds no interesting and remarkable advantage with rewording of his definition of observation (observable) by Linden.

4.2.4 Clarifying Other Minor Objections

Nickels reviewed Shapere's book, *Reason and the Search for Knowledge*, in 1985[371]. Now that more than two decades have passed since then, one can expect some changes and transformations in Shapere's views on certain issues. In some cases he has modified or transcended his previous positions. Sometimes he has branched into new realms to address new issues, as demanded by the recent developments achieved by contemporary physics in the past two decades. Here I just mention three of them: the notion of success, differences with Pragmatism and his unwillingness to identify himself with historicists.

Shapere does not define 'success' in a pragmatic way. He also does not see success as 'definition of truth'. Many misunderstood Shapere, as Niiniliuoto[372] does, to claim what is successful as true. Shapere gives 'success' only as a criterion of 'reason' not as 'truth'. He clarifies, "'success' and 'relevance' do not define 'truth'; for no matter how successful an idea might be... it is always possible in principle that specific reasons for doubt may arise. It is this possibility that breaks the connection between 'reason' and 'truth';[373] and this break is important for his account of the circumstances under which a scientific claim may be said to be true. A hypothesis can be taken to be true when it is successful with respect to its domain, coheres with the theories of other domains and "satisfies other such criteria (like, that is not a conceptual device – fiction, idealization, and so on)"; however, what it precisely means to be true "must be given by the science involved".[374]

There are further significant differences between Shapere and traditional pragmatism: i) For traditional pragmatism there was presumably something ultimate about the 'consequences' in terms of which beliefs were to be judged successful; but for Shapere what corresponds to 'consequences' are specifically designated as the items of a domain and domains can alter in the light of new discoveries and new theoretical explanations; ii) Other criteria of

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[371] Nickles, 1985.
[372] Niiniliuoto, 1984
[373] Shapere, 1980b, in Nickles (ed), 1980, p xi
[374] Shapere, 1991c, p. 658-9, foot note 2.

acceptability (besides success) with regard to a domain have arisen in the course of inquiry, and these can, under specifiable conditions lead to the conclusion that even "Success in accounting for a domain is not a sufficient condition for truth, or even for belief; under certain specifiable circumstances, it is not even a necessary condition".[375]

From all the discussions above it is obvious that Shapere has strong appreciation and inclination towards historicism. He firmly believes that the role of history is very important and the knowledge of history is essential to understand the knowledge-seeking process, so much so, people like Doppelt finds fault with Shapere that he pays more attention to history of science at the cost of content of science. However he is not happy to identify himself with the historicists, as he claims his views are significantly different from those of the historicists.

4.3 MY ASSESSMENT OF SHAPERE'S VIEWS

Shapere's views[376] are unlike the ones held by either the logical positivists or the historicists. His views deserve serious consideration. His position may be viewed, **not just as an attempt to tread a balanced path between the two opposing trends of logical positivism and historicism, but also a bold effort to go beyond of both of them, whereby he inculcates the strengths, and avoids the weaknesses, of both of them.** Thomas Nickels[377] finds a healthy combination in him, which is quite rare among the philosophers of science: Shapere though follows a thorough historical approach (highlighted by Kuhn and Feyerabend) and yet highly critical of it. He is different and determined in his approach to the issues of philosophy of science. He clearly brings out that the Positivists' account of science is very formally objective and rational but irrelevant to actual history of science,

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[375] *Ibid.*

[376] Shapere's journey into philosophy of science spans over the past four decades and still, in his rather advanced age of 81, he is intellectually sharp and physically healthy to carry on with his valuable contributions to philosophy of science. I had the privilege of discussing his ideas in person, between July – October, 2006, at his residence, at Winston-Salem, North Carolina, USA. He is known for his innumerable, even complicated, case studies from the history of science to drive his points home. He is presently busy giving final touches to his forthcoming book, *The Rational Dynamics of Scientific Inquiry*, which he aims to be highly comprehensive of all his vigorous and persistent research in all these long years. He plans to come out with another book on *The Values of Knowledge* As I understand it is not going to be merely an academic accomplishment, rather a study of his own personality development That is why, about this project he mentioned in a personal meeting on 6th October, 2006, "I mainly do it (writing the book) for myself, it clears up what I am"

[377] Nickles, 1985, pp. 310-312

while historical account (Kuhn and Feyerabend) of science is highly relevant, but relativistic and irrationalistic. Thus an account of science is normally seen as either in ironclad logical standards or in relativistic historical practices. But Shapere thinks it is possible to have an adequate account which includes a measure of both the views; and so he demands that "an adequate philosophy of science must show how it is possible that we *might* know, without guaranteeing that we *must* know"[378]. He seems to be unique in handling a certain concerns of the area, so much so that Nickles observes, "He has ever been a 'loner' rather than a 'party man' (e.g. a positivist or a Kuhnian), and hence has never switched parties. The result is a coherent and often attractive vision of scientific inquiry"[379]. In this Section I like to assess some of the significant contributions of Shapere.

4.3.1 Background Information and Its Proper Role in Science

Rationalists did not give much importance to Background information, while Historicists, though recognized its role, yet they did not decipher the actual need and its role in science. As the Historicists failed to realize that there are valid checkpoints in background information they could not avoid the danger of relativism. But Shapere has shown, rightly so, as to how science bases itself on background information and at the same time preserves its rational character in terms of the 'given'. Shapere claims that the developments in modern science (about 400 years) have shown, that we need 'to learn how to learn' about reality, how to think and speak about it, how to refer to what we study and how to judge the results of our investigation[380].The demarcation of science and non-science is not given or discoverable by armchair logic, but develops with the growth of a distinction between beliefs that are worthy of being included or not in the pool of background information. From this we realize, that the demarcation between the observable and the unobservable, the scientific and the non-scientific, scientific possibilities and impossibilities, scientific problems and pseudo-problems, scientific claims and pseudo explanations – all these "***are not something given once and for all, but rather shift as our knowledge and understanding accumulates***".[381] Therefore, science is an enterprise that has evolved over

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[378] Shapere, 1984h, in 1984a, p 227
[379] Nickles, 1985, p. 310.
[380] Shapere, 2001a, in Hoyningen-Huene and H. Sankey (eds.), p. 200.
[381] Shapere, 1978, p. 1000 (emphasis mine).

generations, as a tradition that has been criticized and constructed, and as a process of inquiry, in which we build on background information.

Further, observation, theory, objects of study, and conceptions of our objects of our study – all depend on the body of knowledge available at a given time, and evolve with it, often leading to a recategorization, reconceptualization, and even redescription of the furniture of the world. Therefore, **historical development is not something external and accidental to the very understanding of reasoning and knowledge.** Looking at science as a part of the evolution of human species entails a radical reformulation of the aims, methods of philosophy of science and of much the philosophical enterprise in general. Science must be both the object of our investigation and the framework within which they are undertaken. As a growing enterprise we can't say anything about the limits of science. We cannot know in advance what turns science would take as centuries go by. It is arrogance to say that science can learn everything, while it will be ignorance to lay unavoidable limits in its quest for knowledge. We can't say that what we know is as things are! Therefore, "We must, after all, build our beliefs about the world we live in on the basis of the best information we have, wherever possible believing what we have reason to believe and doubting what we have specific reason to doubt."[382]

4.3.2 Knowledge-Seeking Process as Contingent Interactional Empiricism - Its Implications

Shapere argues that the usual criticisms against classical empiricism show ***where*** it went wrong and ***why***, but could not show that ***in principle*** it went wrong. Further, even if all the claims of classical empiricism were to be positively fulfilled that would not have given us the complete and real understanding of science. With his strong arguments (about the non-availability of 'the given'; the theory ladenness of observation and the empirical nature of the empirical doctrine itself), he has shown how empiricism alone would, not only not help science to progress but also would positively hinder the progress. The doctrine of empiricism itself is empirical, and not analytical; therefore Shapere argues, "When rightly understood, empiricism itself, like the processes and conclusions it addresses, is an empirical

[382] Shapere, 1978, p. 1001.

doctrine, and can in principle bring us to a stage at which it outgrows itself".[383] Therefore one has to go beyond empiricism especially in the context of contemporary science.

Shapere prefers to call his understanding of science as **'Rational Descendent of Classical Empiricism'.** It agrees with the classical empiricism in that all our knowledge is based on the *interactions* with the world; but at the same it departs from it, in understanding what that interaction means. An interaction is determined by our knowledge; different fields understand interaction differently; a given field may exclude or ruthlessly limit the role of sense perception. Thus it is a correction to classical empiricism to show that there is no necessary dependence on sense perception. However, it goes beyond sense perception; it expands the meaning of sense perception to include instruments, and what is invisible; and it recognizes background information and thus it is *rational.*

Shapere's view of science is ***neither absolutistic (foundationalistic), nor relativistic:*** it is not the former, because even the highest levels of background beliefs are also revisable, and nor is it the latter because the background beliefs are based on reason. The picture of the knowledge-seeking enterprise which emerges here is ***neither an a prioristic rationalism, nor a sensory empiricism.*** It gives importance to both what we infer from observation and to what we add to the interpretation of the given situation (i.e. the background beliefs). It recognizes that we need background beliefs to draw inferences from observation and of course these beliefs too can be modified or rejected. ***It is an emergence and departure*** from more primitive conceptions. The concepts of reason, explanation, method and science themselves develop and change in the light of the increasingly sophisticated interactions with the universe around us. So we learn how to learn!

Shapere's view of science is ***both historical and rational*** at the same time. For what counts as rational is something we learn in our historical contacts with nature. There is no universal or ahistorical method for science. The efforts to find such method for science have always been a failure. As Werner Heisenberg discovered the uncertainty principle in quantum physics, Jozef Zycinski thinks that we can speak of epistemological uncertainty principle; i.e. the attempts to find one universal set of cognitive procedures and methods are

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[383] Shapere, 2000, p. 162.

baseless.[384] ***It overcomes undue scepticism.*** Doubts may arise about our background beliefs and consequently the knowledge claims that we make, but until they arise we have to hold them as knowledge. Unlike the traditional philosophy of science, ***it is far more concerned with content than of the formal structure of science.*** Our ancestors' primary concerns were of day-to-day life, like, food, family, shelter. Their concepts or beliefs were often unclear, inconsistent; they were just enough to deal with their daily life concerns. From such beliefs, our today's sophisticated ideas have descended. ***So any knowledge-seeking enterprise must take this aspect of evolutionary context of inquiry seriously.***

4.3.3 Chain-of-Reasoning and the Rejection of Essentialism

Shapere denies both ***the Pre-suppositionist view*** (i.e. there are some higher level standards of rationality to judge the changes in the lower level) and ***the Relativist view*** (i.e. the changes in the criteria are not rational and therefore no progress in science). Shapere rejects all presuppositionist theories, not just because of, as Doppelt points out[385], the dogmatic contention that there is no fixed meta-scientific logic, structure, standards, but also for two other reasons: a) philosophers have failed to find such structure (in future they might find out!); and b) even if they did that would not avoid relativism (why not?), but would merely place the grounds for relativism in the structure of the way we must inescapably think. Therefore as a working hypothesis, let us see how much of the scientific enterprise can be accounted for without such fixed meta-scientific features.

Shapere proposes 'a chain of developments connecting two consecutive sets of criteria' and a rational evolution can be traced down between the two sets. The aims of science and the notion of 'reason' itself change, just as the lower-level theories change, in accordance with the changes in the substantive beliefs about the world. Thus Shapere is opposed to, what he calls, 'essentialism' (i.e. there are defining and unchanging characteristics of science in the face of new discoveries about the world). But Shapere demands that even the laws of logic may have to be modified in the light of scientific practice. Nothing is beyond revision but the change is gradual and piecemeal. If everything changes, one can wonder, as McMullin does, whether science will one day become an activity like foot ball; for "If change extends

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[384] Zycinski, 1995, p. 257
[385] Doppelt, 1988, p. 112.

to all levels, are there then no constraints on the kind of activity science might become? Could it, in principle, become something entirely unlike what it is today by way of piecemeal change?"[386] Shapere cannot claim that it won't become an activity like foot ball without taking recourse to some essence, or some transcendental argument. We cannot anticipate the future forms of scientific rationality, which would be like expecting Democritus to have known the modern atomic physics. Some sort of running thread is presupposed here, I guess. Though Shapere denies such unity for Kuhn (which can be seen, in fact, as an element of Essesntialism), Shapere himself seems to be relying on such a notion in his conception of rationality in science. He cannot afford to reject essentialism outright, while his concept of chain-of-reasoning implies a ray of essentialism to ensure some line of continuity of the enterprise.

4.3.4 Problems with Notions of 'Success' and 'Adequacy'

One of the elements to assure rationality in science, for Shapere, is the element of 'success'. But success, in my opinion, need not be the deciding factor for rationality. For, an action even if it does not meet with success, can very well be rational. Though he gives it as one of the criteria, I think, it can't be a necessary criterion.

In the absence of universally accepted basic standards of rationality, Laudan and Shapere, as Doppelt claims, have to rely upon the notion of 'success' to show that the changes are rational. But they are in need of giving a universal notion of success or will end up question-begging notion of internal success. Doppelt argues that we need a 'global' view of success to rationally justify changes in scientific methods and changes. But Stump asserts that global notion of success is unwarranted "as we don't have the burden of showing that there are no losses over the entire history of science, rather only that any particular choice of a theory or a standard is better than its rival"[387]. For Shapere also success is in the sense of 'domain' specificity, not a universal one. Further, Shapere[388] answers Doppelt that his notion of rationality needs lot more than success.

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[386] McMullin, 1988b, in 1988a, p. 18.
[387] Stump, 1991, p. 461.
[388] Shapere, 1988a, p. 134-6.

Shapere gives two general sorts of criteria for science: ***success*** (how an account of science accounts for the items of its domain) and ***adequacy*** (which is expressed in terms of consistency, completeness and compatibility). These criteria are historical products. Though they are once thought to be transcendental, are now internalized to judge a scientific belief. However these two criteria are changeable themselves. Though these have been established as an ideal for science, his tendency to fallibilism makes him give us a warning regarding the future changeability of these criteria themselves, that is, however fullfillable and long-cherished ideals they may be, one needs to be prepared to modify or even reject them in the light of new findings[389]. But if the ideals of *success* and *adequacy* are modified or rejected, McMullin rightly wonders, then success can no longer be a normative principle in accounting for the data and accurate prediction need not be concern for science. If the predictive success can in principle be kept aside from science we have to face far reaching consequences. For we have strong hopes in the present science that "it is at least partially 'correct', that its findings have some permanent worth, that its goals have been at least partially fulfilled" but if "these goals might have to be entirely set aside, our convictions about the epistemic and ontological status of the best-supported theories in contemporary natural science would have to be substantially qualified"[390].

4.3.5 Shapere - Giving Less Importance to Social Considerations?

Shapere obviously gives importance to the historical context in understanding science. But he does not seem to give due importance to the sociological (external) factors that shape the scientific enterprise. He says there is no appeal, even implicit, to 'social context'. He even claims that as science becomes more and more sophisticated it becomes more and more autonomous in its reasoning. But is science describable without any reference to the social context?... He is against the 'the strong programe' of Sociology of science; he says that one needs to decide the role of internal and external factors "case-by-case..." - that means, in some cases, is 'the strong program' right in saying only external factors shape science? To learn the influence of internal and external factors, he demands, one must consider science case-by-case, and he ends up saying that shows the need of the piecemeal approach. Is the piecemeal approach true for the modern science too? If nature is studied in a

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[389] As quoted by McMullin, 1988b, in 1988a, p 21
[390] *Ibid.*

compartmentalized manner, then what about all the merits of the unification of various domains of the 20th century? Further, we do see that more sophistication in science necessitates interdisciplinary approach with other fields of knowledge-seeking enterprises of humanities. If so, how can autonomy in its reasoning increase? What is a good reason needs also to be decided in an inter-disciplinary way, not in an autonomous manner.

4.3.6 Correcting Historians of Science!

After the World War II, History of science became a separate discipline. Historians of science neglected or even denied rational considerations. They focus more on external factors, like psychological, social, religious, institutional contexts and political affiliations. All these factors are relevant and important to the study of science. There is no eternal unchanging line of demarcation (like Popper's falsification), rather it emerges from history of science over the decades. Further, what is considered to be a reason, and why it is considered as a reason also evolve. Historians use historical episodes (not classical empiricism's induction or H-D Method) to understand science. However, ***historians make some basic assumptions***: Content of science may change, but not its nature (what counts as a reason / goal / methods don't change) and Shapere does not agree with them. It is true, the role of history is fundamental in understanding science; but historians mistakenly thought that the distinction between science and non-science cannot be, and even should not be, made. Philosophers, on the other hand, focus on logic of science, meaning of meta-scientific concepts, and absolute line of demarcation and methods of science in order to derive the 'essence' of science; but Shapere argues that this view is also wrong. We must not focus on the essence of science, rather on the development of what counts as a reason in science. Thus Shapere makes a correction to the approaches of the historians, and it seems to be quite a valid one.

4.3.7 Shapere on Observation

Shapere's analysis of the need of the background information to understand what observation is has shown to be more necessary and intrinsic than what the traditionalists used to think about it. He explains how the element of 'the given' in the background information prevents the danger of relativism in this issue. He, as we have seen earlier, has

made it clear that, in modern science, observation cannot be limited to sense-perception. Sense perception was thought to be both necessary and sufficient to understand science; but experiments in modern sciences show that it is neither. It is shown that sense perception does not have any central role, rather only a limited role, and that too pushed to the periphery of the investigation, only to interpret the results assembled by the instruments.

Today's science seems to uphold the causal theory of observation, that is, observation is just a causal process(es) from the object to the brain. These processes are explicable in scientific terms. The real world is not as it is perceived. Actually an object is a colorless matter consisting of innumerable atoms. They have a propensity to absorb or reflect certain rays of light of different wave lengths. We are able to see a given colour depending on the way our eyes and brain have been constructed. The sensation is the culmination of the long causal process(es) between the object and the brain, and therefore, it is not the real property of the said object. Shapere seems to go even a step further to claim that for 'observation' there is no need of even a human observer. For him, observation is basically an interaction between an object and the receptor. The interaction is such that some information of the object is transmitted to the receptor, which may be human or a machine. As an interaction, the observation process largely depends on the background information. Both the observation and observability depend on certain theories.

Jan Faye, however, argues that an observation as such needs some human observers. Observation involves some sort of beliefs and therefore what is done by an instrument is in fact only a measurement. If no such beliefs are involved in observation there is hardly any difference between a camera 'seeing', a scanner 'reading a document' and human observing. Since ***beliefs are involved in human observation***, two people need not necessarily agree about what they see, though the causal processes from object to brain are of the same type. So Faye argues that perception and scientific observation consist in belief acquisition; therefore, we are not merely seeing something, but are seeing that 'something is the case'. It is not the case that we see something and then decide what it is and "this intentional component is that which elevates perception to observation".[391]

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[391] Faye, 2000, p. 173.

Further, Shapere makes a distinction between ***direct and indirect observation***; if the information from the source reaches the receptor without any interaction with the passing medium, it is a direct observation (e.g. observing the core of the sun by collecting neutrinos). Indirect observation is where the information has some interactions with the medium before it reaches the receptor (e.g. observing the core of the sun by studying photons). However, Peter Kosso argues that the demarcation between the direct and the indirect observation is not clear; for it depends on where one has the boundary line of the receptor. For, the neutrino experiment (said to be a direct observation!) involves a receptor with a cleaning fluid, with which neutrinos interact to send positrons from the decaying argon, to the particle counter; the neutrinos are not directly recorded there. A similar situation can be shown in the photons experiment (said to be an indirect observation!) as well. Why can't one take the interaction of the photons with the outer material of the sun to be analogous to the cleaning fluid of the receptor? Why can't one call this too as a direct observation? Thus, since there is no clear and non-arbitrary demarcation it seems to be only an artificial distinction[392]. Though Kosso seems to have a point, Shapere is not completely wrong. For, there are other interactions that the photons undergo, not only before they reach the receptor, but also even before they reach the surface of the sun itself; the photons take 10^5 to 10^6 years to travel the distance of 400,000 miles to reach the surface of the sun, while **neutrinos take only very very negligible time** to reach there! Lots of interactions are bound to be there and that makes the experiment with the photons to be an indirect observation.

Shapere, in spite of all his efficient analyses of background information, does not seem to give sufficient importance to the aspect of ***consensus in the scientific community***. Perhaps, he thinks that the notion of background information takes care of this aspect. But I think it is so important in modern science that it needs a specific mention and even it needs to be a separate condition, along with Shapere's three conditions discussed earlier, for something to be observed (observable). Therefore, in Chapter 5, "A Holistic Understanding of Rationality in Science", I make an attempt to compare Shapere's elaboration of the neutrino experiments with the Gravitational Wave Experiments, to show how the scientific

[392] Kosso, 1989, pp. 20-22.

community plays a crucial role in determining what is, or is not, an observation (observable).

In general, one may think, as Nickles (in spite of his great appreciation for Shapere's work) does, that Shapere lacks "crisp, logical and methodological formulas"[393]. However Nickles himself is aware that Shapere might answer that this sort of fuzziness is unavoidable, for that is the way science and reality are; and further "The single truth, and the precision, simply are not there..."[394] Having said that, I must acknowledge that no one can deny that Shapere is known for his patient and persistent analysis of the issues in philosophy of science. He sees values both in the traditional empiricism and rationalism. While being faithful to philosophical inquiries he keenly listens to scientists as well. I agree with Robert Cohen and Marx Wartofsky when they say that "He (Shapere) sorts things out, with logical care and mastery of the materials, as with an epistemological curiosity for the historical happenings which is both critical and respectful"[395].

About his own approach, Shapere seeks a serious consideration from the world of philosophers of science. If so, he is convinced that his new approach will be seen as paving the way for an enriched understanding of the inquiry of science, incorporating the strengths of the traditional views, while removing their weaknesses.[396] I am fascinated by the way Shapere sees a vibrant dynamism in the human inquiry of knowledge. We seem to move on to the unknown from the known. He succinctly puts it: ".. we build on what we already know (or at least believe), we learn how to learn, we learn how to understand etc."[397] He seems to be right because in the long process of evolution, the unbelievable potentialities of human brain are slowly and steadily revealing themselves as centuries unfold. The human brain is unravelling the enormous mysteries of reality and only the sky (if any!) seems to be the limit. The summary of Shapere's ideas must include, I think, his words reflecting his noble attitude and a sincere realization, which, in my opinion, every genuine seeker of knowledge must possess: "We must be prepared for the possibility that there are indeed

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[393] Nickles, 1985, p. 312.
[394] Shapere, 1984m, in 1984a, p.22.
[395] Cohen and Marx Wartofsky, in editorial preface, of Shapere, 1984, p viii.
[396] Shapere, 1991, p 676.
[397] Shapere, over personal email, on 30 Sept, 2003, p 2

Ambedkar, "The Buddha's law of *Karma* applied only to *Karma* and its effects on the personal life. There is however an extended doctrine of *Karma*. According to it, *Karma* included *Karma* done in past lives. This is a most pernicious doctrine. This doctrine is often found to be attributed to the Buddha."[287] One can clearly understand the strong motive behind Ambedkar's rejection. Because the principles like *Karma* upheld as metaphysical justification for the social oppression, views the sufferings of the downtrodden as punishment for misdeeds in former lives. However, at the same time, Ambedkar found certain merits in the *Karma* theory, especially in the element of causality. "No Buddhist will deny that everything is under the sway of causality. Unless are regard all humankind as linked together as parts of one universal whole, we cannot perceive the full significance of the doctrine of *Karma*. Not only are the murderer and thief responsible to society, but society is equally responsible for breeding such characters." [288]

Ambedkar considers four noble truths as a leader monkish accretion; for Ambedkar, the four noble truths as presented in the Canonical account of the Buddha consist of the first Sermon, (*Dhammachakka Pavattana Sutta*) was problematic for their attribution of suffering to the ignorance and craving of suffers. Ambedkar's main objections to the four noble truths are as follows: Since suffering is a material reality, or at least predominantly a material one, any kind of valid account should mainly focus on the material aspect of it, i.e., socio-political aspects of the suffering. Social conditions should be considered into the main account of suffering. However, the four noble truths treat suffering in a purely psychological way. According to it, the mental state of the suffering is the cause of suffering. Virtually sufferer and his mental states is the cause of suffering. According to Ambedkar, this kind of psychological explanation of suffering is spreading permission in the suffering. He wrote in the introduction of his work, 'the four Aryan truths deny hope to man and make the gospel of Buddha a gospel of pessimism.'

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[287]Ambedkar,B.R, '*The Buddha and His Dhamma*' Siddhartha Publications, Bombay, 1991, p 338.
[288]Ahir D.C., *The Pioneers of Buddhist Revival in India*, Blue Moon Books, New Delhi, 1996, p 238.

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AN INTEGRATED VIEW OF RATIONALITY IN SCIENCE

5.0 Introduction

In this Chapter I attempt to arrive at an integrated view of rationality in science. I first analyze a few traditional views of rationality, in **Section 1**, to bring out their inadequacies. I evaluate in some detail the view of equating ***rationality with deducibility***, which has been quite influential in the past few centuries. I am not of the opinion that every aspect of the traditional account of rationality needs to be rejected or reformulated. For instance, I explain the role of **inductive reasoning**, in developing an adequate account of rationality in science. Due to the shortcomings of the traditional account of rationality, there is a need to revise it. Therefore, in **Section 2**, I elaborate on the need for such a revision. I support my arguments with the views and alternatives of the traditional account of rationality, put forward by **Hilary Putnam** ('Integrated View of Rationality'), **Stephen Toulmin** ("Over-reliance on Rationality), **Christopher McMohan** ('Collective Rationality') and **Stephen Nathanson** ('Reasonable form of Rationalitsm').

Next, I elucidate, in **Section 3,** my account of rationality in science. **Reasonableness is the distinguishing character of a comprehensive account of rationality.** I enumerate some of the features of the notion of reasonableness, like Imagination, the Role of the agent, Common sense, the rejection of Zero-tolerance, Skeptical attitude, an Enriched notion of Objectivity, a bit of Pragmatism, the role of Judgment, and the Consensus of the scientific community. I categorize these features for the sake of more simplicity and precision, under three groups, though they need not be taken as water-tight compartments; namely, **Reasonableness in Scientific Methodology, Reasonableness in Scientific Practice and Reasonableness at the Personal level of Scientists.** I further explain how this notion of reasonableness plays a role in Skepticism and Critical Thinking.

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CHAPTER 1

Ambedkar holds a perception that the religion is a vital force, a scheme of moral governance and foundation for human society. He also says "While I condemn a religion of rules, I must not be understood to the opinion that there is no necessity for a religion. It is the foundation of society, the basis on which all true civil governments rest and both their sanction. Consequently, "when I urge that these ancient rules of life be annulled, I am anxious that a Religion of principles, which alone can claim to be a true Religion, shall take its place."[352] For Ambedkar, religion is necessary as a system of values and as a science of social reconstruction. Religion is necessary for the over all development of an individual and it is a system of such socio-cultural values, which would carry all the individuals on equal plane and would create an equal status for all communities. He looked at the religion not as a road to salvation but as the basis for social interaction. Ambedkar wanted a religion, with morality in order to build up nationalism with the association of Indian culture. He always wanted a religion with complete Indian culture and nature. He also emphasized that a religion should be free from exploitation, and true religion does not justify exploitation.

According to Ambedkar, the ideal of religion always wins over the secular practical ideal. This shows how great the difference in the force and sanction of these two ideals over the human mind. A religious ideal never fails to work so long as there is faith in that ideal. There is a criticism against Ambedkar that says that Ambedkar was against religion and wanted to destroy the religion, in contrary, one should remember that he called for the destruction of religion of rules and not of principles [353] On such principle, he tries to impress upon the necessity of religion. Thus he condemns a religion of rules. Here, Ambedkar agree with Burke that, 'True religion is the foundation of society, the basis on which all true civil government rests, and both their sanction".[354]

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[352]Moon, Vasant, ed, B.R Ambedkar's, *Writings and Speeches,* Vol III, Govt of Maharashtra, Bombay, 1989, p 73
[353]Ibid, p 75.
[354]Ibid, p 76.

Ambedkar deems religion to be essential to personal as well as social life. Religion exercises a great pressure of moral power over a person's heart and mind, builds up the person's character, it is a powerful driving force for human activity and it instills hope. According to Ambedkar religion can only satisfy the human being who is not satisfied with material things. A liberative religion alone can renovate the human minds of those who are socio-culturally enslaved. Ambedkar pertinently illustrates "the dominion which religion exercises over the minds of men."[355]

Ambedkar says that the true religion holds together society based on the moral force that exercises over the members. Its ethical power prevents social evils, crimes and atrocities, thus religion alone can cultivate equality, liberty and fraternity and the enforcement of justice and order. Thus religion is an important governing principle in the society. For Ambedkar "That which governs people is Religion. That is the true definition of Religion." [356] For him, religion is also an important source of power in the society. Ambedkar recognized the influence of religion over people and its function as effective power-source in Indian society. And, he rejects the view that the religion to be idiosyncratic worship of God for the salvation of one's soul. His idea of religion is basically social and, it is defined in terms of moral and social order based on its ideal and principles. Consequently, the perception of Ambedkar on religion is based on principles, values and ideals where a society is governed by both individual and society that are preserved, promoted and sanctified.

According to Ambedkar, Hinduism as a religion faith is based on the infallibility of *Vedas*. Ambedkar says that, "The Hindu is not prepared to face any inquiry; there is no act of the Hindu, which is not covered or ordained (his) Religion."[357] He also refutes the idea that Hinduism holds all religions that are good and true. By saying this it wants to avoid the application of reason or the criterion for acceptance or non-acceptance of religion. Ambedkar believes that religion could be either liberative or oppressive; it all

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[355]Ibid, p 77.
[356] Ambedkar B.R, *Why Go for Conversion?*, Dalit Sahitya Academy, Bangalore, 1987, p 16.
[357] Ibid, p 22.

depends on various factors. Religion could function as a tool of domination if it propagates infallibility and requires total surrender to its totalitarian perspective. Religion is liberative if it is open for the notion of revolution or change. The social ideal of a particular religion, which is the divine scheme of governance of that religion, decides whether it is good or not good.

On the question of God's existence and the role of religion and morality, Ambedkar says that the religion is necessary for man and society to manage the secular and moral affairs of man kind, but to hold the view that, all religions are equally true and good is to cherish a wrong belief. Most of the existing religions are theistic and metaphysical; but to maintain that God is an essential element of a religion is also to nourish a mistaken faith. Religion, according to Ambedkar, wish to develop the social systems of their own choice to bring men together in peace for progress; but to bestow a divine governance over them so as to prevent the growth of an open society. The Religions must preserve their Textbooks for guiding the people in right direction; but to believe in their infallibility and divine authority is to mar the growth of free inquiry and critical reason. The eternal soul is unknown and unseen, a mere metaphysical speculation and to say that an individual's aim of life is to achieve its salvation *(Moksha)* is to escape the social responsibility bestowed on him as a member of society.

All the religions develop some sort of prayers and pilgrimages, rituals and ceremonies, as religious duties for men, simply being certain appendages to a religion; but the most integral part of a religion is the Morality it professes for the welfare of mankind. The center of Religion and Man, the base is Morality, the aim is the secular welfare of Mankind, and the means is the righteous conduct embedded in social responsibility that all human beings owe towards their fellow-beings living in human society. And lastly, the test of Justice and Utility must be applied to judge the relevance of a Religion, and that consists in the trinity ideal of Liberty, Equality and Fraternity to effect the necessary change in its social norms of cruel and dynamical nature."[358]

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[358] Keer, Dhananjay,*Dr Ambedkar Life and Mission*, Popular Prakashan, Bombay,1991, pp 4 94 – 4 95

For Ambedkar the function of religion is to provide legitimacy to the set of values and rules that would help establish a moral order among human beings. These values and rules could be particularistic, relatively arbitrary and community specific when the communities were small and isolated. Concepts of local deities and of behavioral norms that were thought to please them were an adequate base for a semblance of social order so long as they served the interests of the power elite in the community. But with the changes in technology, in the means of production and the means of communication, isolated human groups were forced into contact with one another, and the need arose for new values and rules which were more universal. Thus what were needed were a more universal morality and more universal concept of Godhood.

Ambedkar reiterates that the religion is a social force and stands for a scheme of divine governance. The scheme becomes an ideal for society to follow. The ideal may be non-existent in the sense that it is something, which is constructed. But although non-existent, it is real. For an ideal it has full operative force which I inherent in every ideal. Those who deny the importance of religion not only forget this; they also forget to realize how great the potency is and sanction that lies behind a religious ideal as compared with that of a purely secular ideal. A religious ideal has a hold on mankind, irrespective of an earthly gain; this can never be said of a purely secular ideal. A religious ideal never fails to work so long as there is faith in that ideal." [359] For Ambedkar, God who permits the survival of immoral social divisions in the society like caste is no God. Ambedkar objects the worship of God who permits the existence and survival caste system. Advocating Buddhism he discarded the *Shastras,* and also their authority as did by the Buddhā and Nanak.

The *Dhamma* as true Religion

The final rejection of all religions and "religion" as such, as understood in the theistic sense, took place when Ambedkar chose the non-theistic Buddhist *Dhamma* as the true

[359] Moon, Vasant, ed., *Dr. Babasaheb Ambedkar's Writings and Speeches,* Vol I, Govt. of Maharashtra, Bombay, 1989, p 68.

religion. In his book that he wrote for the Neo-Buddhism titled, *The Buddha and His Dhamma,* denounces "religion" and contrasts it with the *Dhamma* of Buddha which is not considered a "*religion*" by all the European theologians. Here by religion he means a theistic religion: "This is what Religion has come to be and this what it connotes-belief in God, belief in soul, worship of God, curing of the erring soul, propitiating God by prayers, ceremonies, sacrifices, etc."[360] Stating that *Pradanya* and *Karuna* are the corner stones of Buddha's *Dhamma*, Ambedkar explains the difference between the subject matter of religion and the subject matter of *Dhamma:* "The two are poles apart. The purpose of Religion is to explain the origin of the world. The purpose of *Dhamma* is to reconstruct the world."[361]

Ambedkar equates *Dhamma* is with morality. He regrets that in non-*Dhamma* religions morality is not given prominence nor is it effective. He asks the question that what the place of morality in *Dhamma* is and gives the simple answer that morality is *Dhamma* and *Dhamma* is morality. In other words, in *Dhamma* "morality takes the place of God although there is no God in *Dhamma*. In *Dhamma* there is no place for prayers, pilgrimages, rituals, ceremonies or sacrifices."[362] Morality is the essence of *Dhamma*, without it there is no *Dhamma*. "Morality in *Dhamma* arises from the straight necessity for man to love man. It does not involve in the sanction of God. It is not to please God that man has to be moral. It is for his own good that man has to love man."[363]

The rational and scientific principle is the other pillar on which *Buddha-Dhamma* of Ambedkar needs to be stressed and substantiated. Being a man of science and a philosopher, who was influenced by secular scientific rationalism that swept the West, Ambedkar, was cautious to avoid anything that would smack of superstition, and verge on the border of the irrational. Nothing that cannot be proved rationally and argued logically can be part of his philosophy. The influence of Western Philosophy on his modern scientific mind was great. Not solely a single school of thought, but various

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[360] Ambedkar B. R., *The Buddha His Dhamma*, Siddhartha Publications, Bombay,1991, p 226
[361] Ibid, p 227.
[362] Ibid, pp 230 – 231.
[363] Ibid, p 231.

trends in philosophy such as the secular humanism of Renaissance and Enlightenment, Socialism, Marxism, Positivism, Liberalism, Utilitarianism, engaged his attention and left their marks on his mind.[364]

In the light of all these, Ambedkar strove hard to make his new religious sect thoroughly rational. He hinges his arguments unshakably in the Buddha's rational epistemology of "dependent origination", that is, things are related to each other in cause and effect relationship in the ceaseless change of reality.[365] Accordingly, the speculative and supernatural beliefs in God *(Brahman)* or the eternity of the *Soul (Atman)* or heaven *(Moksha)* do not enter his scheme. *Dhamma* is not a belief in the supernatural being but the striving for a moral humane fraternal social life. *Dharma* in the *Vedic* Brahminic religion was to offer sacrifices *(Yagnas),* rituals and prayers to worship God (*Brahman*). These praises, offerings and sacrifices are offered in order to gain heavenly benefits hereafter, along with the earthly gains.

Ambedkar lays stress on the Buddha's reinterpretation of *Dhamma* as morality and his rejection of Brahminic understanding of *Dharma* as sacrifices and prayers. Thus, Ambedkar comes to reject all the theistic religions and the age-old Hindu beliefs, the existence of God *Brahman* is an *Atman, Soul*, *Samsara* theory of transmigration, the *Karma* theory of the effects of past, affecting the present life, and the *Moksha* theory of life after death. Infallibility of *Vedas* is not accepted and *Upanishadic* thought is considered pure imagination.[366] Further, Ambedkar, while accepting the Buddha and his *Dhamma,* presents him as the most rational and enlightened of human beings, and his *Dhamma* as the most scientific system, at least as Ambedkar understands and interprets it.

The Buddha is presented as one who did not force his followers, but who gave complete freedom of thought. He rejected the infallibility of sacred books, divine authority and the revelation. The Buddha, emphasizes Ambedkar, unlike the other founders and innovators

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[364]Jatava D R, *The Social Philosophy of B R Ambedkar*, Phonenix Publishing Agency, Agra, 1965, pp 41- 43, and 267 – 268.

[365]Ambedkar B R, *The Buddha His Dhamma*, Siddhartha Publications, Bombay, 1991, p 247

[366]Lederle M, *The Untouchables' Claim to Human Dignity*, Journal of University of Poona, Humanities Section, Poona, 1976, pp 71 – 72.

of religions like Moses, Jesus, and Mohammed does not claim to be of divine origin, nor receiver of divine revelation as a divine prophet. The Buddha claimed to be only in 'Enlightened' human being who, in turn, is a *marga-data,* the finder and giver of the way, and not, as others have claimed to be, a *moksha-data,* giver of salvation.[367] Finally, according to the rational scientific principle, Ambedkar tries his best with all the intellectual calibre that was at his disposal in great store, to clarify and reinterpret some of the accusations against Buddhism, which he calls "misunderstandings." He gives scientific explanations for the same and proves them to be useful to the society.

Ambedkar affirmed the inevitability of a religion. He said that "a man made with hunger did not resort to theft not feared the legal consequences, but because of pressure his religion exercised over his mind". Religion had a direct connection with the laws based on the reason. He often said that whatever good he had in him were the fruit of religion, he also emphasizes that, he wanted religion, but did not want hypocrisy in the name of religion. To him, religion is the driving force for human activity. Man cannot live with bread alone. Since he has a mind it needs food for thought. He considered the foundations of religion to be essential to the practices of society."[368] Ambedkar's personal philosophy of life and political involvement was based on religion. His whole philosophy was based on the fundamental principles of liberty, equality and fraternity which borrowed from the teachings of his master, the Buddha.[369]

Herbert Spencer describes religion as "the weft, which everywhere crosses the warp of history." This is true in every society. But religion has not only crossed everywhere the warp of Indian history, In fact it forms the heart and soul of the Hindu mind. From his birth to death, the life of Hindu is influenced by his religion in relation to his food, dress,

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[367]Keer Dananjay, ed , *Dr Ambedkar's: The Buddha and His Dhamma*, Siddhartha Publications, Bombay, 1991, pp 151 – 157

[368]Kuber W. N , *B R Ambedkar*, Publication Division, Ministry of Information and Broadcasting, Govt of India, New Delhi,1990, p 80.

[369]Keer Dananjay, *Dr. Ambedkar: A Memorial Album*, Popular Prakashan, Bombay, 1982, p 459.

occupation, marriage, etc.[370] Another reason why Ambedkar lays stress on religion as a social force is that it provides the people with the motivation to realize the same religious ideals that are more powerful than the practical secular ideals. Religion, social status and property are all sources of power and authority, which one man has, to control the liberty of another and also leads to legitimacy.[371]

Ambedkar separated religion from theology, in order to ascertain the functions and purpose of religion. Ambedkar insists that "The primary things in religion are the usages, practices and observances, rites and rituals and theology is secondary, its objective is to rationalize them."[372] In the same way, religion should also be distinguished from what is considered to be supernatural. It is not to think religion as though it was super-natural.[373] It is not right to view religion as an individual, private and personal matter, nor is it to be mistaken as the zenith of the special religious instinct inherent in the individual nature. The correct view is that the religion, like language is social for the reasons that either it is essential for social life or individual has to have it because without it's involvement he cannot participate in the life of the society.[374]

Ambedkar spells out its functions: *Firstly*, from the savage society to our present day the main social function of religion is concerned with life, life processes and the preservation of life. The religious ceremonies are related with the stages of life with events like birth, puberty, marriage, death, sickness, war, drought, pestilence or concerned with the cultivation of food grains and cattle that furnish to human social life.[375] God's place in religion is only as a means for the conservation of life and that the end of religion is the

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[370]Moon Vasant, ed., *Dr.B.R Ambedkar's, Writings and Speeches*, Vol .III, Govt. of Maharashtra, Bombay,1989, p 23

[371]Moon,Vasant, ed., *Dr B R Ambedkar's, Writings and Speeches*,Vol I, Govt of Maharashtra, Bombay,1989, p 45.

[372]Moon, Vasant, ed., *Dr B R Ambedkar, Writings and Speeches*, Vol V, Govt of Maharashtra, Bombay,1989, p 407.

[373]Ibid.

[374]Ibid, p 409.

[375]Ibid, p 407.

end of conservation and sanctification of social life.[376] In the same way this is true for the present society also, though this essence of religion is hidden or forgotten. "The life and the preservation of life make up the essence of religion even in the present day society are beyond question."[377]

Secondly, Ambedkar asserts that the best statement regarding the purpose of religion given by Charles A. Ellwood who had written that, "Religion projects the essential values of human personality and of human society into the universe as a whole. It unavoidably arises as soon as man tries to take up a valuing attitude towards this universe, no matter how small and mean that universe may appear to him .. What the reason does for ideas, religion does then for the feelings. It universalizes them; and in universalizing them, it brings them into harmony with the whole of reality.[378] As C.A. Ellwood understands 'social values are universalized and also continued to be spiritualized by religion for the realization of a specific social purpose'.

Ambedkar says that Religion emphasizes, universalizes social values and brings them to the mind of the individual who is required to be familiar with them in all his acts in an order that he may function as an approved member of the society.[379] *Thirdly*, maintaining the social control and social order is the significant function of religion. Religion acts as an organization of social control by prohibiting the individual's beliefs and practices that go divergent to the good of the larger group. Thus religion is an influential way of social control, more powerful than the Law and Government. Ambedkar again quotes Ellwood to strengthen his argument, "Without the support of religion, Law and government are bound to remain a very insufficient means of social control. Religion is the most powerful force of social gravitation without which it would be impossible to hold the social order in its orbit."[380]

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[376]Moon, Vasant, ed., *Dr.B.R.Ambedkar, Writings and Speeches*, Vol I, Govt.of Maharashtra, Bombay, 1989, pp 408 - 409.
[377]Ibid, p 407
[378]Ibid, p 409
[379]Ibid.
[380]Moon,Vasant, ed, *B R.Ambedkar, Writings and Speeches*, Vol I, Govt. of Maharashtra, Bombay,1989, p 411.

Though, different religions given different theistic explanations about the purpose of Religion, Ambedkar rejects them all and offers his own formulation. According to him, the purpose of religion is "To make the world a Kingdom of Righteousness"[381]. What does he mean by the Kingdom of Righteousness? What does it entail? What are the means to realize this ideal scheme? Can this goal be reached at all? Ambedkar clears all these doubts in the following verses, which he puts in the Buddha's mouth: To the question "What is the purpose of religion?" The Buddha's answer is very different. He did not tell people that their aim in life should be to reach some imaginary heaven. The kingdom of righteousness lies on earth and is to be reached by man by righteous conduct. What he did was to tell people that to remove their misery each one must learn to be righteous in his conduct in relation to others and thereby make the earth the kingdom of righteousness.[382]

In addition, two other purposes were also added, they are, the training of man's mind, instincts and dispositions and the courage to stand by what is right, even alone.[383] A religion that does not have as its core, morality essential for social order and progress, is anathema for Ambedkar. His religion of Neo-Buddhism is nothing else but the way, the *marga,* which would realise not the kingdom of God here on earth or in the otherworldly heaven, in *moksha*, but a religious path that would usher in the just, moral "Kingdom of Righteousness."[384]

The *Dhamma* would not only enforce morality by detachment,[385] it would purify the mind and cleanse it of all the passions,[386] bring forth harmony, cater to the growth of all the individuals in the society without discrimination, thus fostering equality and fraternity.[387] It would establish proper human relationships essential for happiness,[388] with *karuna* and *maitri*[389] and thus remove sorrow *(Dhukka).*[390] It would in a special way

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[381]Ibid, p 201- 202.
[382]Ibid, p 201.
[383]Ibid, pp 201 – 203
[384]Ibid, pp. 200 – 202.
[385]Ibid, pp 170 and 296.
[386]Ambedkar B. R.*The Buddha His Dhamma*, Siddhartha Publications, Bombay,1991, pp 73 – 74.
[387]Ibid
[388]Ibid, pp 146 – 147, and 178.
[389]Ibid, pp 38 – 39.
[390]Ibid, p 83.

protect the weak leading their liberation, and stop the class-caste conflicts resulting in a class-casteless society.[391] Psychological revolution is brought about by shedding of the ego and the desires through detachment and enlightenment. But one cannot stop with this. He/she must continue with the social revolution to remove the causes of *Dukkha.* Love, *karuna with maitri*, demands this. Liberation of the oppressed and the *Dalits* is the task of the En-lightened persons.

Religion, Modernity and Nation building

Ambedkar regarded that religion is necessary for nationalism, since religion is the essence of cultural heritage and value system that are very much necessary for the formation of a civil and political community and, necessary factor for building a powerful nation. Ambedkar was not in favour of the depressed classes converting them selves into Islam or Christianity, as both these religions are alien to Indian culture and therefore they cannot provide the foundations of a political and social community. Ambedkar's theory of religion based on this concept is expressed as, "If the depressed classes join Islam or Christianity they not only go out of the Hindu religion but they also go out of the Hindu culture. On the other hand, if they become Sikhs, they remain within the Hindu culture. This is by no means a small advantage to Hindus. What the consequences of conversion will be to the country as a whole is well worth bearing in mind, Conversion into Islam or Christianity will denationalize the depressed classes. If they go to Islam, the number of Muslims will be doubled and the danger of Muslim domination also becomes real." [392] Ambedkar opens up a big problematic territory here. It had touched the many issues related to the concepts of religion, culture and nation. Ambedkar has evaluated each one of these concepts from the marginalized interest point of view. One might wonder about the Ambedkar's differentiation of the terms 'Hindu religion' and 'Hindu culture'. His coinage of the term Hindu culture seems to be, thoroughly equivalent to Indian culture. Scholars ought to differ from Ambedkar's equation of Hindu culture with that of Indian culture. But we may accept with his implied view that culture is a broader category than religion. The second issue dealt by Ambedkar is the question of conversion. While

[391]Ibid, p 232 – 234.
[392]Moon, Vasant, *Why Go for Conversion*? Dalit Sahitya Akademy, Bangalore, 1987, p 19.

preferring conversion into Indian religions such as Buddhism and Sikhism, Ambedkar discards conversion into Islam and Christianity on the ground that they are not Indian in origin.

Here Ambedkar's option could be named as soft moderate or limited conversion. The reasons behind this limitation may be his nationalistic concern and his fear of alienation of the *Dalits* that he did not want to leave his followers with the risk of losing their national identity. Even after clarifying these aspects, Ambedkar's conclusion remains debatable. It clearly implies that he considered both religion and culture as constituent element of nationalism. That is why he was searching for such a religion within the Indian culture. His concept of religion became not only highly political but came very closer to social living.

The religion can also be tested by yet another set of criteria that Ambedkar has outlined in his article, 'Buddha and the Future of His Religion.' B.A.M. Paradkar gives an astute summary of these criteria in his essay, "The Religious Quest of Ambedkar': Apart from the classification of religion into a 'Religion of Principles' and a Religion of Rules, Ambedkar maintained four essential criteria as the ways of testing the utility of a religion. Firstly, a society in order to hold itself together, it must have either the endorsement of the law or the sanction of morality. But the part played by law in this respect is very small. It is proposed only to keep the minority within the range of social discipline. "The majority is left out and has to be left out, to sustain its social life by the postulates and sanction of morality. Religion, in the sense of morality must therefore remain the governing principle in every society."[393] Secondly, in order to function, Religion must exist with reason, which is merely another name for science. In other words, an understanding between science and religion should not be preposterousness. Thirdly, moral code is not enough for religion, but its moral code must recognize the essential canons of social life, namely liberty, equality and fraternity and finally, religion must not consecrate or ennoble poverty. Ambedkar said, 'Renunciation' of riches by those who have, it may be a blessed state but poverty can never be. To announce poverty to be a

[393]Paradkar B. A. M., *The Religious Quest of Ambedkar*, Ajay Prahaghan, New Delhi, 1968, p 51.

blessed state is to misrepresent religion, to perpetuate vice and crime, to consent to make earth a living hell.[394]

According to him, most important of all, "The problem for the Depressed Classes was to find a solution along the lines which would preserve their national homogeneity with in Indian culture. While seeking a definable religious identity, they had to strive for national and political unity."[395] It should also be stressed, as explained below, that finally Ambedkar's choice fell on Buddhism because he had rejected all other theistic religions as irrational and superstitious, not only because it belongs to Indian culture. This seems to be reason why he preferred to revive a degenerated and profligate Buddhism, than to join any of the live religions readily available now in India.

While discussing the reasons for the conversion, Ambedkar goes into the societal functions of religion, namely, the protection of life and the social control which are achieved by religion, by spiritualizing and sanctifying the values of life as final.[396] These social functions can also serve as the criteria to judge the value of a religion. To some extent, a particular religion is able to fulfill the social function of a religion, only to that extent, it can be deemed to be good religion. Ambedkar himself favourably uses this criterion and questions the usefulness of Hinduism. He asks whether it acknowledges the personal dignity and equality, strives for justice and promotes the social advancement.

The untouchables or *Dalits* need three possessions: "First thing that they need is to end their social isolation. The second thing is, to free them from their lowliness complex. The third thing is, Will conversion meet their needs?"[397] Again he asks, "Can religion alter this psychology of the untouchables? Will conversion raise the general social status of the

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[394]Ibid.
[395]Ibid, p 53
[396]Moon, Vasant,ed , *B R Ambedkar's Writings and Speeches,* Vol V, Govt of Maharastra, Bombay, 1989, pp. 407-410.
[397]Ibid.

untouchables?"[398] These questions also serve as the criteria to judge the value of a religion in the line of Ambedkar's thought.

More over all the religions may not pocess the identical nature. Besides being an authority, which defines what is good, religion is a motivating force for the promotion and spread of the 'good'. Are all religions approved in the means and methods they advocate for the promotion and spread of good? The Philosophy of Religion, as Ambedkar defines it, differs much from the comparative Religion. All the religions are equally true and good, but not in the field of Ambedkar's 'Philosophy of Religion'. In his view Philosophy of Religion begins where the Comparative Religion ends. He accuses comparative Religions for creating the impression that all religions are equally good and true, and that there is no need of discerning between them. According to him, this belief is positively and perceptibly wrong and there is no greater error than this.

He also elaborates that Religion is an uncertain phenomenon, it can be constructive or harmful, it can help to promote the good of society or it can bring adversity, it can also be liberative or oppressive. For instance, particular religion is more ready to lend a hand than others, or a religion can cause more harm compared to the others. It is a fact of experience, and it is to determine this fact properly that we need a norm to judge the value of various religions. To dismiss the false ideology that all religions are good and to point out that religion can also be harmful or helpful. Ambedkar quotes Prof. Tiele's vivid survey of the progress as well as destruction caused by a religion.[399] A force which shows such a strange difference in its result can be accepted as a good religion without examining the form it takes and the ideal it serves. It all depends upon what kind of social ideal that a given religion, as a divine scheme of governance, holds out. This is a question, which is not answered by the science of comparative religion. Indeed, it begins where comparative religion ends. "The Hindu is simply trying to avoid it by saying that

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[398]Ibid, p 418.

[399]Ambedkar quotes the following perceptive passage of Prof. Tiele, Moon, Vasant, ed.,*B R Ambedkar's Writings and Speeches*, Vol V, Govt. of Maharastra, Bombay, 1989, p 24.

although religions are many, they are equally good."[400] "Ambedkar strongly condemns this ideology that all religions are true."[401]

According to Ambedkar, God is a human creation. In the primitive period the primitive man regarded anything as divine power, which he was not able to understand. "This power was originally malevolent, but later on, it was felt that it could also be benevolent. Later the power was called God or the creator."[402] So man developed the theory of God to explain natural phenomena. Ambedkar raised a question that if God was benevolent then why his own creations are considered untouchables. In his perception, God was an embodiment of hatred and injustice because it was said that the unjust social structure, which gave birth to Untouchability, is a God given one hence it cannot be changed. Hence, Ambedkar rejected the idea of God created by religion.

The efforts of Ambedkar to engage into a hypothetical and practical analysis of the Hindu social and philosophical order, attempted to build counter-ideology in order to re-construct Indian society, to cleanse impurity, to unify the untouchables, to give an identity and a goal, to fight for devising ways of advancing the social, political and economics conditions of the downtrodden. Ambedkar's analysis on the Hindu social order seriously questions the centrality of caste system and its viewpoint of social domination and successive oppression and intolerance. Ambedkar asserted the pathway of social resistance to the debasing Hindu social order. He said, "however sympathetic you may be to our cause, the fact of your being orthodox Hindu, your being part and pillar of the orthodoxy, deprives you of any right to advise us... this is a question of power, of caste, of self-interest and partiality. This is not a question of knowledge, intelligence, of the reason this you should desist from preferring us. Say what you may but we are not willing to tolerate this injustice."[403]

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[400] Ibid.

[401] Ambedkar B. R,"*The Buddha and the Future of His Religion*," The Mahabodhi, April-May 1950, p 203. Cited by Paradkar B A M, *The Religious Quest of Ambedkar*,in T S.Wilkinson and .M.M.Thomas, eds , *Ambedkar and the Neo- Buddhist Movement*, Bangalore, CISRS, 1972, p 52.

[402] Keer, Dhananjay, *Dr Ambedkar; Life and Mission*, Popular Prakashan, Bombey, 1991, p 253.

[403] Gore, M. S., *The Social Context of an Ideology – Ambedkar's Political and Social Thought*, Sage Publications, New Delhi, 1993, p 98.

Ambedkar's criticism of Hindu social order is based on his understanding of the democratic heritage of the western society. His hypothetical beginnings are derived from the clarification and rational tradition of modern Europe. From that tradition, he had inherited the values of liberty, freedom, equality and fraternity and he measured the Indian society on the foundations of these values. According to Ambedkar, the indispensable future of a social order is that it should be built on the initial notion of freedom. Freedom as both philosophy and practice is the basis of human society, as human beings naturally possesses the freedom of will. As they grow and progress, so would be the social order, which must be flexible as to allow newer changes according to the science of the times and human progress.

The other important concept in Ambedkar's direction of good social order is that it should distinguish the individual in the society. By recognizing the individual, a good social order together recognizes the good of the community. The individual is not to be sacrificed for the sake of collectively. So, the chief role of a good society is accepted as a person and not a cog in the wheel turned for the purpose of social mobility alone. He/she needs to be respected in the society for the reason that he is a human person.

Ambedkar emphasises that the human existence is not to be treated solely in the physical sense alone, but it has to be valued in the sense of something higher than that. According to which every human being has a spiritual super-existence through knowledge and love. In Ambedkar's ideology, respecting the every individual devoid of any caste or class stratification is sacred. "The inviolability is at the core of the concept of liberty."[404] According to Ambedkar, three important kinds mark the principle of a reconstructed social order. Human society is to be built on the foundation of freedom or liberty, equality and fraternity. These values are based on the notion that an individual is not a means but an end itself. While the notion of liberty emphasizes the inviolability of the human person, the concept of equality insists the right of the individual to be treated as an equal and to be respected as a complete member of the society irrespective of his attainments. According to Ambedkar, fraternity is the "disposition of an individual to

[404]Ibid, p 261.

treat men in reverence and love and dignity and the desire to be in unity with other fellow beings."[405] It strengthens the society and it gives vigour for the individuals to commit for the welfare of all. According to Ambedkar the Hinduism comprises of caste social order is an order of graded inequality. "'*Saṇskritization*'[406] is impossible that one can not change his caste and fraternity must also be sacrificed as the proper climate for the change of caste status, merely by adopting the behavioral development of personality."[407]

Ambedkar is of the opinion that the non-Aryan depressed classes are the "the broken-men", who eventually came to be treated as marginalized, belonged to Buddhism. Ambedkar's theory is that the contempt of Buddhism and beef - eating is the root of unsociability in Hinduism. It was his disputation that the outcastes, by converting themselves into Buddhism were only improving their original dignity "which was earlier clouded by the 'horrible and vicious dogma' of caste and untouchability."[408] Ambedkar held that *Dalits*, the broken people, who fled from the villages after the tribal wars and came to be expelled from the *Chaturvarna* social system of the *Vedic* Brahmins and later, came to be treated as the depressed classes were Buddhists by religion.[409]

Ambedkar's theology of Religion is praiseworthy on many counts. It has emphasized the *social* function of religion without neglecting to emphasize its necessity for *personal* growth. It laid more stress on *orthopraxis*, the right moral conduct based on love, than doctrines, cults, rituals and devotional practices. Many magical trappings of religion and doctrinal binding chains have been broken down by his theology. He has emphasized the liberative, prophetic, critical dimension of religion.

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[405]Moon, Vasant, ed , *Babasaheb Ambedkar's Writings and Speeches*, Govt of Maharastra, Vol III, Bombay, 1989, p 97.
[406]Srinivas M.N, *Social Change in the Modern India*, Orient Longman, Hyderabad, 1988, p 67
[407]Moon, Vasanth ed, *Dr. Babasaheb Ambedkar's Writings and Speeches*, Vol III, Govt of Maharastra Bombay,1989, p 99
[408]Paradkar B. A M, "*The Religious Quest of Ambedkar*," Ajay Prahaghan, New Delhi, 1968, p 63.
[409]Zelliot E, "*Religion and Legitimation*", Princeton University Press, Princeton, 1969, p 98.

Ambedkar's Theology is *humanistic and anthropological*, his thought is Social Humanism.[410] Ambedkar's main concern was to regain the full humanity deprived of caste oppression and sex discrimination, which are not only economic alienations but also primarily anthropological alienations. In his theology, Ambedkar gave importance to the common good, and the establishment of a humane social order, a society based on liberty, equality and fraternity of all the people. As a part of it, *Holistic human development* was much insisted upon. He would never take rest only with the fulfilment material well-being, and often reminded his people of the spiritual salvation, mental enlightenment, cultural transformation, social status, unity, love and peace, which are essential for happy and holy life.

Ambedkar religion is a religion of humanity, a religion at the service of humans to understand the humanness.[411] It is very much *contextual and cultural* He would not accept wholesale, the imported Marxian theory, which does not take into account caste and religion, which are very powerful and influential factors in the Indian context and culture.[412] He rejected also Islam and Christianity that are foreign and were attached to the anti-national and imperialistic countries. By the revival of Buddhism, Ambedkar did a great service to the *Dalits*. The return of Buddhism not only gives identity and explanation to the *Dalits*, it has also revived the Dalit Dravidian, non-Aryan, non-Brahminic "Indian" culture, whose ancient religion was Buddhism.[413] It has exploded the myth of Hindus, who equate Indian culture with Hindu-Hindi culture, and India with Hindustan.

Ambedkar's theological approach was *analytical as well as synthesist.* His writings

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[410]Ibid, pp 4 – 5, and 261 – 269.

[411]Ibid, pp 265 – 267.

[412]Jatava D. R, ed, *On contextuality of Ambedkar's thought, The Political Philosophy of B R Ambedkar,* Phoenix Publishing Agency, Agra,1965, p 2 Sections 3. 4 2. and 6. 4.

[413]Jatava D. R, *The Political Philosophy of B R Ambedkar*, Marathi Dalitha Sahitya, *Marathi Dalit Literature Movement*, a unique one of its kind, was inspired by Ambedkar, *for a collected translations of modern Marathi Dalit literature*, Arjun Dangle, ed , Poisoned Bread, New Delhi, Orient Longman, 1992, R. S. Khare, *The Untochable as Him self, Ideology Identity, and Pragmatism among the Lucnow Chamars*, New York, Cambridge University Press, 1984; Ibid., pp 6 – 8, 139 – 143, and 150 – 151; Donald E. Smith, India, *As a Secular State*, Princeton, Princeton University Press(1963), 1967, chapter 13: " *Hinduism and Indian Culture,*" pp. 372 – 378; P. 2

expose his inquisitive mind, which would not rest content with simplistic understanding but would reach to the heart of the matter. Posing one question after another that takes him deeper, and deeper Ambedkar comes up with the real causes and reasons for the matter in argument.[414] At the same time his theology exhibits many points of synthesis. Steering clear of the existing "*isms*", ideologies and schools of thought, and assimilating the best from them, Ambedkar offers an original synthesis that follows the Buddhist middle path.[415] As already mentioned, there is a synthesis of the clarification of the East and the West in his thought. Similarly, in his Theology we find salient features of American Liberalism and Russian Socialism, individualism and collectivism, materialism and spiritualism, scientific positivism and religious wisdom, which blend together in his synthesis. His liberative praxis also uniquely combined in its scheme both the Gandhian *Satyagraha* and Marxian class struggle. The social analysis of Ambedkar was again a blend of the economic analysis including Dialectical Historical Materialism, and the cultural analysis of religion, culture and social institution of caste.[416] His Dalit revolution included both the Cultural Revolution and social revolution.

Ambedkar's Theology is essentially *stereological and eschatological* Its aim and dream was to build up the Kingdom of Righteousness and *Dhamma Raj by* perfecting the social order gradually. To begin with, socio-religious reform for equality, national independence, democratic constitutional forms of government and state socialism are to be realized. The transformation of the social relationships and attitudes, based on the new value-system of liberty, equality and fraternity, is the foundation of the new just egalitarian society. Justice, social, economic and political, is to be secured for every member of the national and the human family. Only then can humane divine state of love and peace can reign in the universe, with blessedness and happiness for all creatures, the

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[414]Jatava D. R , *The Social Philosophy of B R Ambedkar*, Phoenix Publishing Agency, Agra,1965, pp 39 - 42.

[415]Jatava D R, *On contextuality of Ambedkar's thought*, (ed)*The Political Philosophy of B R Ambedkar*, Phoenix Publishing Agency, Agra, 1965, p 2 Section 6. 4 5

[416]Philip Mathew and Ajit Murican, eds , *Religion, Ideology and Counter – Culture*, his "*Non – Brahmin and Dalit Movements and their implications for Anti – Caste Struggle*," in Bangalore, Horizon book,1987, pp 207 – 226.

humans and the nature. With this eschatological hope, the Ambedkar spiritual struggle for the *Dhamma Raj* strives ahead. Another striking feature in Ambedkar's theology is non-dogmatism and provisionalism. As his guru, the Buddha, he strives hard to influence us to be rational and scientific, and not to believe anything on the word of someone else, because so and so said it, or because it is claimed to be a divine revelation. He made it very clear to his people that he does not want blind followers, and also that nothing of what he has written is perennial, infallible and dogmatic.[417] Instead, he calls attention many times to the Buddhist principle of impermanence and constant change.[418] Hence, "Ambedkar was also ready to admit, 'There can be no finality in thinking."[419] A responsible person must be ready to learn and rethink, and not to get enslaved by consistency, which is a '*virtue of an ass*'; he wants neither himself nor us to belong to that category.[420]

At the same time, we also find his theological approach *universalistic in nature.* It wishes the welfare of all people. It wants the end of class-caste struggle, so that all can live in peace and prosperity. Ambedkar urged the *Dalits* to strive not only for their own welfare, also for universal liberation and peace. The benefits of growth and social reform, according to Ambedkar, must not be usurped by the minority but accrue to all.[421] Ambedkar's Theology emphasized the common good, the just social order that will secure justice and equality for all the citizens. It strives for the universal peace of the Kingdom.

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[417]Keer,Dananjay. *Dr Ambedkar*, p 489; and D R. Jatava, *The Political Philosophy of B R Ambedkar*, Phoenix Publishing Agency, Agra, 1965, p 6

[418]Moon, Vasant,ed., *B R Ambedkar's Writings and Speeches*, Vol III, p 442; Ambedkar B R, *The Buddha and His Dhamma*, Siddhartha Publications, 1991 pp 169, 370, 388, 399, and 415

[419]Jatava D. R, *The Social Philosophy of B. R Ambedkar*, Phoenix Publishing Agency, Agra, 1965, p 3

[420]Ibid.

[421]Ibid, p 293.

CHAPTER-VI

CHAPTER – VI

AMBEDKAR'S VIEWS ON PHILOSOPHY AND MORALITY

The main objective of this chapter is to highlight the Ambedkar's philosophy of morality. For Ambedkar, morality is the basic need of humanity, as it would create a just and powerful community. He believed that morality was necessary for the growth of a strong and powerful nation. He says that religion is a system of socio-cultural values, which would bring all the individuals and would create a spiritually powerful community. Ambedkar said that Religion was a force which promises equal opportunity to all. He was also categorical that Buddhism alone could create a climate favorable to human equality and except Buddhism rest of the religions appeared to be false and unjust in their nature. As Hinduism already became corrupted and degenerated since it separated itself from the key element of morality. The critique is seen in operation in the rejection of religions and ideology, which clearly shows that without the existence of morality sufficient justice, cannot be promoted for the marginalized in the society.

The aim of this chapter is to explain the perception called 'new theology of morality' of Ambedkar who offered philosophical reasons to reject all religions and ideologies to prefer Buddhism as true dynamics of moral religion. He is of the opinion that morality is the central element for any religion. He has reinterpreted the Neo-Buddhism from the original teachings of Buddha that is purely based on the morality. Ambedkar emphasises on the transformation of the marginalized in the ideological terms as well as in the practice. In his view, morality is very much necessary for their 'spiritual ideology reforms' in the Hindu society. His quest and struggle for the liberation of marginalised had aimed to enter into the *Hindu* temples and consequently burnt the *Manu Smriti*, his ideological foundation for the egalitarian society remained as the core of his moral philosophy. Hinduism detached itself from morality so it degenerate and become corrupted. Hinduism has lost the three principles of liberty; equality, fraternity; and values necessary for the restructuring of Indian society based on Buddhism. This chapter explains the various reasons for his rejection of Hindu religion and its immoral ideologies; therefore he had decided to join Buddhism.

The underlying moral and logical assumptions of Ambedkar can be understood in terms of technical metaphysical concepts of liberty, equality and fraternity that associated with the philosophical notions of universality and rationality. Further, the inner essence of Ambedkar's intellectual development also can be understood as the attempt to realise his concepts of freedom and fraternity. Thus Ambedkar's main concern shifts from proclaiming the philosophical nature of freedom to ever-deepening interests of the social and historical conditions that produce inequality, exclusion and alienation. Ambedkar's writings are full of moral judgements - implicit and explicit. From Ambedkar's early writings and also from his childhood experience made him to attack on the Hinduism. His analysis on the Hindu religious order with specific reference to the problem of the *caste* and *Untouchability* is potential of providing a viewpoint of liberation. Ambedkar made scathing attack on Hinduism as a philosophy and religious immoral order and how it paved way for a practice of *Untouchability* and social degradation. Ambedkar was fired by outrage, indignation and the burning desire for a better world through the establishment of true *Dhamma.*

According to Ambedkar, morality is a "form of social consciousness; it is a social institution which regulates the conduct of people in all spheres of their social life. Morality expresses the general social requirements and interests of society through generally recognised injunctions and evolutions that are supported by the people. Ambedkar says that an individual relaying on the moral conceptions produced by society, assimilating them in the process of education, the individual may independently regulates his behaviour to a considerable extent and judge about the moral significance of all developments that takes place around. Thus Ambedkar says that the individual should not only act as the object of social control, but also as its conscious subject. Most of the philosophical, theological, religious, ethical writings of Ambedkar, along with his sociological writings are polemical in character."[422] Even, "*The Buddha and His Dhamma,* his most systematic book on religion, contains many passages which are polemic and apologetic, besides the dialectical disputes of the Buddha."[423]

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[422]Keer Dananjay, *Dr Ambedkar: A Memorial Album*, Popular Prakashan, Bombay, 1982, p 3

[423]Ambedkar B. R, *The Buddha and His Dhamma*, Sidharth Publications, Bombay,1984, pp 156 – 157, 159, 351– 364, and 370 – 371.

Morality being a complex social formation it concerned with: what are rights, rightness, duty, responsibility, obligation, justice, punishment, virtue, conscience and wisdom? How are customs, public opinion, laws, contracts, authority, self realisation and god or religion is related morality? What actions are accepted in a society, what norms of behaviour are adopted for the people to follow, what part do intentions play in determining rightness, can practical moral problems be solved generally, or do specific problems like caste, race and religion require separate treatment?. All these forms of moral consciousness are united into a logically ordered system which can prescribe, motivate and appraise moral actions. In addition to general human elements morality also incorporates historically transient and class, caste norms, principles and ideals. According to Ambedkar morality is socially constructed, and says that, the morality and moral norms are formed in the moral consciousness of society.

Ambedkar says that the Hinduism is a religion, which is not founded on morality. Whatever morality Hinduism has it is not an integral part of it. He argues that the morality is not embedded in Hindu religion, for him, it is a separate force which is sustained by social necessities and not by the injection of Hindu religion. According to Ambedkar, the Hindu social order lacks the spirit of solidarity. Ambedkar says that, "the reasons for this want of solidarity is not far to seek. It is to be found in the system of graded inequality where by the Brahmin is above every body; the *shudra* is below the Brahmin but above the untouchables. If the Hindu social order were based on the inequality, it would have been over thrown long ago. But it is based on graded inequality so that the *Shudra* while anxious to pull down the Brahmin, he is not prepared to see the untouchables raised to his level. He prefers to suffer indignities heaped upon him (rather than) to join the untouchables for a general levelling down of social order. The result is that there is nobody to join the untouchables in (there) struggle (against the oppressive caste system). He is completely isolated."[424] Thus, Ambedkar argues very resplendently that Hindu social order is caste bound and rooted in a morality called *varnasramadharma,* hence, it is no more remains to be a moral order or dharma. It turns

[424]Moon, Vasanth, ed, *Babasaheb Ambedkar's: Writings and Speeches* Vol V, Government of Maharastra, 1989, p 116.

out to be an *adharma* or immorality. While many of Ambedkar's arguments criticizing the caste social order are embedded in the modernist enlightenment tradition of the west, equally important are his criticisms, which are hailing from his moral conscience. He evaluates the moralistic foundations of Hindu social order.

Ambedkar, in his thesis on the *Annihilation of Caste of 1936* provides a brief analytical summary of caste social order and the need for the total annihilation of it. While attempting to flatten the caste Hindu apologies for the prevalence of casteism, Ambedkar insisted that caste is not merely a division of labour but more truly it is a division of labourers. It attaches a value hierarchy. It is hegemonic in its structure. The division of labour is not based on choice ether; it is based on one's birth in a specified caste group. Thus, the Hindu social order is no a free order of human choice. It upholds a theory of the predetermination so as to evade or escape radical interrogation of the system. The function of Caste, Ambedkar observed, is to divide and disorganize the social groups for the social, culture and political monopoly of the high caste Hindu. Caste, for Ambedkar is an uncivilized social act about which the caste Hindu is not prepared to bring about any change. As a system of social organization, caste performs the role of 'divide and rule' method of domination of the lower social groups.

The terrible suffering, pain and pathos of cultural deprivation, economic exploitation, social ostracism, and political domination caused by the ruthless monstrous caste-system, made Ambedkar whole-heartedly hate the caste system and anything or anyone related with its continuation. As he admits, such hatred for injustice is a must for the activists who wish to fight for a just and egalitarian order;[425] yet it should not, as it was in the case of Ambedkar, make one blind to the advantages, though few, of the jatilcaste-system.[426] Here we are not referring to the *Brahminic Varna vivastha,* caste-social order, the in egalitarian hierarchical ideology, slave system, and the system of *Untouchability* which must be totally abolished. It is due to some advantages that caste system, in its present

[425]Moon, Vasant,ed.,Ambedkar's preface to his, Ranade, Gandhi and Jinnah (1943), *Writings and Speeches*, Vol V, Government of Maharassstra, Bombay, 1991, pp 208 – 209.
[426]For a discussion of advantages and disadvantages of politicized of caste system, J. Murdoch, *Review of Caste in India*, Prem Rawat, Jaipur, 1977, p 216

form of *jades,* still survives and is on the flourish, even in our modern times leading to gruesome atrocities and gaining political out.[427]

Ambedkar points out the intricacy cabled in the order of casteism. According to him, the social order of Hinduism does not contain any principle of social transformation. In the caste order, other than the Brahmins, those who occupy the higher caste order aspire to become higher and higher by 'infection by imitation' however in practice such an upward movement is not a possibility. In the order of its hegemonic hierarchy, the upper or middle caste groups do not and cannot have any inclination towards equilibrium or change towards equality and justice.

Ambedkar asserts that the Hindu is morally unconcerned about the untouchable He had no conscience in this matter. By his absence of conscience, the caste-Hindu is a great obstacle to the removal of *Untouchability.* The untouchable does not belong to the society of the Hindu and the Hindu does not feel that he and the untouchable belong to one society. According to Ambedkar's observation, the Hindu social order is an outright denial of both spontaneity and a life freedom for mankind. Instead it upheld the belief in the tradition of *manana* (transmission of the old knowledge to generation) and conformity of the past rules and regulations of tradition. It is infected with a strong sense of finality and fixity paving no way for any scientific progress and revolution in society.

Ambedkar observes that the Hindu Social order tends to deprive moral life of freedom and spontaneity and to reduce it to a more or less anxious and servile conformity to externally imposed rules. There is no loyalty to ideas; there is only conventionality to command. The laws are inequities in that they are not the same for one class as for another. "The laws are made arranged to be the same for all generations. The laws made by certain persons called as the lawgivers. This code has been invested with the nature of finality of fixity."[428] This passage in the writings of Ambedkar shows his deeper

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[427]For an understanding of politisization of caste, Rajni Kothari, *Caste in Indian Politics*, Orient Longman. New Delhi, Section 1. 1

[428]Moon, Vasant, ed., *Dr Babasaheb Ambedkar's Writings and Speeches*, Vol V, Government of Maharastra, Bombay,1989, p 118.

consideration of the dynamics of an ideal source of the society. It presupposes that a society must include in itself the sources of its own change and transformation without which it cannot promise its forward movement and growth. Ambedkar's assessment of the instant of spontaneity as one of the sources of social dynamics helps him to appraise the Hindu social order and come to the conclusion that it lacks such a basis.

From the previous discussion and analysis of Ambedkar, we can record a few and methodological structure of Ambedkar's observations about the theoretical backdrop of his analysis of the Hindu social order. For Ambedkar, the Hindu social order is grounded in immorality. It is against justice, liberty, equality and fraternity. It is a collection of closed units that enclose themselves leaving no room for relationship and social intercourse. It is an order of self-imprisonment that enslaves the human into the caste prisons. It segregates 'infection by imitation' which in turn affects every consecutive caste groups and eventually. The Indian society is a system that degrades and alienates human labour and labourers. It lacks any social conscience for being in union. Spontaneity and moral freedom is alien to the system of caste social order. Participation and communication for social living is methodically prohibited in it. Its social expression is the social exclusion whose increasing effect is laid very seriously on the shoulders of the broken people.

Therefore for Ambedkar, rebuilding of the identity of the broken people and through that restructuring Indian society on a moral basis becomes a life mission. Ambedkar's criticism of the caste social order is indivisible from his criticism of Hindu religion. This does not develop into his biased position but on the other hand the nature of the object of his study i.e., the caste social order itself objectively suggests this position. If he starts with evaluating the caste system inevitably, he ends up with the criticism of Hindu religion. If he starts with the assessment of Hindu religion he unavoidably ends up with the disapproval of caste social order. This predictability, we mean, is involuntary in the nature of the object itself. The interconnectedness of caste and religion in India seems to be one of the oldest facts of Indian society. It is notable to remind here that many of the native reform and complaint movements handled the Hindu religion and the caste order,

united in the sense that one cannot be criticized without leaving the other. One can quote the examples of *Carvakas,* Buddhism in the ancient India as well as Phule, Periyar and Ambedkar in modern period. Perhaps, Ambedkar is the one who has provided a consistent hypothetical criticism of the Hindu social order and its caste basics.

Ambedkar has a strong backdrop of western clarification of thought that helped him to assess the Indian social structure from the point of view of liberty, equality, and fraternity. When he goes for assessing the structural elements of the Indian society, he looks up into the society from the point of view of individual, as the indispensable unit of the system on the one hand and from the point of view of social whole as the universal aspect of the society. Thus, the individual and the social are the two complimentary vital elements in the theoretical frame of Ambedkar analysis. He is interested not only to define a society or to provide a theoretical discourse of society except basically his intention lies in indicating and providing necessary foundations of a humane society. And for this he strongly believes that that the sources of change and transformation for the forward movement of a society are essential. Such an approach of Ambedkar helps him to assess the Hindu *order* at a deeper level.

Another very significant facet of Ambedkar's method is the social democracy and democratic constitutional feature of his thought. Ambedkar powerfully holds that social democracy is an explanation to relocate the caste social order. Ambedkar criticizes the Hindu social order from a moral direct of view. For him, since the Hindu social order lacks any moral conscience and value basis, he gave an advice that the Hindu society has to be reconstructed on the basis of an ethics of emancipation. For Ambedkar, liberty, equality and fraternity are the values that would offer a viable and humane Indian social order. From Ambedkar's study of the Hindu social order we could deduce the following projects of Ambedkar. The purpose of Ambedkar is to establish an alternative to the Hindu social order. Such a task in Ambedkar may be classified in two folds: On the one hand, Ambedkar wanted to establish the identity of the untouchables as an indigenous social religious '(Buddhism) group that resisted caste inequality from its very inception. And on the other, he ignited an ongoing social, educational, political movement, an

action for liberation, which would continue to raise the cause of justice in the Indian society, irrespective of the pains and sufferings in its encounter with the orthodoxy.

Morality as Inclusive

Ambedkar as a humanist he fight against untouchably or the evil of casteism is not a simply a fight for the downtrodden people. Moreover it is a fight for the moral redemption of the humanity. Existence of *Untouchability* may be only a direct challenge to the downtrodden only. But it is a moral challenge to all humanity. Caste and *Untouchability*, therefore it is crucial problem for humanity in general, rather than an only problem of down trodden. Deconstructing the identity of the untouchables, in the case of Ambedkar, is sill of reconstructing a society, which in turn conceives the possibility of building up a humanized world. Therefore, if the human society requests to be really a social whole, then it should attend to the broken- particular, namely the discriminated. The universal to be universal needs to restore the broken particular if not what is claimed to be universal is pseudo. Such a task he envisaged needs to be carried on at two interlined levels. One at the level of the philosophical or theoretical, while the other at the level of the practical. At its philosophical level of Ambedkar sets example for the need for a clear lucid and serious understanding and analysis of the theoretical foundations of an oppressive system. At the realistic level, he has suggested the need for a continuous discourse and a communication of resistance against any oppressive forces like caste and *Untouchability*.

The major theme of Ambedkars' analysis of morality is that the religious immorality is based on the philosophical and practice of social dominance. The Hindu religious philosophy and its socio-cultural appearances are grounded on the belief that human life is unequal and immoral, therefore cannot scream for religious and social equality. Those human beings are pre-determined to be born unequal and therefore cannot lay claim to equality either in terms of their religious-spiritual status or in terms of their social, economic, civic or political status in the community. The morality is also played main role to survive religion to right path. The religion is survived in the wheel of morality in action and the Hindu religious moral ideology always hurting to the depressed people.

This shows the morality of the Hindu is purely social. This means that the level of his morality is merely traditional and customary. There are two evils of customary morality. In the first place there is no surety that it will always be charged with sincerity and purity of motive. For it is only when morality penetrates to the deepest springs of purpose and feeling in' the individual that pretense will cease to find a place in human behavior. In the second place customary morality is an anchor and a drag. It holds up the average man and holds back the man who forges ahead. Customary morality is only another name for moral stagnation. This is true of all cases where morality is only customary morality. But the customary morality of the Hindus has an evil feature that is peculiar to it. Customary morality is a matter of meritorious conduct. Ordinarily this meritorious conduct is something that is good from the general or public point of view. But among the Hinduism the commendable conduct is not concerned with the worship of God or the general good of community. Meritorious conduct in Hinduism is concerned with the giving of presents, of good and of honour to the Brahmins. Hindu Ethics is worship of the superman.

The morality arises from the "direct necessity for man to love man."[429] Ambedkar makes it comprehensible that, "it is not to please God that man has to be moral, rather for his own good qualities that man is to love man."[430] In the struggle for existence the individual's rights may not' be catered for, and at times his or her interests can be, rare by the group. Similarly, "a weak group may also be discriminated by a stronger group, hence the indispensability; ability of the *law of love*, fraternity and brotherhood, which is another name for morality."[431]

The norms devised by Ambedkar, as criteria to assess the ideal scheme of obligations, were mainly to deal a deathblow to Hinduism. He was persuaded that Hinduism badly needed reform, and wanted to expose the oppression it had unleashed and the slavery it had perpetuated on the depressed. He was one of the victims of the social system of Hinduism, and so he should know what Hinduism aimed at. Which of these was Ambedkar attacking? What Hinduism did he condemn and reject? After discussing,

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[429]Jatava D.R, *The Social Philosophy of B R Ambedkar*, Agra, Phoenix Publishing Agency,1965, p 231.
[430]Ibid. and A.Thumma, *Prema Yoga*. Oxford University Press, New York, 1974, p 232.
[431]Ibid, pp 233 – 234.

various meanings of the word 'Hindu' as denoting a religion, parentage, country and a race. Ambedkar points out that he is dealing with Hinduism in which caste has become indispensable as doctrine, ideology and sanctified social order. Hinduism that is object of his derisive attack is that Bahrainis variety, a Hinduism who's 'care is the creed 'of caste',' and where "the *Manu Smriti* must be accepted as the Book of Religion."[432] Ambedkar quotes Max Muller and affirms that his target is, "Modem Hinduism rests on the system of caste as on a rock which no arguments can shake."[433] Ambedkar sees that Hinduism is not a religion for individual justice with equality, fraternity and liberty and it fails to bring social utility of just, free and moral social order as the ideal scheme of divine governance. In the sense Hinduism has failed to lift the depressed.

Ambedkar arrives at the final judgment of Hinduism: The only answer is that Hinduism is overwhelmed with the fear of contamination. It has not got the power to purify. It has not the desire to serve and that is because by its very nature it is in human and unmoral. It is a misnomer to call it religion. Its philosophy is against to very thing for which religion stands.[434] Hinduism is destined for failing the trial by the first norm of justice. It is found advocating inequality as the dependable doctrine: "This brief analysis of the Philosophy of Hinduism from the point of view of justice reveals in an obtrusive manner how Hinduism is adverse to equality, antagonistic to liberty and opposed to fraternity. Indeed, inequality is the *Soul* of Hinduism."[435] The second norm of social utility equally fails to free from domination: "If these conclusions are sound, how can a philosophy which disconnects intelligence from labor, which expropriates the rights of man to comfort vital to life and which prevented society from mobilizing resources for common action in the hour of danger, be said to satisfy the test of social utility."[436]

Ambedkar puts the rational and logical question that what difference would it have made if I had taken Hindu Ethics as the basis for deducing the philosophy of Hinduism? Most

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[432]Keer Dananjay and Dr Ambedkar, *Babasaheb Ambedekar's Writings and Speeches*, Vol III, p 336 &Vol IV, pp .5 – 8, *The Buddha and His Dhamma*, Which was being written at the same time, Sangan Books, London, 1987, p 487.
[433]Ibid, p 488.
[434]Keer Dananjay, *Dr Ambedkar: A Memorial Album*, Popular Prakashan, Bombay, 1982, p 92.
[435]Ibid, p 66.
[436]Ibid, p 71.

students of Hinduism do not remember that just as in Hinduism there is no difference between law and Religion so there is no difference between law and ethics. Both are concerned with the same thing namely regulating the conduct of the low class Hindus to *subserve* the ends of high Caste Hindus. The false pictures of Hinduism in as much as "I have omitted to take into account the *Upanishads* which are the true source of Hindu philosophy."[437]

Ambedkar reiterates that the Inequality is the *Soul* of Hinduism. The morality of Hinduism is only social. It is unmoral and inhuman to say the least. What is unmoral and inhuman easily becomes immoral, inhuman and infamous. This is what Hinduism has become. Those who doubt this or deny this proposition should examine the social composition of the Hindu Society and ponder over the condition of some of the elements in it. It is essential to emphasize the great part played by crime in the general life of these peoples. A boy is initiated into crime as soon as he is able to walk and talk. No doubt the motive is practical, to a great extent, in so far as it is always better to risk a child in petty theft, who, if he were caught, would probably be cuffed, while an adult would immediately be arrested. Women, who, although they do not participate in the actual raids, have many heavy responsibilities, also play an important part. Besides being clever in disposing off stolen property the women of the Criminal Tribes are experts in shoplifting. The only answer is that Hinduism is overwhelmed with the fear of pollution. It has not got the power to purify. It has not the impulse to serve and that is because by its very nature it is *inhuman* and *unmoral.*

The concepts of rightness and wrongness lie close to the core of Ambedkar's moral thought. His explanation of rightness is in relation to duty, responsibility, oughtness, justice, virtue and wisdom. Acts are right because they produce good results for the most people. Rights consist in acting for the benefit of others; wrong action is one's own benefit. Self-seeking is selfish and selfish is the root of all evils. The cure for this evil is to pursue the opposite course that is love others and promote their good. For Ambedkar democratic form of government is considered right because it is believed to produce the best results for the most people.

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[437]Ibid, p 73.

Ambedkar's morality is not only with rightness, but also with rights. This is more often associated with political and legal philosophy, since people seem to be more concerned about their legal than their moral rights. According to Ambedkar, "rights are real only if they are accompanied by remedies. It is no use giving rights if they aggrieved person has no legal remedy to which he can resort when his rights are invaded. Consequently when the Constitution guarantees rights it also becomes necessary to make provision to prevent the Legislature and the Executive from overriding them. This function has been usually assigned to the Judiciary and the Courts have been made the special guardians of the rights guaranteed by the Constitution."[438] Ambedkar says that the "rights are protected not by law but by the social and moral conscience of society. If social conscience is such that it is prepared to recognise the rights which law chooses to enact, rights will be safe and secure. But if the fundamental rights are opposed by the community, no law, no Parliament, no Judiciary can guarantee them in the real sense of the word."[439] Thus the right is the minimum claim upon the services of others as a duty is the minimum claim of others upon us.

For Ambedkar fraternity is another name for morality. He says that the fraternity is nothing but another name for brotherhood of men and women which is another name for morality. Ambedkar concludes that the "fraternity is the name for the disposition of an individual to treat men as the object of reverence and love and the desire to be in unity with his fellow beings."[440] According to Ambedkar "fraternity strengthens socialites and gives to each individual a strong personal interest in practically consulting the welfare of others. It leads him tom identify his feelings more and more with their good or at least with an even greater degree of practical consideration for it. Ambedkar argues that with a disposition to fraternity, the individual comes as though instructively to be conscious of himself as being one who of course pays a regard to others. Thus the good of others

[438]Moon, Vasant, ed., *Dr Babasaheb Ambedkar's Writings and Speeches*, Vol I, Government of Maharastra, Bombay,1989, p 406.
[439]Ibid, p 222.
[440]Moon, Vasant, ed., *Dr. Babasaheb Ambedkar's Writings and Speeches*, Vol III, Government of Maharastra, Bombay,1989, p 97.

becomes to him a thing naturally and necessarily to be attended to like any of the physical conditions of our existence."[441]

For Ambedkar morality and religion are inseparable and that morality is able to be understood only in the context of religion and it has been at the center of his philosophical discussion. According to Ambedkar, religion must be essentially moral; religion cannot live unless it interacts with other forms of spiritual life as morality, beauty, and truth. Religion is thus when compared with morality it turns out to be at once *infra* and *supra* ethical. The fact that the religion takes as its point of departure human life, for this it provides a goal. Without such a destiny in sight religion cannot exist, provided with it faith passes on far beyond the realm of morality.

Ambedkar says that the religion is not an end in itself It is meant for the preservation of life and human welfare. Hence, religion is not the one that has the final say; it is not infallible, absolute, inflexible nor permanent. Jesus insisted that the Sabbath is made for the humans and not for preventing the saving and the preservation of life of human beings and other animals. So also, Ambedkar stressed that religion is for humans and not humans for religion.[442] For him, "man and morality must be the centre of religion."[443] Humanist to the core, Ambedkar was ready to throw away any religion or religious practice; however, ancient and sanctified that does not promote human welfare.

For Ambedkar, morality is based on love.[444] Morality is sacred and has taken the place of "God" in his Philosophy. It must not be desecrated even by the mighty, so that it is able to protect the weak in the society. He felt that the foundation of morality is love. The reason for this love is not anything mystical, it arises from man's natural condition, out of the necessity of peaceful coexistence, the need of protecting oneself and the weak, and to bear each other for a happy life on earth.

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[441]Ibid, pp 97-98.
[442]Jatava,D. R. *The Social Philosophy of B. R Ambedkar*, Phoenix Publishing Agency, Agra,1965, Section 3. 3. 3. 2.
[443]Moon,Vasant, ed., *B. R. Ambedkar's, Writings and Speeches*, Government of Maharastra,Bombay,1991, Vol.III, p 442.
[444]Jatava D.R, *The Social Philosophy of B R .Ambedkar*, Agra, Phoenix Publishing Agency, 1965, p 267.

The ultimate vision and "goal of Ambedkar's liberative struggle is the Kingdom of Righteousness which, according to him, is the important purpose of *Saddhamma:* The Buddha by his *Dhamma* laid foundation to the Kingdom of Righteousness on earth and urged both the *Bhikkus* and the laypersons to strive for it."[445] The kingdom of righteousness consists of love, peace and justice for all.[446] It is the total and integral liberation of all, of every human being, every community and every nation on earth. Ambedkar's struggle all his life to liberate the oppressed community, which was the worst, affected by the caste system.[447] The liberation of the *Dalits* was not an end in itself, nor does it fulfil the ultimate goal of establishing the kingdom of righteousness, which entails the liberation of all peoples. Ambedkar urges the *Dalits* to work for the liberation of all at the first *deeksha* ceremony: "You must pledge today that you, the followers of Buddha, will not only work to liberate your-self, but will try to elevate your country and world in general... go forth to liberate people."[448] Dalit revolutions are for the liberation of all, to build the Kingdom of humanism.

The ideal of the kingdom of righteousness is realized in practice in a new society that is just and egalitarian, that is based on the principles of liberty, equality and fraternity.[449] The blue print for the new society of Ambedkar's dream was drawn out by him from Buddhism that was incorporated in the Preamble of India's Constitution. All the members of this ideal society are assured of justice-social, economic and political; Liberty of thought, expression, belief, faith and worship; Equality of status and have opportunity. Fraternity is assuring the dignity of the individual and the unity of the Nation. In the new

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[445]Moon, Vasanth, ed , *Babasaheb Ambedkar's Writings and Speeches*, Vol V, Government of Maharastra,1989, pp 318 – 319

[446]Ambedkar B. R, *Buddha and His Dhamma*, Siddhartha publications, Bombay, 1991, p 79.

[447]Keer Dananjay, ed , *Babasaheb Ambedkar's, Writings and Speeches*, Vol II, 1982, pp 609, and 655 – 656; pp. 449 – 500; G. S. Lokhande, B. R. Ambedkar – *A Study in Social Democracy*, Intellectual Publishing House, New Delhi, 1977, pp 143 – 156

[448]Moon, Vasant, Thus Spoke *Ambedkar's, Writings and Speeches,* Government of Maharastra, Bombay, Vol II, 1982, pp 164 – 165.

[449]Ambedkar B. R., *The Buddha and His Dhamma*, pp. 318 – 319; *Writings and Speeches*, Vol I, pp 57 – 58; Jatava D.R., *The Social Philosophy of B R Ambedkar*, pp 86 – 93 and 231 – 269, G. S Lokhande, Ambedkar B. R.– *A Study in Social Democracy*, Intellectual Publishing House, NewDelhi,1977, pp 50 – 63; Section, 3. 4. 2.

ideal society, "what is important is high ideals and not noble birth. No caste, no inequality; no superiority; no inferiority; all are equals."[450] Thus the new society is socialistic in its economic structure; democratic in political structure and egalitarian in social structure. It is free from every form of exploitation, dictatorship, domination and the oppression of caste, class, gender, ethnic nationality and culture. The just society is where even the weakest group receives recognition, equal respect, dignity and identity, and is bequeathed with special affirmation, reservations and privileges to promote itself.

Ambedkar proposes that the "Cleansing the mind of it's the impurities,"[451] "Training the mind to turn bad disposition into good disposition,"[452] awareness of the impenitence of all things, cultivation of detachment,[453] controlling of all passions[454]and cessation of all desires and craving.[455] Only armed with detachment and enlightenment an individual and society can strive for the Kingdom. This psycho-cultural revolution must precede and accompany the socio-political revolution. Ambedkar emphasizes "A good disposition is the only permanent foundation of and guarantee of permanent goodness."[456] To state it positively, the process of detachment and enlightenment unleashes the powers of love, which are the basis and the force of revolution. Unless one overflows with "an all-embracing love for the entire universe,"[457] one cannot worthily and effectively participate in the struggle for the Kingdom. None of the other means employed to attain realization, "has a sixteenth part of the value of loving kindness. Loving kindness, which is the freedom of heart, absorbs them all, it glows, shines, it blazes forth."[458] The Kingdom of Righteousness can be made an historical reality only if both the monks as well as the lay - persons strive in practice to love and serve. Mere preaching "would not result in the creation of that ideal society based on righteousness. Compassion that is the essence of

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[450]Moon, Vasant, Thus Spoke Ambedkar, Vol II, 1982, pp 164 – 165, D R Jatava, *The Political Philosophy of B R Ambedkar*, Agra, Phoenix Pub House, 1965, pp 81 – 160.
[451]Ambedkar B. R, *The Buddha His Dhamma*, Siddhartha Publications, Bombay, 1991, p 166.
[452]Ibid, p 202.
[453]Ibid, p 170.
[454]Ibid, pp 156 and 165.
[455]Ibid, p 296.
[456]Ibid, p 202.
[457]Ibid, p 301.
[458]Ibid, p 214.

the *Dhamma* requires that every one shall love and serve, and the *Bhikkhu* is not exempt from it. A *Bhikkhu,* who is indifferent to the woes of mankind, however perfect in self-culture, is not at all a *Bhikkhu.*"[459]

Any religion that enslaves the minds of the people by fear or force, curtailing their liberation and freedom, that denies justice, equality and democracy that hinders universal fraternity, is no religion at all. Such religious practices, ceremonies and customs are to be rejected, and such doctrines are to be corrected. Even when a single person or small group is oppressed by a religion, a religious person or a religious class, that religion is in need of urgent reform. Domination of the clergy, exploitation of people in the name of devotions, superstitious and magical ceremonies, and outdated and irrelevant practices, over-spiritualization of religious doctrines, and deification of religious figures and saints, distort religion. We need religion for the liberation of humanity, but from the religion that does not liberate humanity we need liberation.

Ambedkar urges the *Dalits* to free themselves of such superstitious and magical religion and the fatalistic attitudes inculcated by the enslaving doctrines of *karma* and *love* [460] These not only impoverish and enslave, they also entrap the minds. While Ambedkar bequeathed the *Dalits* a religion of wisdom and compassion, a religion of loving service and self -sacrifice, and a religion of morality of love, to strive for the Kingdom of Righteousness, he condemned all superstitious practices. Ambedkar says that what is needed for salvation are not these but a critical, prophetic, liberative religion. Further, he reiterates that a liberative religion alone can inspire and inform the people with wisdom, and empower them with detachment and love, to struggle for the political power, to transform the unjust structures, and to usher in the *Dharma Raj.*

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[459]Ibid, pp. 318 – 319.
[460]Keer, Dhananjay, *Dr. Ambedkar· Life and Mission*, Bombay, Popular Prakashan, 1991, pp 233 – 235.

In short, the purpose of the liberative religion is to "teach the virtues of fellow feeling, equality and liberty"[461] and thus build the Kingdom of *Dhamma*. Hence, the urgency for all the religions to purge themselves of the magical practices, outmoded cults and ceremonies, irrelevant institutions and traditions, outdated doctrines and dogmas, and unleash the liberative elements and the revolutionary potential that is present in all of them. Only then can they be effective paths to the Kingdom.

Dhamma as a scientific morality

Ambedkar emphasized that the Buddhist ethics is not a mere rules or guidelines for the individual purity and its sanctity. Certainly Buddhist ethics very much talk about the importance of minds to be cleansed. But that is not confined in itself. If we look on the morality of the all other religion we could have find out that all principles are directed towards the individual aspect of ethics. They are narrowed down as some kind of instruction to the individuals. One thing which we have to notice is that it does not mean that socially aspects are totally excluded from it. But social aspects are also included in the frame work of individuality. The best example of this is Christian dictum "Love thy neighbour as you love yourself"[462]. The dictum which can be considered as the paramount of social concern is also exactly a preaching of individual oriented ethics. Actually that principle is also an advice to an individual to change his mind from the selfish motives. Other religions if we look we can find out that certain instruction to an individual which are quite appropriate to keep the current social order. Hinduism is the evident example. But only in Buddhist ethics we can find out the ethical aspects which address society as whole, which emphasizes with the social concerns.

Ambedkar makes out this difference very clearly and emphasizes the social-morality of the Buddhism in 'Buddha and His *Dhamma*'. "What is the purpose of religion? Different religions have given different answers. To make man seek after God and to teach him the importance of saving his *Soul* is the commonest answer one gets to this question. Most

[461]Ibid, p 273.
[462]Dr. Billy Graham, "*The bible is a book*", ed, The Bible, *New Testament Gospel According to Luke*, Chapter X, verse,27

religions speak of three kingdoms. One is called the kingdom of heaven. The second is called the kingdom of earth and the third is called the kingdom of hell. All the religions preach that to reach this kingdom of heaven should be the aim of man and how to reach it is the end of all." But Ambedkar emphasize that for Buddha, the purpose of religion was entirely different. To the question what is the purpose of religion Buddha's answer was entirely different. "He did not tell people that their aim is life should be to reach some imaginary heaven. The kingdom of righteousness lies on earth and is to be reached by man by righteous conduct "[463]

Ambedkar tries explains that the Buddhism is not related to the concept of God but morality. But what become now evident in Buddhism is that the purpose of morality is defined as to make the earth of righteousness. One should here note that many religions talks about the earth of love, but only Buddhism talks about the earth of righteousness. According to Ambedkar in Buddhism virtue is defined in socially aspects. It is this which distinguishes Buddhism form all other religions[464]

Moreover what is appealing is that Buddhist ethics is not the denial of the Individual ethics, beyond it, the individual ethics and social ethics both are construed and formed in the critical engagement with each other. May be one wonder that how we can categorically define certain values as social and individual. It is true that this division is not a water tight division. But in emphasis, one can define that certain values are socially oriented and certain others individual oriented. Certainly righteousness is social virtue. It is because righteousness is not merely a person's attitude towards others. This is a virtue which exists in the social relation only. This is not something which resides in one person and expressed towards other. But something which is only evolving in social relation. In certain sense we can distinguish both these kinds of values as follows: Social relation is quite necessary for the definition of the social value. Individual value also most of the time includes social relation, but for the definition of it social relation is not a necessary one.

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[463]Ambedkar B. R , *Buddha and His Dhamma*, Siddharth Publications, Bombay, 1987, p 283
[464]Ibid.

But at the same time Buddhist ethics are not the denial of individual aspects of ethics. But what we can see in Buddhist ethics is critical engagement between individual aspect and social aspects. In Buddhism both guides each other while in other religions it is only one-way relations. That is individual aspects determines the social aspects. But Buddhism offers the possibility of interaction of both it is evident from following: "Only righteousness can remove this inequity and the resultant misery. That's why Ambedkar said that religion must not only preach but must inculcate upon the mind of man the supreme necessity for being righteousness in his conduct "[465]

Ambedkar proposed the ideal of *Saddhamma*. For Ambedkar: "*Dhamma* is *Saddhamma* when it makes learning open to all. *Dhamma* is *Saddhamma* when it teaches that mere learning is not enough. It may lead to pedantry *Dhamma* is *Saddhamma* when it teaches that what is needed is *prajna* (Pranya). *Dhamma* is *Saddhamma* only when it teaches that *Prajna* is not enough. *Sila* must accompany it. *Dhamma* is *Saddhamma* only when it teaches that besides *Prajna* and *Sila,* what is necessary, is *Karuna Dhamma* is *Saddhamma* only when it teaches, that more than *Karuna* what is necessary is *Maitri, Dhamma* to be *Saddhamma* must break down barriers between man and man. *Dhamma* to be *Saddhamma* must teach that 'worth' and not' birth' is the measure of man. *Dhamma* to be *Saddhamma* must promote equality between man and man."[466] The functions of *Saddhamma* are in the first place to cleanse the mind of its impurities and in the second to make the world a kingdom of righteousness. In order to practice *Saddhamma,* however, *Dhamma* must promote *prajna* or insight, and this it does by making learning open to all, by teaching that mere learning is not enough as it may lead to pedantry, and by teaching that what is needed is *Prajna* or right thinking.

Moreover *Dhamma* as *Saddhamma* only when it teaches that *Prajna* must be accompanied by *Sila* or right action as well as by *Karuna* or compassion for the poor and helpless and by *Maitri* or love for all living beings. It follows that, in order to

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[465]Ibid, p 284.
[466]Kuber W. N, *B R Ambedkar*, Ministry of Information and Broadcasting, Govt. of India, New Delhi, 1978, p 96.

Saddhamma, Dhamma must break down the barriers between man and man must teach the worth and not birth and must promote equality between man and man. According to Ambedkar the practice of *Saddhamma* includes, to cleanse the mind of its impurities; to make the world kingdom of righteousness; to make learning (*knowledge*) open to all; to teach the relevance of what is learnt in education; to practice moral *virtues (Sila);* to promote mercifulness *(Karuna);* and to promote *Maitri* or fellowship. As part of negations, for the *Dhamma* to be *Saddhamma* it should involve in breaking away the barriers between men or among human beings. The *Dhamma* to be *Saddhamma* must teach worth and *not* birth as the measure of man. Buddha is against the theory of the supremacy of birth as described in the concept of *Chaturvarna.* Instead, he preached the idea of the worth of man. He says no one is an out caste by birth- and no one is a *Brahmin* by birth and the most important element in the *Saddhamma,* more than *Prajna* is *Sila*. The *Sila* is *Karuna,* love of human beings and *Maitri* which is love of all living beings.[467]

According to Ambedkar, merits of Buddhist philosophy were as follows: Buddhism demanded living experience and a life divine, attainable there and now; not after death, it was realism and never idealism. It upheld liberty, equality, truth and justice; it emphasized humanity, love and peace. It was dynamic, scientific and all embracing. Its explanation of life and its meaning and purpose of birth and death and its aftermath were very clear, intelligible and logical. Above all, man was the center of his study and examination and not anything outside of him. Ambedkar tried to prove that the untouchables were Buddhists. In his thesis on the origin of *Untouchability* he made it clear that today's untouchables were once Buddhists.

"Buddhism was an Indian religion and the Buddha was nearer to the untouchable masses. Buddhism could withstand even the severest scientific test and had the power and capacity to direct destines of the modern world. The untouchables would join with the world Buddhist community and thus pave the way for world brotherhood."[468] Ambedkar said that, "Buddhism gives three principles in combination, which no other religion does.

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[467]Jatava D.R, *The Social Philosophy of B R Ambedkar*, Agra, Phoenix Publishing Agency,1965, p 301.
[468]Ambedkar, B. R, *Buddha and The Future of His Religion*, Bheem Patrika Publication, Jalundur, 3rd Edn. 1968, p 5.

Buddhism teaches *prajna* (understanding) as against superstition and supernaturalism, *Karuna (love)* and *samata* (equality)... Neither god nor *Soul* can save the society,"[469] Referring to Marx's philosophy, Ambedkar observed that Man cannot live by bread alone. He has a mind, which needs food for thought. Religion instills hope in man and drives him to activity. Hindu religion has watered down the enthusiasm of the downtrodden. And "I found it necessary to change my faith and embrace Buddhism."[470] Ambedkar says that Religion emphasizes, universalizes social values and brings them to the mind of the individual who is required to be familiar with them in all his acts in an order that he may function as an approved member of the society.

Ambedkar's intervention in Hindu social order is considered as a Copernican revolution in the realm of morality and religion. Analysis shows that, Ambedkar's attempt to justify morality without reference to transcendental religious beliefs is a first step to make the realm of morality as an autonomous one. The concern for the universal well-being is the main consideration of Ambedkar's scheme of morality. Thus, external considerations are no longer being above moral principles. Ambedkar makes such a morality the basis of religion, which he constructed as *Dhamma*. In this construal, he redefines the centre of religion as morality rather than God. According to Ambedkar, Natural law is the basis of moral order of universe. *Dhamma* for Ambedkar is all-inclusive. The underlying meaning of the *Dhamma* is a message of equality and fraternity.

Ambedkar's position is that morality in religion would not be an effective one. In religion, morality is only a wagon which is attached to it. It is attached and detached as the occasion requires. Ambedkar notes that "Morality comes in only wherein man comes in relation to man. Morality comes into religion as a side wind to maintain peace and order....Be good to your neighbour because you are both children of God....The action of morality in the functioning of religion is therefore casual and occasional."[471] Ambedkar affirms that morality is *Dhamma* and *Dhamma* is morality that is inclusive. Further

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[469]Ibid.

[470]Rob Peter, ed, *Dalit Movements and the meaning of labour in Indian,* Oxford University Press, New Delhi,1993, p 18.

[471]Ambedkar, B. R, *The Buddha and His Dhamma*, Siddhartha Publications, Bombay, 1987, p 322

analysis shows that, Ambedkar's attempt to justify morality without reference to transcendental religious beliefs is a first step to make the realm or morality as an autonomous one. The concern for the universal well-being is the main consideration of Ambedkar's scheme of morality. Thus, external considerations are no longer being above moral principles. Ambedkar makes such a morality the basis of religion, which he construes as *Dhamma*.

In accordance with the Lord Buddha, Ambedkar also insists that the purpose or religion and spirituality are not mere quest of notion or truth. His analysis shows that this is not a defensible claim. Buddha also analyzes the metaphysical quest as follows; "Morality is justified in theistic religion in terms of reward and punishment give by God to the individual. Atheistic religions justify morality in terms of the doctrine of karma, according to which, morally good or bad lead to consequence, which are pleasant or painful to the agent. Therefore, the ethics in both theistic and atheistic religious lead to a kind of egoistic consequentialism."[472] This implies that the morality and its principles, roughly which can be considered as the benefit of all, is built on the egoistic basis. Morality is defined and prevailed in most religious by looking on the consequence of violation or maintenance, which ego would face. Here, suggests that in Ambedkar's reconstruction of Buddhism, is morality is justified in terms of universalistic consequentalism.

As we mentioned earlier Ambedkar extensively talks about the individual aspects of ethics through Buddhism. However, what one has to notice is that in this point also it differs from the other religion substantially. Through providing certain rule what other religion advocates the suppression of certain aspects of individuality and life. Advocation of asceticism is the best example for it. And these individual ethical values are also construed as looking toward some heaven or other supernatural ideas. But Buddhism stands for the fullness of life and formulated ethical principles by looking on the face of reality. According to Ambedkar, to live in *Nibbana* is *Dhamma*. According to Buddha, Nothing can give real happiness as *Nibbana*. Of all doctrines taught by the Buddha, the

[472]Pradeep P. Gokhale, *Reconstructing the World*, 'Universal Consequentilism A Note on Ambedkar's Reconstruction of Buddhism Sri Satguru Publications, New Delhi, 1993, p 127

doctrine of *Nibbana* is the most central one. Brahmanic Upanishadic and Yogic traditions consider *Nibbana* as salvation of *Soul*. There three ideas which underlies in the Buddhist conception of *Nibbana*. "Of these the happiness of a sentient being as distinct from the salvation of the *Soul* is one. The second idea is the happiness of the sentient being in *Samsara* while he is alive. But the idea of a *Soul* and the salvation of the *Soul* after death are absolutely foreign to the Buddha's conception of *Nibbana*. The third idea which underlies his conception of *Nibbana* is the exercise of control over the flames of the passions which are always on fire."[473]

And for the individual Ambedkar said that the "Buddhism teaches social freedom, intellectual freedom, economic freedom and political freedom to man."[474] Ambedkar's approach to Buddhism thus, is social, philosophical and ethical rather than and mystical, as even a short account from' *The Buddha and His Dhamma'* will be sufficient to reveal. Ambedkar wanted to explain the teachings of Buddha by using the classification used by Buddha himself, namely the classification of *Dhamma* into the three categories *Dhamma,* Not-*Dhamma (ADhamma), and Saddhamma* As per the understanding of Ambedkar the concept of *Dhamma* in Buddhism refers: "To maintain purity of life is *Dhamma;* to reach perfection in life is *Dhamma;* to live in *Nibbana* is *Dhamma,* to-up craving is *Dhamma;* to believe the all compounded-things are impermanent is *Dhamma.* And to believe that *Karma* is to be an instrument of morality, it is *Dhamma.*" [475]

Normally all the religions have either Scripture as their base or God as their center. But for Buddhism, Morality replaces both the scripture and God. Ambedkar observes, "The religion of the Buddhism' is morality. It is embedded in religion. It is true that in Buddhism there is no God in place of God there is morality. What God is to other refrains, morality is to Buddhism"[476] A morality, which was, based on the principles of

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[473]Ambedkar B. R , *Buddha and His Dhamma,* Siddhartha publications, Bombay, 1987, p 234.
[474]Shashi, S. S, ed., *Ambedkar and Social Justice,* Vol I&II, Ministry of Information and Broadcasting, Govt. of India, New Delhi, 1992, pp 92 – 93.
[475]Kuber W. N, *B R. Ambedkar,* Ministry of Information and Broadcasting, Govt. of India, New Delhi, 1978, p. 93.
[476]Busi S. N, *Mahatma Gandhi and Babasaheb Ambedkar*, Saroja Publications, Hyderabad,1997, p 325.

truth and love. Hinduism, according to Ambedkar, did not recognize the principles of freedom and equality and had not succeeded in evolving a universal morality.

The *Dhamma* for Ambedkar is a practice of certain specified negation. To explain what a *Dhamma* is, *not-Dhamma,* Ambedkar lists various negations or immoral activities that Buddha advocated in order to promote its social message. "Belief in the Supernatural is Not-*Dhamma (ADhamma). Beliefs in Ishwara (God)* is not essentially a part of *Dhamma* based on union with *Brahma* is a false *Dhamma* Belief in *Soul* is *Not-Dhamma Belief in Sacrifices is Not-Dhamma Belief based on Speculation is Not- Dhamma.*"[477] *ADhamma* or *Not-Dhamma* consists in the belief in the supernatural as the cause of events, in the belief that the world was created by God, in the belief that *Dhamma* is based on union with *Brahma,* in the belief that sacrifices including animal sacrifices are a part of religion, in the belief that speculations regarding the origin of the self and the universe are a part of religion, in the belief that the reading of books is *Dhamma,* and in belief in the infallibility of sacred books like the *Vedas* as against *Adahmma,*

Morality is based on the Natural Order of the Physical world. It is evident from the natural phenomena that there is an order of the physical world. There is certain order for the movement of heavenly bodies, regularity for the seasons. These are called '*Niyamas*' in Buddhism. "Similarly there is a moral order in Human society. How is it produced? How is it maintained? Those who believe in God have no difficulty in answering the question. And their answer is easy. Moral order is maintained by Divined dispensation. God created the world and God is the supreme governor of the world. He is also the author of moral as well as of physical law. Such is the argument in support of the view that the moral order is maintained by Divine Dispensation."[478]

Ambedkar contests these arguments. He asks "For if the moral law has originated from God and if God is the beginning and the end of the moral order and if man cannot escape

[477]Ibid, p 95.
[478]Ambedkar B. R., *Buddha and His Dhamma*, Bombay, Siddhartha publications 1991, p 242.

from obeying God, why is there so much moral disorder in this world."[479] According to Ambedkar, Natural law is the basis of moral order of universe. "...God leaves it to Nature to work itself out in obedience to the laws originally given by him."[480]The moral order is maintained by Kamma Niyam and not God which maintains the moral order in the universe. "The moral order of universe rests on man and on nobody else. *Kamma* means man's action and *Vipaka* is its effect."[481]

The basic question is that an action right or wrong because God commands or prohibits it, or God commands or prohibit the action because it is already right or wrong? A divine command ethicist takes the position that the standard of right or wrong is the commands and prohibitions of God. According to the divine command theory "an action or kind of action is right or wrong if and only if and because it is commanded or forbidden by God."[482] According to the Natural law theory, the basic principles of morals are objective, accessible to reason, and based on human nature. An action is right if it serves to fulfill human nature and wrong if it goes against human nature. Our human nature includes various inclinations and tendencies. The task of reason is to discover, sort out and order these inclinations in accord with appropriate human fulfillment.

However, in the analysis of Ambedkar's position one can find out that Ambedkar clearly counter the argument for the divine command ethics. Major divine command ethics' arguments are based on the conception that God is the first cause. That is God cannot be causally affected by anything. Therefore it is difficult to claim that God chosen which is already good, that is God is causally affected. All the similar positions already assume the supremacy of God in all senses. This presupposition which Ambedkar denies thoroughly through out his theological positions and especially in his construal of Buddhism. If certain presupposition are accepted as certain, it itself is obstacle to the critical engagement and analysis. Divine command ethics can be defended only on the ground

[479]Ibid, p 243.
[480]Ibid.
[481]Ibid, p 244.
[482]Frankena W K, *Ethics*, 2nd edn, oxford university press, NewYork, 1989, p 28.

that it follows from certain beliefs we have about God's nature and status and about the character of the relationship between god and Human beings.

In Plato's *Euthyphro*, Socrates raises the question, "is what is holy because the gods approve it, or do they approve it because it holy."[483] According to Boyd and Vanarragon observe in their article 'Ethics is based on natural law" that "These questions, first posed in Plato's *Euthyphro* have long troubled theists, because each of the obvious question carries with it unpleasant consequences. In other words, these questions appear to introduce a dilemma, as can be seen in the following argument:

- If God's command makes an act right, then morality is arbitrary.
- If God commands an act because it is right, then God's command is not essential to morality.
- Either God's commands makes an act right, or God's commands an act because it is right.

  Therefore,
- Either Morality is arbitrary or God's command is not essential to morality."[484]

Ambedkar's position was that the natural order of the universe is the basis of the morality. Ambedkar interprets the concept of *Karma* as, "the law of *Karma* has to do only with the question of general moral order. It has nothing to do with the fortunes and misfortunes of the world. It is concerned with the maintenance of the moral order in the universe"[485]

Dhamma for Ambedkar is social. *Dhamma* is social in the sense that it is all embracing and for all humanity .In other religions, a person leading a secluded life and performing certain rituals is considered to be a religious man but in Buddhism a man's behaviour towards his fellow-beings is the test of his being religious. *Dhamma* teaches righteousness which means right relations between man and man in all spheres of life.

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[483]Janine Marie Idziak, *Divine Commands are the foundation of Morality*, Oxford Clarendon Press, Oxford, 1978, pp 290-299

[484]Boyd, Craig A and Vanarragon, Raymond J '*Ethics is based on natural law*" Francis Printer, London, 1987, p 94.

[485]Ibid, p 95

Society, therefore, cannot do without *Dhamma* If *Dhamma* is not social and is not for the welfare of the people then it has no value for suffering humanity. Further, the underlying meaning of the *Dhamma* is a message of equality. Where there is equality, there is hope for individual initiative, progress and attainment of *Nirvana,* the supreme state of Bliss, the ultimate aim of every Buddhist.

Further, in most religions there is no place for morality but morality is the essence of the *Dhamma.* Without it, there is no *Dhamma* In *Dhamma* morality takes the place of God although there is no God in *Dhamma.* Then Ambedkar discusses the principle of *Ahimsa* of Buddha. In Buddhism *Ahimsa* is a principle and not a rule. Buddha made a distinction between the 'need to kill' and the '*will to kill*'. Buddha denounced *Himsa* (Violence) and advocated a ban on the killing of animals for the sake of food, sacrifice, sport or pleasure; but it is wrong to interpret that He banned *Himsa* under all circumstances. But Buddha said that no one should run away from the Army with a view to join *Sangha* This means that the Buddha was not against killing for the defense of the country. The principle of '*the need to kill*' and the 'will to kill' therefore is correct. To kill is entirely a matter of necessity and personal moral responsibility. Every act has to be guided by man's own *Prajna* and *karuna.* Buddhism in *Ahimsa* means non-aggressiveness; but in self -defense, if anyone needs to fight then he should fight.

Ambedkar tried to find the difference between *religion* and *Dhamma* in relation to their purposes and the way that different terminologies like *karma* and *Ahimsa* or non-killing are interpreted and used. Then he went to explore the relation between *Dhamma* and religion out of which he asserts that mere "Morality is not enough, but it must be sacred and universal."[486] Morality, he asserts, has no place in religion. Religion is concerned with the relation between man and God and morality is concerned with the relation between man and man. Though every religion preaches morality, morality is not the root of religion, it can be attached if it is needed or detached if it is not needed. The action of morality in the functioning of religion is not a serious one but casual and occasional.

[486]Kadam, K. N, *Dr Ambedkar The Emancipation of the Oppressed*, Sangam Books, London,1993, p 105

After describing the non-closeness of morality and religion Ambedkar takes *Dhamma* for his analysis and say that "Morality is *Dhamma* and *Dhamma* is Morality."[487]

As per Ambedkar's understanding Morality is the essence of *Dhamma* and the absence of it there is no *Dhamma.* Religion attaches every thing to God and man is expected to do every act to appease God. His responsibility himself to serve and save the fellow beings. But *Dhamma* is not like that every thing the man does, is for his own self. He says that the "Morality in *Dhamma* arises from the direct necessity for man to love man. Such morality does not require divine sanction. It is not to please God that man has to be moral. It is for his own good that man has to love man."[488] This morality, which is *Dhamma,* is not to satisfy a particular group but serves to protect the weak from the strong standards, and rules and which safeguards the growth of the individual. It is what makes liberty and equality effective, for if there is liberty for some but not for all and equality for few but not for the majority, what is the remedy? The only remedy lies in making fraternity universally effective. What is fraternity? It is nothing but another name for brotherhood of men, which is another name for morality.

That is the reason Buddha said that *Dhamma* is morality and as *Dhamma* is sacred so is morality. As he begins writing the portion on the *Dhamma,* 'and his interpretation of "What the Buddha Taught", Ambedkar lists out 'different views of the Buddha's *Dhamma*" on "What others have understood him to have taught": "What are the teachings of the Buddha?" This is a question on which no two followers of the Buddha or the students of Buddhism agree. To some *Samadhi* is his principal teaching. To some it is *Vippassana* (a kind of *Pranayam*). To some Buddhism is esoteric. To others it is exoteric. To some it is a system of barren metaphysics. To some it is sheer mysticism. To some it is a selfish abstraction from the world. To some it is a systematic repression of every impulse and emotion of the heart. Many other views regarding Buddhism-could be collected.' [489]

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[487]Ibid.
[488]Ibid.
[489]Ambedkar B. R, *Buddha and His Dhamma*, Siddhartha publications, Bombay, 1991, p 158.

Ambedkar is justified in his reinterpretation of Buddhism; he has left a few gaps unfilled. Firstly, by not linking his community of Neo-Buddhists to any of the existing Buddhist *Sangha,* he fashioned a gulf between them. He refused to accept the existing forms of Buddhism, as they were not, he deemed, faithful to the original teaching of the Buddha.[490] This shortcoming has not only isolated the Neo-Buddhists depriving them of historical continuity, and a continuous tradition, it also deprived them of a *Sangha* and religious leadership to guide them.[491] The sudden demise of Ambedkar widened this gulf much more.

Ambedkar tried to turn to Buddha's original teachings and *Dhamma* and the social order advocated by him. He had preferred among the various Buddhist forms the original Hinayana rather than the Mahayana form. The society must have either the sanction of law or the sanction of morality to hold it together. Without either the society is sure to go to pieces. Religion, if it is to function, must be in accord with reason which is another name for science. It is not enough for religion to consist of a moral code, but its moral code must recognize the fundamental tenets of liberty, equality and fraternity. Religion must not sanctify or ennoble poverty.[492] Ambedkar's principles, for interpreting Buddhism are rationalism and utilitarianism coupled with Socialism. He not only consciously employs them, also recommends them to those who are in doubt regarding the authenticity of the Buddha's teaching, as test-stones to clear the misunderstanding and confusion: One has therefore to be very careful in accepting what is said in the Buddhist canonical literature as being the word of the Buddha. There is however one test which is available. If there is anything that could be said with confidence that it is. He (Buddha) was nothing if not rational, if not logical. Anything therefore which is rational and logical, other things being equal, may be taken to be the word of the Buddha.

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[490]Asgar Ali Engineer, ed., *Religion and Liberation*, Delhi, Ajanta Publications, 1989; Stan Lourdusamy, *Religion as a Political Weapon*, Calcutta, Multi Book Agency, 1990; and Paul Puthanangady, *Towards an Indian Theology of Liberation*, Bangalore, NBCLC, 1986, Section 5. 2

[491]Michael Mahar J, ed., *The Untouchables in Contemporary India*, Tucson, The University of Arizona Press, 1972, pp 122 – 123.

[492]Keer, Dhananjay, *Dr Ambedkar Life and Mission*, Popular Prakashan, Bombay, 1991, p 421.

Usually science or reason is considered as in rival position of religion or religion bounded morality. The direct difficulty science could pose for religious belief would be direct scientific refutation of essential religious principles. But refutation can emerge only out of genuine conflict and that fact imposes some boundaries. For instance, many believe that science and religion operate in different domains or levels. If such positions are correct, there can be no genuine conflict. Any apparent conflict would represent trespassing or confusion. Further more, serious conflict between science and religion is possible only if both purport to be true. Consequently if religious commitment is non-negative or non-propositional, genuine conflict seems impossible. That's why Ambedkar's position one who takes religion very seriously must approach it with a scientific attitude. Otherwise our religion would be a superstition. Making religion more active or creative or critical is making it scientific. Making it non-scientific is blocking the growth religion; consequently it would become an ideology which advocates intolerance. And as per Ambedkar's position only through the critical engagement with science and reason one can draw the limits of religion. Drawing the limit is never deteriorating the system, it only corroborates it.

The second thing is that "the Buddha never cared to enter into a discussion, which was not profitable for man's welfare. Therefore anything attributed to the Buddha, which did not relate to man's welfare couldn't be accepted to be the word of the Buddha."[493] This test for dealing with the teachings of the Buddha, Ambedkar offers, is to distinguish between those matters in which the Buddha was certain and those in which he was not and so gave only tentative views. Social relevance, that is making the *Dhamma* relevant to the present Indian context and to the unequal oppressive situation of the *Dalits*, should be considered the major principle and key to his interpretation. For, the above mentioned second test of the three prescribed by him, to clear the doubts that arise out of confusion and suspicion, again reiterates the use of the principle of existential social utility as important in interpreting the *Dhamma.* Ambedkar, with other *Dalits*, was in search of a religion with a revolutionary social message and the ideal of equality that enforces the

[493]Keer, Dhananjay, *Dr. Ambedkar· Life and Mission*, Popular Prakashan, Bombay, 1987, pp. 254 – 255.

moral social order of a class-casteless prosperous fraternal human society.

Ambedkar was also desperately in quest of and consciously trying to remake a religion, that is relevant for the independent, democratic, socialist, secular, sovereign Republic of India. He was strongly convinced that Hinduism with its Brahmin domination, and the ideology of inequality, that maintains with fear and force the hierarchical social order, of ascending power and descending contempt, as its ideal scheme of divine governance, was no more relevant to new India. As it is evident from his historic 1956 talk, he was seeking to revive a religion that is relevant and useful to the present world situation.[494] The *Dalit* critical principle, which is the key to Ambedkar's *Dalit* Hermeneusis, is at work, as was shown earlier, in his critique of all theistic religions, and the ideologies of Gandhism and Marxism that is the basis of Indian Communism. It is all the more effective in the reinterpretation of Buddhism. Ambedkar offers a revolutionary version of Neo-Buddhism to serve the cause of *Dalits*.

The gospel of Buddha according to Ambedkar is only a part of the religious revolution of Ambedkar, namely, "First to produce a Buddhist Scripture/ Bible, second, to make changes in the organisation, aims and objects of *Bhikkhu Sangha*, third, to set up a World Buddhist Mission,"[495] came to be realized. The Buddhist Bible that he authored was first titled as *Buddha and His Gospel* and was later on changed to '*The Buddha and His Dhamma.*'[496] Ambedkar consulted all the available sources on the Buddha to write this book, considered to be his *magnum opus* It is a book of more than 400 pages, which was corrected again and again even as it was on print. So much was Ambedkar's concern to make it perfect, up to date, and relevant to the contemporary social situation, that even on the night of his death he lay correcting the preface for the same book.[497] A few copies had been first printed by him and circulated for comments, and the final version was out of the press only in 1957, a few months after his death.[498]

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[494]Ibid, p 490.
[495]Paradkar, "*The Religious Quest of Ambedkar*,"Ajay Prahaghan, New Delhi 1968, p 66
[496]Keer Dananjay, *Dr Ambedkar Life and Mission*, Popular Prakashan, Bombay,1987, p 489
[497]Ibid, pp 488 and 513
[498]Bhole's R. R, ed ,*Introductory Writings*,and Ambedkar B R, *The Buddha and His Dhamma*, Siddhartha Publications, Bombay, 1991, pp 105 – 108

As Ambedkar had originally intended, *The Buddha and His Dhamma* it reads like the Gospels with the biography of Compassionate Buddha interspersed with this teachings. The Buddha's inspiring life, noble mission, loving deeds, and the wise doctrine are combined to make the book a real Buddhist's Bible. Like the *Bible,* it is also broken down into books, chapters, and verses. It is rare to find a book on the Buddha and his *Dhamma* from which one can learn his teachings and life as much as one does from Ambedkar's gospel on the Buddha. It is in fact derived from Ambedkar's collection of hundreds of books on the Buddha.

The comments of Ambedkar on the original *suttas* and the biography are so inter-twined in, *The Buddha and His Dhamma;* at times it is difficult to distinguish who is talking. Ambedkar has also deliberately emphasized the social message of the Buddha. Ambedkar and reinterpreted his teaching and projected his personality to bring out not only the enlightened Siddhartha Gautama full of wisdom, *prajna,* but also the compassionate one, full of *karuna* and *maitri.* It is indeed a social gospel of Buddhism. It lays more stress on love and service than wisdom and insight. Doctrines of Buddhism did Ambedkar hold and teach? In the central part of his Bible, Ambedkar dedicates a whole book to summarise the main teachings of the Buddha and the main doctrinal matters regarding the *Dhamma.* He candidly presents what are *Dhamma, Adhamma* and *Saddhamma* according to the Buddha. The main titles and points of the book' 'What the Buddha taught' are: What is *Dhamma*? "It is to maintain Purity of Life; to reach Perfection in Life; to live in *Nibbana*; to give up craving; to believe that all compound things are impermanent; to believe that *Karma* is the instrument of Moral Order."[499]

What is *Saddhamma*? His answer is that *Dhamma* is *Saddharma* when it makes learning open to all; teaches that mere learning is not enough and may lead to pedantry, that what is needed is *Pradnya*, that *Pradnya* is not enough, but must be accompanied by *Sila*, that besides *Pradnya* and *Sila* what is necessary is *Karuna*, and that more than *Karuna* what is

[499]Ambedkar B. R, *The Buddha and His Dhamma*, Siddhartha Publications, Bombay, 1991, pp 229-233.

necessary is *Maitri*. *Dhamma* to be *Saddhamma* must break down barriers between man and man, teach that worth and not birth is the measure of man, and must promote equality between man and man.[500]

Ambedkar's views of the Perfection in Ethical and spiritual life comes through a) watchfulness, b) mindfulness and c) right understanding.[501] The virtue of liberty giving is essentially a product of compassion; compassion is the root of Bodhisattva's life. "His enlightenment is nothing but liberality or charity."[502] He thinks thus: "My neighbour suffers his pain just as I suffer mine; why should I be anxious about myself and not about him."[503] The perfection of charity leads to the equivalence of me and my fellow beings. When to me, as to others, pain and fear are unpleasant, there is no special to protect my own person and not others. Compassion is the only virtue to which a saint must apply himself; all other virtues will follow up naturally.[504] Nothing is superior to charity; even the vow of chastity. Liberality consists not only in giving material goods, things of enjoyment, but also in giving spiritual knowledge. Liberty born of compassion is the supreme means of conciliating creatures by alms giving, lovable speech, kind cooperation, and by sharing the joys and woes of beings.

The Ambedkar's essence of morality is self-preservation for the sole aim of benefiting creatures. It is therefore, necessary to ensure good rebirths in order to undertake the career of a Bodhisattva. For this purpose morality must be observed. Without self-preservation, one cannot preserve others. This self-preservation is accomplished by the constant study of the scriptures.[505] In order to increase morality one must beware of Marv's evil deeds. Evil must be avoided, frivolity must be avoided; friendship must be cultivated with those established in the Doctrine. In order to protect against evil lapse, the following must be avoided: bad friends; forgetfulness of the idea of Enlightenment;

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[500]Paradkar, "*The Religious Quest of Ambedkar*," Ajay Prahaghan, New Delhi,1968, p 69
[501]Joshi Lal Mani, *Studies in the Buddhistic Culture of India*, Motilal BanarasiDass, New Delhi,1977, p 101.
[502]Ibid, p 102.
[503]Ibid.
[504]Ibid.
[505]Ibid, p 103.

despondency and lack of enthusiasm. Evil must be discarded by active service of man, and of the *Sangha*.[506] Confession of sins before Buddha's and Bodhisattvas also contributes to moral growth.

Mind control, the Essence of Morality: since all actions are preceded by thought, all feelings, sensations and desire proceed from the mind.[507] When the mind is unfree from attachment and hatred, keep quiet like a wooden piece; whenever it becomes noisy, jovial, critical, self-praising, wicked and deceptive, keep quiet like a wooden piece.[508] When my mind runs after gain, honour, fame, and wants family and servants, "I sit idle like a wooden piece; my mind has turned away from the supreme good, has become selfish, wishes association and conversation, therefore, I am lying like a wooden piece; I do likewise when it becomes intolerant, indolent, fearful, wicked, talkative and partial. These are the ways by which a brave *Soul* brings about the control of vain and soiled minds. Self-possessed in the lap of truth and free from pride, I bold the mind as a created thing; I have rendered my body completely inactive, it does not react to the objects of sense."[509]

Love thy foe: Pain is disliked by all; those that are in the grip of passions and torture themselves, may torture others as well. Fire will burn wherever it is; anger rises out of this fire of passion and don't out of the objects. It is a pity that I dislike pain but like the body, the house of woe. It is unwise to be angry with men who injure us, for they are only acting under the influence of causes and conditions; and the foremost of these causes are our wicked deeds of previous existence. "My enemy takes a stick to beat me, and I have assumed this body, liable to be wounded, and destined to be beaten. Far from being angry with my enemy I ought to consider him almost as beneficial as the Buddhas, for he affords me the opportunity of practicing patience and forgiveness of wrongs, which blots out my sins. Am I to make this principle of salvation the cause of my condemnation? Let

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[506] Ibid, p 104.
[507] Ibid, p 105.
[508] Ibid.
[509] Ibid.

us rather pity our enemies who ruin themselves by their anger, and let us think of means of saving them in spite of themselves as the Buddhas do."[510]

Further, he says that, it is because of anger that "I have suffered in hells a thousand times, but have always sought after my own good. It befits my career of patience that I should welcome such pain as would help removal of the miseries of the world. Never grudge the joy of others, rather be happy by the happiness of others."[511] He who wants Enlightenment wants everything for every body; he who is jealous of the property of others has no thought of Enlightenment.[512] Do not be misled by praise, honour or gain, they are false and deceptive. The living beings are the proper filed of spiritual career even as the Buddhas; worship of beings is the worship of Buddha; friendliness towards beings in fact amounts to Buddha-worship. Ambedkar has strong belief that all beings have the seed of Buddha-qualities.

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[510] Ibid, pp106 - 107.
[511] Ibid, 107.
[512] Ibid.

CONCLUSION

CONCLUSION

The present study tries to explain Ambedkar's views on philosophy, religion and morality. It started with discussing Ambedkar's comments on the place of religion and morality in Semitic and Indic traditions. Ambedkar while commenting on the Semitic traditions, he considers that the altruistic nature of Judaism was under suspicion because of its special preference to Israel. He understood that, the preference may be because of the Jew community has been under the slavery for long time. In that sense, he appreciates the notion of Lord with the Oppressed. Ambedkar was very much enthusiastic and appreciative on the life of the Jesus and the principles of Christianity. However, he disagrees with them mainly on the affirmation of speculative ideas of the religion and other superstition in the practice. Moreover, his main criticism has been that the principles of equality and other valuable things withered by church in its practices. His complaint against another Semitic religion the Islam was mainly for its intolerance, which develops from the persistent affirmation of only one true God.

Ambedkar's analysis and criticism mainly concentrates on the nature of Indic tradition particularly the Hinduism. He criticizes Hinduism for its attempts to provide justification to the present hierarchical order of the society. Ambedkar says that the Hindu religious philosophy and its socio-cultural appearance grounded on the belief that human life is unequal and immoral therefore cannot scream for religious and social equality. According to Ambedkar human beings, in Hindu tradition pre-determined to be born unequal and therefore cannot lay claim to equality either in terms of their religious-spiritual status or in terms of their social, economic, civic or political status in the community. The major theme of Ambedkar's' analysis of religious immorality based on the philosophical and practice of social dominance thus, the Hindu religious moral ideology always hurting to the depressed people.

Ambedkar appreciate the democratic, equalitarian aspect of Buddhism and its realistic and scientific attitudes. Ambedkar says that the Buddhism is a true religion guided by the three principles of Knowledge, right path and compassion. Ambedkar provided a message that the change from Hinduism to Buddhism only can provide, honor, respect,

status, standard civilized life and freedom from slavery. Ambedkar said, it is impossible for humanity to live peacefully and righteously without Buddha and his *Dhamma* Ambedkar adopted Neo-Buddhism as the means to annihilate caste. Since Ambedkar rejected all other religions as theistic superstition, he chooses to revive Buddhism. His scientific rationalism was also too strong. This religious approach to the whole problem, we must admit, has led Ambedkar to give more importance to socio-religious reform and the caste struggle.

Ambedkar persuaded that Hinduism badly needed reform, and wanted to expose the immorality and oppression it had unleashed and the slavery it had perpetuated on the depressed. He was the victim of the social system of Hinduism. After discussing, various meanings of the word 'Hindu' as denoting a religion, parentage, country and a race. Ambedkar points out that he is dealing with Hinduism in which caste has become indispensable as doctrine, ideology and sanctified social order. Ambedkar sees that Hinduism is not a religion for individual justice with equality, fraternity and liberty and it fails to bring social utility of just, free and moral social order as the ideal scheme of divine governance.

Ambedkar arrives at the final judgment of Hinduism: The only answer is that Hinduism is overwhelmed with the fear of contamination. It does not have the power to purify. It has not the desire to serve and that is because by its very nature it is in human and unmoral. It is a misnomer to call it religion. Its philosophy is opposed to very thing for which religion stands. Hinduism is destined for failing the trial by the first norm of justice. It advocates inequality as the dependable doctrine. In his brief analysis of the Philosophy of Hinduism from the point of view of justice reveals in an obtrusive manner how Hinduism is adverse to equality, antagonistic to liberty and opposed to fraternity. Indeed, inequality is the soul of Hinduism. Secondly, its norm of social utility equally fails to free from domination. If these conclusions are sound, Ambedkar asks the questions that how can a philosophy that disconnects intelligence from labour, which expropriates the rights of man to comfort vital to life and which prevented society from mobilizing resources for common action in the hour of danger, said to satisfy the test of social utility.

The relation of religion and morality is an important in Ambedkar thought process. Ambedkar perhaps the one who has set forth most clearly the way in which the relation between specifically religious belief and the ideal of the good life should prevail in specific social formation. Ambedkar's thesis is that morality must be autonomous and that it must not be held in the leading strings of religion, theology or dogmatic metaphysics. Ambedkar adopts uncompromising position that the morality is not maintained by the Divine dispensation but it rests on the individual. The action of right and wrong is depends upon the God is repugnant to Ambedkar.

Ambedkar takes recourse to the classical argument to disprove the existence of God who allows evil and suffering in the world. According to him, the notion of God as good and the existence of evil and suffering are incompatible. Ambedkar develops a series of arguments for the futility of the notion of the existence of God taking recourse to Buddha's arguments. Ambedkar questions the integrity of God. He is basically raising the ontological question on the nature of God. If God is the answer to everything then he should take the responsibility for the evil also? The God who sanctions social discriminations cannot be said to exist. If God is omnipotent, man must be passive and in the final analysis, the freedom of the will is under question. If at all god is existed, then why there is so much evil why his hand so rarely spread to bless? *Man is only responsible to his own mistakes and creations, not applying for unknown God, whether God supposes to exist or not.*

This means that the idea of religion is abhorrent for Ambedkar. According to him what is loosely referred as the religious morality is thought to be authoritarian in spirit and antagonistic to the freedom of an individual. However, the possibility that morality might be need of religious foundations but its authoritarian character is not considered. It is the opposition to religious authority in the matter of motives and norms which alienates the fellow human beings rejected by Ambedkar. In this context Ambedkar says that the morality and the religion are inseparable and that morality is able to be understood only in the context of religion and it has been at the center of his philosophical discussion. According to Ambedkar, religion must be essentially moral; religion cannot live unless it

interacts with other forms of spiritual life as morality, beauty, and truth. Religion is thus when compared with morality it turns out to be at once *infra* and *supra* ethical. The fact that the religion takes as its point of departure human life, for this it provides a goal. Without such a destiny in sight religion cannot exist, provided with it faith passes on far beyond the realm of morality.

It must be remembered that Ambedkar categorically defends the autonomy of morality. Like Spinoza, Ambedkar says that the good life is not a means to something else but is itself a supreme end. Hence according to Ambedkar morality must be autonomous in the sense that, no alien considerations, like the fear of tyrannical God or deity from an absolute Hindu religious *Dharma* should be admitted as valid determining the conduct of human persons. Again he says that any consideration of earthly gain or worldly reward and success should not determine the truly moral conduct. The good is to chosen for its own sake, just as the good life is to be lived for its own sake. Thus in any respect according to Ambedkar the morality is truly autonomous. However, Ambedkar persistent question is still remains that which morality is dependent for its content on the norms and concepts derived from which religion. Here, Ambedkar makes clear difference between Buddhism and Hinduism and takes the position that the Hindu social order is immoral and it is against the human freedom and fraternity.

Ambedkar's model of theology on religion is a good model available for us in India to emulate. We need to follow Ambedkar's methodology not only to learn from the great master and achieve what he did, also to carry forward his struggle, and the liberation of all. It is quite clear that Ambedkar's intervention in the philosophical realm is clearly guided by the socio-political reason. Ambedkar holds a perception that the religion is a vital force, a scheme of moral governance and foundation for human society. In Ambedkar's sense, religion is necessary as a system of values and as a science of social reconstruction. He looked at the religion not as an instrument for the individual salvation but as the basis for social interaction. And Ambedkar focuses on the notion of Liberative religion. Through this notion what he emphasizes that notion of religion is quite essential to social transformation. But for him, all the factors in the social transformation are self-

subsistent in itself (i.e. social structure, individuals, religion etc). Ambedkar redefines the notion of religion also in the basis of reason and scientific method. He redefines the purpose of the religion. This redefinition is what makes him to embraces of Buddhism. Ambedkar equates *Dhamma* with morality.

The morality of love arises from the direct necessity for man to love man. He makes it comprehensible that it is not to please the God that man has to be moral but for his own good qualities, man has to love man. In the struggle for existence the individual's rights may not' be catered for, and at times his or her interests can be, rare by the group. Similarly, a weak group may also be discriminated by a stronger group, hence the indispensability ability of the *law of love*, fraternity and goodwill, which is another name for morality. The most important in, *Saddhamma,* more than *Prajna* and *Sila, Sila* is *Karuna,* love of human beings and *Maitri* that is all living beings.

Ambedkar stressed that religion is for humans and not humans for religion. For him, man and morality must be the centre of religion. Humanist to the core, Ambedkar was ready to throw away any religion or religious practice however ancient and sanctified if that does not promote human welfare. According to Ambedkar, Buddhism demands living experience and it was realism and never idealism. It upheld liberty, equality, truth and justice; it emphasized humanity, love and peace. It was dynamic, scientific and all embracing. Its explanation of life and its meaning and purpose of birth and death and its aftermath were very clear, intelligible and logical. Above all, man was the center of his study and examination and not anything outside of him.

Buddhism which was an early Indian religion and the Buddha was nearer to the untouchable masses. Buddhism could withstand even the severest scientific test and had the power and capacity to direct destines of the modern world. The untouchables would join with the world Buddhist community and thus pave the way for world brotherhood. Ambedkar said that, Buddhism gives three principles in combination, which no other religion does. Buddhism teaches *prajna* (understanding) as against superstition and supernaturalism, *Karuna (love)* and *samata* (equality). Neither god nor soul can save the

society, referring to Marx's philosophy, he observed, man cannot live by bread alone. He has a mind, which needs food for thought. Religion instills hope in man and drives him to activity. Hindu religion has watered down the enthusiasm of the downtrodden. And I found it necessary to change my faith and embrace Buddhism Ambedkar says that Religion emphasizes, universalizes social values and brings them to the mind of the individual who is required to be familiar with them in all his acts in an order that he may function as an approved member of the society.

Ambedkar's intervention is considered as a Copernican revolution in the realm of morality and religion. Analysis shows that, Ambedkar's attempt to justify morality without reference to transcendental religious beliefs is a first step to make the realm of morality as an autonomous one. The concern for the universal well-being is the main consideration of Ambedkar's scheme of morality. Thus, external considerations are no longer being above moral principles. Ambedkar makes such a morality the basis of religion, which he construes as *Dhamma*. In this construal, he redefines the centre of religion as morality rather than God. According to Ambedkar, Natural law is the basis of moral order of universe. *Dhamma* for Ambedkar is all-inclusive. The underlying meaning of the *Dhamma* is a message of equality.

Ambedkar's position is that morality in religion would not be an effective one. In religion, morality is only a wagon which is attached to it. It is attached and detached as the occasion requires. Ambedkar notes that the morality comes in only wherein man comes in relation to man. Morality comes into religion as a side wind to maintain peace and order....Be good to your neighbour because you are both children of God....The action of morality in the functioning of religion is therefore casual and occasional. Ambedkar affirms that morality is *Dhamma* and *Dhamma* is morality.

The terrible suffering, pain and pathos of cultural deprivation, economic exploitation, social ostracism, and political domination caused by the ruthless monstrous caste-system, made Ambedkar whole-heartedly hate the caste system and anything or anyone related with its continuation. As he admits, such hatred for injustice is necessary for the activists

who wish to fight for a just and egalitarian order. Towards the end of his life, Ambedkar had to stand lone most of his life, with no support from other ideologists, parties, and religions, because of his non-compromising attitude. His strong critique of them all and avoidance, made them also shun him. The adoption of Buddhism further isolated him. However, he refused to accept the existing forms of Buddhism, as they were not, he deemed, faithful to the original teaching of the Buddha. This shortcoming has not only isolated the Neo-Buddhists depriving them of historical continuity, and a continuous tradition, it also deprived them of a *Sangha* and religious leadership to guide them.

Study on Ambedkar reveals that his address towards religion is not a mere crave towards addressing a religion as a social institution but it was very deep that concentrated on the structure of social system in its wholeness. Ambedkar holds a perception that the religion is a vital force, a scheme of moral governance and foundation for human society. In Ambedkar's sense, religion is necessary as a system of values and as a science of social reconstruction. He looked at the religion not as an instrument for the individual salvation but as the basis for social interaction. He redefines the purpose of the religion. This redefinition is what makes him to embraces of Buddhism.

Religion is not an end in itself. It meant for the preservation of life and human welfare. Hence, religion is not the one that has the final say; it is not infallible, absolute, inflexible nor permanent. Ambedkar stressed that religion is for humans and not humans for religion. For him, man and morality must be the centre of religion. Religion instills hope in man and drives him to activity. Hindu religion has watered down the enthusiasm of the downtrodden. Ambedkar says that Religion emphasizes, universalizes social values and brings them to the mind of the individual who is required to be familiar with them in all his acts in an order that he may function as an approved member of the society. The concern for the universal well-being is the main consideration of Ambedkar's scheme of morality.

According to Ambedkar, merits of Buddhist philosophy were as follows: Buddhism demanded living experience and a life divine, attainable there and now; not after death, it

was realism and never idealism. It upheld liberty, equality, truth and justice; it emphasized humanity, love and peace. It was dynamic, scientific and all embracing. Its explanation of life and its meaning and purpose of birth and death and its aftermath were very clear, intelligible and logical. Above all, man was the center of his study and examination and not anything outside of him. Ambedkar tried to prove that the untouchables were Buddhists. In his thesis on the origin of Untouchability, he made it clear that today's untouchables were once Buddhists. Buddhism was an Indian religion and the Buddha was nearer to the untouchable masses. Buddhism could withstand even the severest scientific test and had the power and capacity to direct destines of the modern world. The untouchables would join with the world Buddhist community and thus pave the way for world unity. Ambedkar said that, Buddhism gives three principles in combination, which no other religion does. Buddhism teaches *prajna* (understanding) as against superstition and supernaturalism, *Karuna (love)* and *samata* (equality).. Neither god nor soul can save the society.

Thus, external considerations are no longer being above moral principles. Ambedkar makes such a morality the basis of religion, which he construes as *Dhamma.* In this construal, he redefines the centre of religion as morality rather than God. *Dhamma* for Ambedkar is all-inclusive. The underlying meaning of the *Dhamma* is a message of equality. Ambedkar's position is that morality in religion would not be an effective one. Ambedkar notes that morality comes in only wherein man comes in relation to man. Morality comes into religion as a side wind to maintain peace and order....Be good to your neighbour because you are both children of God....The action of morality in the functioning of religion is therefore casual and occasional.

Buddhism is the truly civilized earliest ethical system where man called upon to have himself governed by him. The Buddha alone has the glory of having rightly judged the intrinsic greatness of man's capacity to workout his salvation without extraneous aid. No other religion insists upon the values of knowledge and evil of ignorance so much as they are in Buddhism. No other religion lays so much stress upon keeping one's eyes open. No other religion has formulated such deep-laid plans for mental culture. The Buddhist moral

ideal, the *Arhat,* had to be both normally and intellectually great. The Buddha as essential to salvation, and ignorance as one of the two main causes of failure to attain it (craving or attachment being the other) always stressed knowledge. If there were any religion that would cope with modern scientific and spiritual needs, it would be Buddhism.

The teachings of a religion which is competent with modern science is essential for the future human race, the higher teachings on ultimate realities by Lord Buddha, that is known as *Abhi-Dhamma*, should be studied in schools and universities as "*Mental science*" or "*Ultimate Science*". The Buddha's *Middle way* is the only way, which can systematically eliminate all the defilements of the mind and thus offer total inner peace and eternal happiness.

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International Stock Market Integration: A Time Series Analysis

A Dissertation Submitted to the University of Hyderabad in Partial Fulfillment of the Requirement for the Award of the Degree of

Doctor of Philosophy

in

Economics

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DECLARATION

I hereby declare that the dissertation entitled **"International Stock Market Integration: A Time Series Analysis"** is an original research work carried out by me under the supervision of Prof Naresh Kumar Sharma, Department of Economics, for the award of Doctorate of Philosophy in Economics from the University of Hyderabad

I declare to the best of my knowledge that no part of this dissertation has been earlier submitted for the award of any degree in part or full to this or any other University

08/10/2009

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CERTIFICATE

This is to certify that Mr Ajaya Kumar Panda has carried out the research work embodied in the present dissertation entitled **"International Stock Market Integration: A Time Series Analysis"** for the degree of Doctor of Philosophy in Economics, is prepared under my supervision

I declare to the best of my knowledge that no part of this dissertation was earlier submitted for the award of research degree in part or full at any University

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Ajaya Kumar Panda

To

Nana and Bou

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CHAPTER I

CHAPTER I

INTRODUCTION AND BACKGROUND

1.1 Introduction:

During late twentieth century and the early twenty first century, financial markets of the developing as well as developed countries have experienced explosive growth of capital flows in the form of financial transactions Flexibility in capital movements and integration of financial services due to openness of economies across the globe is considered as one of the major factor for achieving optimality in capital allocation The process makes the capital flow from low return capital markets to high return capital markets It also takes into account the risk return trade off associated with capital allocation in a global scenario Development of financial markets and financial openness are making the financial systems interlinked

A move towards integrated markets is expected to lower the cost of capital, increase investment opportunities both for local and foreign investors and also to lead to significant welfare gains from higher savings and growth made possible by risk sharing at international land Investors look forward to invest in different stock markets across the globe to make their portfolios more diversified A more diversified allocation assumes that prices of stocks do not move together due to varying market fundamentals, asymmetric information, speculation and market noise which make the room open for the investors to hedge against down side price movements This is one of the factors that generate interest among researchers and policy makers to study the long run equilibrium relationships and dynamic interactions among the stock markets Highly integrated markets are likely to lead to an increase in the persistence of volatility and spillover effects The shocks in one market get easily transmitted to another market The degree of integration of the domestic market with any of the stock markets of the world increases the sensitivity and transmission of shocks within stock markets One market is being reflected in another market with its pros and cons If the degree of integration and the speed of volatility transmission can be measured, then it will be relatively easy to predict behavior of one market by studying the behavior of other markets

A number of studies find several integrating relationships among stock markets using time series techniques Such studies have used different approaches in selecting economies, stock markets and they are also selective specific to economic events Hence the conclusions regarding global market integration become specific to particular study and it is quite difficult to locate the relative position of stock markets at world level Thus it is useful to study the interlinking effects among the stock markets at world level This study attempts to analyze the dynamic interactions and the long run equilibrium relationships among leading stock markets of the world taking equity markets into considerations The study also analyzes the structure and level of development of stock markets and the persistence of volatility of the equity markets Selection of the leading stock markets for the study is based on a comprehensive study of stock markets across the world Major stock market development indicators are analyzed to focus on the depth of the stock markets in a cross-country study The study includes 65 major countries' stock markets These countries are also clubbed in seven regional blocks

1.2 Background of the study:

The process of stock market (equity market) integration is a part of major reform effort that includes financial sector, external sector, reforms related to FDI and FII and also of the economy as a whole The development of local securities markets of the emerging market economies and the reduction of foreign investment barriers are some of the efforts to widen financial integration It is a two way process of increasing the accessibility of domestic investors to invest in foreign markets and also allowing the foreign investors a place in the domestic market It is widely accepted that the elimination of investment barriers to financial integration allows the firms to choose the most efficient sources and market to invest Greater financial development and financial integration is expected to provide better platforms for the allocation of capital

Financial integration may also encourage financial development leading to financial efficiency With the inflow of foreign funds, the integration process will increase competition within less developed economies and thereby improve efficiency of their financial systems An efficient financial system also encourages economic growth with developed capital structure and proper technological involvement Empirical studies

undertaken so far suggest that high income countries are fairly integrated It is also linked with the fiscal and monetary structure of the economy The structure of the monetary system gets directly reflected to a larger extent in a bank based financial system than in a capital market based financial system Bank based and capital market based financial systems are two different entities in terms of their features and functions Both the systems can be complementary or competitive based on their approach and functions Generally in the early stages of economic development bank based financial systems are active The system in these early stages is more regulated than market based It encourages long-term investment with a stable cost in the form of rate of interest Hence it is useful for a capital intensive investment with less financial coverage But capital market based financial system ought to have a highly developed and well regulated stock market Financial openness and market determined rates are the strength of this system

Among the capital market instruments, debt and equity stand as two different and basic sources of external finance In a mature financial market, investors have opportunities to use both the instruments In the absence of a full-fledged capital market, it is the debt market that plays the role in arranging funds for required investors But after a substantial development of financial markets in an economy through emergence of well regulated stock markets, the opportunity of equity finance increases relatively to debt finance \When economy develops, stock market emerges with an active new issues and secondary market and also with necessary regulations{ Accessibility to information increases with a lower cost and in such circumstances equity market becomes more attractive and lucrative than bond market Hence the sole purpose of the study is to analyse the stock markets of different countries of world in both qualitative as well as in quantitative way The primary way to access the expansion of a stock market is to look at the changes in its various dimensions A simple measure of a stock market's size is the total value of all the shares/stocks in the market at each point in time i e the market capitalization Size of market is important as the level of savings mobilization and risk diversification depends strongly on this indicator Stock market size can also be measured by the number of listed companies in each period But it does not capture all the relevant features of a stock market's development A developed market is also one which is expected to be efficient and liquid market and in which financial funds can be mobilized

at low cost and they can move easily from one investment to another These features of a market can be captured by indicators like volume of shares traded and turn over ratio It measures the level of liquidity in the market

Based on the structure of development, the interdependency among the stock markets across countries develops Increasing integration has induced investors in certain markets to incorporate in their decisions not only information pertaining to the domestic markets but also information transmitted around the world Such behavior is consistent with the efficient markets hypothesis that news generated by international stock markets is relevant for the pricing of domestic securities It is thus interesting to see if the prices in any one market are informationally useful with respect to the prices in other markets and also whether or not there are volatility spillovers across the return structure of stock market indices among different financial markets Where spillover effects are found, integration is likely to have greater success This phenomenon is of particular interest to study the market interlinkages in our context

1.3 Objectives of the study:

The main objectives of the study are as follows

- To analyze the development of stock markets with respect to size and liquidity over the period of 1988 to 2006
- To analyze the dynamic interlinkages and long-run equilibrium relationships between the stock markets by testing their time series properties in various aspects
- To identify the persistence of volatility of the stock markets over a stipulated period of time

1.4 The Nature and sources of data:

The data for the stock market development indicators are not available symmetrically from a distant past for all the countries as the development of stock markets took place at different times in different countries It has been observed that most of the countries have data availability from 1988 onwards Hence this study uses the time series data for stock market indicators since 1988 to 2006 which are in annual frequency

The data of all the stock market development indicators used in this study are not symmetrically available for two of the countries - Taiwan and Bermuda Hence these two countries could not be analysed over the matrix of indicators focused in first objective, but the stock markets of these two countries are analysed in rest of the objectives because of availability of the country bench mark indices The data of the stock market development indicators for all the countries are taken from WDI (World Development Indicators, World Bank) database For the analysis of dynamic interactions, long run equilibrium relationships and the persistence of volatility in the stock markets, the study uses the country benchmark indices of the respective countries' stock markets as the representatives of their respective stock markets Weekly stock market indices are considered to capture the market activities closely The data period is spanning from 2nd week of August, 1995 to 4th week of December 2006, i e 594 weekly observations The data for the country bench mark index has been taken from Bloomberg

1.5 Organization of the study:

The study is organized as follows The first chapter deals with the brief introduction and back ground of the study The objectives along with the nature and data sources are explained briefly The detailed review of the nature of data is presented in objective specific in later chapters Second chapter contains an elaborate understanding of the aspects and measures of financial integration It briefly explains the theories used in different studies to measure capital market integration The earlier literature on various contexts related to the present study is reviewed in the respective chapters dealing with the objectives Third chapter focuses on the first objective i e analysis of the development of stock markets with respective to its size and liquidity The chapter contains the review of related empirical studies, methodology and analysis of the results of first objective Similarly fourth and fifth chapters focus on the second and third objects of the study respectively Finally, the summary and conclusions along with the scope for further research are presented in the sixth chapter The definition of the benchmark indices are presented in Appendix A and some estimated statistics of time series estimations are presented in Appendix IV and V at the end of their respective chapters

CHAPTER II

CHAPTER II

AN OVERVIEW OF FINANCIAL MARKET INTEGRATION

2.1 Introduction:

Integiation of financial maikets within and across economies of the world is related with many economic events Financial maikets all over the world have witnessed giowing integration spuried by deregulation, globalisation and advances in information technology The piocess of globalization leading to the openness of the economy extends the path towards inteinational integiation of world's financial market with new challenges foi monetaiy, financial, exteinal and macroeconomic policies Volatility spill over and crisis sensitiveness of inteinational financial markets with domestic economies duiing 19th and 20th centuries created new policy concerns for a number of economies The integration of financial maiket has been held responsible foi the contagion effects of ciises on the one hand and for enhanced market efficiency on the other The events led the path for major economic iestructuring paiticularly financial and institutional structures and to some extent of adjusting the maciioeconomic policies At the same time attention has also been focused on financial restiuctuiing with an objective to avoid the iepetition of financial crisis On the othei hand, integiation of financial markets is a process that iesults in conveigence of risk-adjusted ietuins on the assets of similai nature in the maikets

The process of integiation also facilitates maiket access to participants to various market segments The maiket paiticipants aie like individual market investoiis, financial institutions as well as financial intermediaiies Financial maikets tend to be more integrated in developed countiies because of faiily developed and open financial system Capital has become moie mobile acioss national boundaries as a iesult, investment in one country is not only depends on its own saving but also on the savings of other countries The exteinalities of a sound economic system with increasing investment opportunities are exploied by both domestic and inteinational financial institutions The extent of integration also makes the domestic maiket piedictable on the basis of an integrated foreign market by invoking efficient market hypothesis

Technological developments, electronic mode of payments and advanced communication systems have substantially reduced the arbitrage opportunities across financial centres, thereby aiding the cross border mobility of funds An efficient financial system achieves the optimum allocation of resources which also contributes to financial stability Quality of financial services also increases new and cost effective intermediation

2.2 Dimensions of Financial Market Integration

The dimensions of financial market interlinkages are not confined within a limited dome Various domestic and foreign factors are covered under a complex interplay of various policy schemes, formation and expansion of financial intermediaries and the co-movements among market participants The scope for financial market integration arises because of the heterogeneity property of the financial market

Various financial market segments are not uniform as they trade in a variety of instruments, which differ in terms of risk and liquidity First, some market segments are national, whereas others are international in nature, depending on where financial transactions occur among participants within a country's geographic boundary or across the border Generally, money and credit market segments involving participation of banks and other financial institutions operating within a country's boundary are national in character On the other hand, foreign exchange markets dealing with cross-border transactions and stock markets with cross-listings of securities and participation of foreign institutional investors are international in nature Second, financial markets differ in terms of depth and liquidity For instance, money market instruments are more liquid, while bonds in the capital markets are less liquid Third, financial markets differ in terms of economic nature of instruments catering to various needs of economic agents For instance, a distinction can be made between saving, investment, credit and derivative instruments Fourth, financial markets are differentiated in terms of risk profile of instruments such as government bonds, which do not involve default and credit risks, and corporate bonds, which are relatively more risky in nature Integration of market segments, thus, reflects an investor's attitude towards risk and the trade-off between risk and return on assets Fifth, market participants in different financial markets could be different such as banks, non-bank financial institutions, including mutual funds,

insurance companies, mortgage institutions and specialised long-term financial institutions Financial markets get integrated horizontally among domestic financial segments and vertically with international financial markets Large scope of globalisation with abolition of external barriers makes vertical integration of the financial markets more prominent as a domestic economy gets integrated with its regional counterparts or with its trade negotiated associates with any of the foreign financial markets Domestic financial market integration entails horizontal linkages of various segments, reflecting portfolio diversification by investors and intermediaries Under horizontal integration, market interest rates typically revolve around a basic reference rate, which is defined as the price of a short-term low-risk financial instrument in a competitive and liquid market It typically provides the basic liquidity for the formal financial system and central banks often use it to gauge the tightness of monetary policy Domestic markets may be closely integrated because intermediaries operate simultaneously in various market segments Regional financial integration occurs due to ties within a given region and some major financial centre serving that region Economic integration might be easier to achieve at a regional level due to network externalities and the tendency of market makers to concentrate in certain geographical centres

2.3 Measures of Financial Integration

The interlinkages process of the financial markets is dynamic and complex given rise to different approaches to measure the structure of financial market interlinkages They are broadly divided into three categories institutional/regulatory measures, quantity based measures and price based measures The legal restrictions on trade and capital flows across border as well as market segments are most frequently used as basic indicators Each of the three categories has been explained below

2.3.1 Institutional Approach:

Institutional approach focuses on the macroeconomic performance of the stock markets The approach identifies the role of financial intermediaries in the functioning of stock market Financial institutions often the banking system of an economy has a significant role in the development of stock markets A well developed banking system not only helps in smooth functioning of the stock markets by maintaining liquidity but

also keeps an option readily available for the market participants in the form of a choice between equity financing and debt financing One may ask why the investors switch from debt financing to equity issue when there is coexistence of both a well developed banking system and a well regulated stock market is an issue for different study? No doubt both of the systems are complementary as well as competitive for optimal allocation of resources Modern financial systems settle down to two main heads of financial institutions namely commercial banks and stock markets Although both type of the institutions are engaged in financial transactions but they follow different modes of operation Banking system generally takes into account the geographical and temporal variation in interest rates with reference to the spread of banks both inside and outside of a country or region Another institutional based approach is Gravity model of bilateral asset trade Martin and Rey (2004) propose a theory of asset trade based on a general equilibrium model from which a "gravity" equation emerges Their model is characterized by fully optimizing agents, endogenous market capitalization and frictions in the asset market Its main implication is that gross flows of asset trade between two countries should depend inversely on transaction costs between the countries such as information costs and efficiency of transaction technology and depend proportionally on market size which is proxied by stock market capitalization

2.3.2 Quantity based Approach:

Liquidity, turnover and market capitalization data are used as quantitative indicators for measuring interlinkages among domestic financial market segments For global integration, capital flows indicate whether a country is becoming more or less financially integrated over time In this context, gross capital flows are a better measure than net flows because net capital flows may underestimate the degree of integration of those countries with similarly large inflows and outflows One limitation of capital flows, as an indicator is that they are influenced by changes in short-term market conditions and can fluctuate sharply Stock measures based on the accumulation of gross capital flows are less affected by short-term market conditions These measures are preferred generally for emerging market economies A more direct measure of financial openness is based on the estimated gross stocks of foreign assets and liabilities as a share of GDP The stock

data is a better indicator of integration since it is less volatile and is less prone to measurement error

2.3.3 Price based Approach:

The commonly used price based measures for gauging price equalisation and convergence of market segments include cross-market spreads, correlations among various interest rates, tests of common trend in the term structure of interest rates and volatility transmission Price-related measures also include covered and uncovered interest rate parity as well as asset price correlations between countries Price based approach always converges to the parity price which is a price for an asset that is directly linked to another price It is commonly used in the context of convertible securities and often referred to as "conversion parity price" or 'market conversion price" It is the price an investor effectively pays to exchange or convert a convertible security into common stock and is equal to the price of the convertible security divided by the conversion ratio (the number of shares that the convertible can be converted into) It is also related with interest rate parity, another measure Theory explains that interest rate differential between two countries is equal to the differential between the forward exchange rate and the spot exchange rate Interest rate parity plays an essential role in foreign exchange markets, connecting interest rates, spot exchange rates and forward exchange rates The interest rate parity is the basic identity that relates interest rates and exchange rates The identity is theoretical, and usually follows from assumptions imposed in economics models Interest rate parity is an arbitrage condition, which says that the returns from borrowing in one currency, exchanging that currency for another currency and investing in interest-bearing instruments of the second currency, while simultaneously purchasing futures contracts to convert the currency back at the end of the investment period should be equal to the returns from purchasing and holding similar interest-bearing instruments of the first currency If the returns are different, investors could theoretically arbitrage and make risk-free returns

2.4 Theories of Financial Market Integration:

Financial market integration at the theoretical level has been postulated in several ways The most popular economic principle for financial integration is law of one price The interest rate structure like covered and uncovered interest parity conditions, asset price models like capital asset price model, arbitrage price theory and Black-Scholes' principle for derivatives trading explain the theoretical back ground of a financial market to be integrated with foreign markets Macroeconomic settlements like similarity in monetary policy, external policy, bilateral trade agreements and regional trade agreements also keep some rooms open to explain the fundamental linkages of financial markets

2.4.1 Law of one price:

The theory of law of one price pioneered by Augustin Cournot (1927) and Alfred Marshall (1930) constitutes the fundamental principle underlying financial market integration According to the theory of "Law of One price" in the absence of administrative and informational barriers, risk-adjusted returns on identical assets should be comparable across markets Commodities can be traded on financial markets where there will be a single offer price and bid price Although there is a small spread between these two values, the law of one price is also being applicable to both No trader will sell the commodity at a lower price than the market maker s offer-level or buy at a higher price than the market maker's bid-level Hence law of one price is an economic rule which states that in an efficient market, a security or any commodity subject to be priced must have a single price, no matter how that is created Hence the theory provides a generalised framework for financial market integration

2.4.2 Gravity Model of International Trade

The gravity model of trade in international economics predicts bilateral trade flows on the basis of economic sizes (often using GDP measurements) and distance between two units The basic theoretical model for trade between two countries (i and j) takes the form of

$$F_{ij} = G \times \frac{M_i \times M_j}{D_{ij}}$$

Where F is the trade flow, M is the economic mass of each country, D is the distance and G is a constant The model often includes variables to account for income level (GDP per capita), price levels, language relationships, tariffs, contiguity, and colonial history (whether Country1 ever colonized Country2 or vice versa) In general Gravity model takes into account the economic sizes and distance between two countries, explains the bilateral trade and investment flows This explains the regional financial integration that can take place with an important means of developing local financial markets through balance of payment adjustments

2.4.3 Capital Asset Pricing Model (CAPM):

The CAPM builds on the model of portfolio choice developed by Harry Markowitz (1959) In Markowitz model, an investor selects a portfolio at time t-1 that produces a stochastic return at time t The model assumes investors are risk averse and when choosing among portfolios, they care only about the mean and variance of their one period investment return As a result investors choose "mean-variance" portfolio, in the sense that the portfolio

1 Minimizes the variance of portfolio return, given expected return
2 Maximises the expected return given variance

Thus, the Markowitz approach is often called a mean-variance model The portfolio model provides an algebraic condition on asset weights in mean-variance efficient portfolio The CAPM turns this algebraic statement into a testable prediction about the relation between risk and expected return by identifying a portfolio Sharpe (1964) and Linmer (1965) add two key assumptions to the Markowitz model to identify a portfolio that must be mean variance efficient The first assumption is complete agreement, given market clearing asset prices at t_1, investors agree on the joint distribution of asset return from t-1 to t time period This distribution is the true one that is, it is the distribution from which the returns we use to test the model are drawn The second assumption is that there is borrowing and lending at a risk free rate, which is the same for all investments and does not depend on the amount borrowed or lent

2.4.4 International Capital Asset Pricing Model (ICAPM):

A quick review of recent past shows that in 1980's, many emerging market economies opened their stock markets to foreign investors and soon after 1990's severe financial crises affected many of these countries These events helped generate a strong debate on the effects of stock market liberalization and two specific concerns have been raised in the literature First one observes co-movement in stock returns across national markets caused by liberalization Some economists have referred to this effect as financial contagion The second concern considers stock market return volatility This issue has been raised by Stiglitz (2002) who states that Capital-market liberalization is inevitably accompanied by huge volatility, and this volatility impedes growth and increases poverty It increases the risks of investing in the country, and thus investors demand a risk premium in the form of higher-than-normal profits To consider these issues it is necessary to have a model showing how discount rates in different countries change when the level of cross border consumption risk-sharing changes The systematic risk premium is the risk premium found in standard CAPM's i e , the covariance of a country's stock returns with respect to returns on the world market portfolio The idiosyncratic risk premium measures the portion of country specific idiosyncratic risk which cannot be diversified away because of imperfect cross border risk sharing It is given by the covariance of a countrys stock returns with returns on the country's adjustment portfolio This adjustment portfolio is so-called because it can be regarded as an adjustment to the world market portfolio This international CAPM allows to show that when there is a change in the level of cross border risk sharing, changes in the discount rate for the country are driven by changes in the idiosyncratic risk premium

2.4.5 Arbitrage Pricing Theory (APT):

An alternative to CAPM in determining expected rate of return on individual stocks and on portfolios of stocks is the arbitrage pricing theory (APT) Broadly speaking, the APT implies that the return on a security can be broken down into an expected return and a surprise component For any individual stock this surprise or news component can be further broken down into general news that affects all stocks and specific news which affects only this particular stock The APT predicts that general

news will affect the rate of return on all stocks but by different amounts The APT in one sense is more general than the CAPM in that it allows a large number of factors to affect the rate of return on a particular security

2.4.6 International Arbitrage Pricing Theory (IAPT):

IAPT as APT overcomes the problem of aggregation when asset demands are summed over the universe of investors who use different numeraires to measure returns This is because the portfolios in international CAPM context represent weighted averages of individual assets whereas the factors in the APT are theoretical constructions which are not constructed to be portfolios of original assets Besides the usual assumptions of APT, IAPT assumes perfect and integrated international capital markets, homogeneous expectation in a given country and that the returns are computed over a very short time interval

2.5 Integrated Financial Markets and Efficient Market Hypothesis:

The basic theoretical case for the Efficient Market Hypothesis (EMH) rests on three arguments which rely on progressively weaker assumptions First, investors are assumed to be rational and hence to value securities rationally Second, to the extent that some investors are not rational, their trades are random and therefore cancel each other out without affecting prices Third, to the extent that investors are irrational in similar ways, they are met in the market by rational arbitrageurs who eliminate their influence on price When investors are rational, they value each security for its fundamental value the net present value of its future cash flows, discounted using their risk characteristics When investors learn something about fundamental values of securities, they quickly respond to the new information by bidding up prices when the news is good and bidding them down when news is bad As a consequence security prices incorporate all the available information almost immediately and prices adjust to new levels corresponding to the new net present values of cash flows An integrated financial market is said to be weakly efficient as the good and bad news of one market get reflected in the corresponding price set of the securities of other market Hence on the other hand it

reflects the predictability of one market through the study of other integrated financial markets which avoids the arbitrage effects among financial markets

2.6 Time series Approach to Financial Market Integration:

For a quantitative analysis of financial market integration, time series techniques are widely used Vector Auto Regression and its powerful innovation accounting techniques such as impulse response and variance decomposition reflect the dynamic interactions among domestic and foreign security prices Volatility spill over under time varying phenomenon is effectively captured by various approaches of Auto Regressive Conditional Heteroscedasticity (ARCH) and Generalised Auto Regressive Conditional Heteroscedasticity (GARCH) models Above all, the aspects the direction of causality and the long run equilibrium among the financial markets across the globe can be modelled through popular Granger causality and the Engel Granger bivariate cointegration model Vector Error Correction being a multivariate approach explains multivariate causality and speed of adjustment of the forecast error term in the market with responses to the random shocks from uncertain information A good number of empirical studies have used the time series techniques to draw conclusions about integration of financial markets within an economy as well as across world market

2.7 Concluding Remarks:

Above models provide background of the theories that enlighten the concept of financial market integration Various studies have focused on different approaches through different ways in tune with their objectives Studies are found to be market specific, country specific as well as region specific In the face of diversity of context and objectives, it is difficult to draw definite conclusions There is scope and need for further work to deepen on understanding of financial market integration Analysis of financial market integration is as varied as analysing economic growth

CHAPTER III

CHAPTER III

ANALYSIS OF DEVELOPMENT OF STOCK MARKETS WITH RESPECT TO SIZE AND LIQUIDITY

3.1 Introduction:

Many developing and almost all developed countries of the world have opened their economy to global capital flows In comparison to foreign direct investment, foreign portfolio/institutional investment has increased dramatically in the late nineties and beginning of twenty first century Economies across the world have tried to regulate their stock markets in order to make it more transparent and efficient A well regulated and developed stock market generally keeps investors' sentiment positive towards their investment It is not only the market but also the respective economic scenarios of the country which effectively matter for investment activities A well developed and well regulated stock market attracts more portfolio investors from different parts of world and the strength of the stock market is reflected in market capitalization, total volumes or values of stocks traded, turnover ratio etc These variables reflect the size and strength of the market and the ratio with GDP can incorporate the size of the economy with size of the stock market A good number of studies are available reflecting economic reforms and financial reforms with stock market development But not many studies reflect the comparative development of the stock market across countries One enormous study by Ash Demirgue and Ross Levine (1995) found large cross country variation over a study on 41 countries' stock markets The study concludes that, large stock markets are more liquid, less volatile, and more internationally interlinked compared to small markets Countries with strong information disclosure laws, internationally accepted accounting standards and unrestricted international capital flows tend to have larger and more liquid markets But the markets with few stocks, small market size, less liquid and less international integration are some times less volatile Development of stock market here means development in size, volume and liquidity

In the present study a sample of 65 countries stock markets are analysed and these countries are clubbed with seven regional blocks The selection of stock markets of the countries is based on the criteria that these have regular and continuous trading

history for the last 10 years Before analyzing the dynamic interlinkages and persistence of volatility between the stock markets, the study makes an attempt to analyse development of these stock markets on the basis of development with respect to size and level of liquidity by using a number of stock market analyzing indicators Though each indicator has its own conceptual and statistical shortcomings, it is very difficult and also inappropriate to draw any conclusions based on any one indicator level Hence the present study uses an array of six key market indicators The indicators and their definitions are mentioned below The indicators are used for analyzing the stock markets through two basic indices namely stock market development index and stock market liquidity index First stock markets are analyzed at world level taking 65 countries in one group Then the stock markets are analyzed at the regional level The commonly used geographical divisions are considered under the study to segregate the countries under seven regional blocks The list of 65 countries and countries under regions are mentioned in Tables 3 1 and 3 2 below

Table 3.1: The List of Countries under Study

Sl. No	Countries	Sl. No	Countries	Sl. No	Countries
1	Argentina	23	Hong Kong	45	Peru
2	Australia	24	Hungary	46	Philippines
3	Austria	25	India	47	Poland
4	Bangladesh	26	Indonesia	48	Portugal
5	Belgium	27	Ireland	49	Romania
6	Bermuda	28	Israel	50	Russia Fed
7	Botswana	29	Italy	51	Saudi Arabia
8	Brazil	30	Japan	52	Singapore
9	Britain	31	Jordan	53	Slovak Republic
10	Canada	32	Korea Republic	54	Slovenia
11	Chile	33	Kuwait	55	South Africa
12	China	34	Lithuania	56	Spain
13	Colombia	35	Luxembourg	57	Sri Lanka
14	Costa Rica	36	Malaysia	58	Sweden
15	Czech Republic	37	Mauritius	59	Switzerland
16	Denmark	38	Mexico	60	Taiwan
17	Egypt	39	Netherlands	61	Thailand
18	Finland	40	New Zealand	62	Tunisia
19	France	41	Nigeria	63	Turkey
20	Germany	42	Norway	64	United States
21	Ghana	43	Oman	65	Venezuela
22	Greece	44	Pakistan		

3.2 Grouping of countries into Regions:

For the study over 65 countries of world, we have divided the countries into seven regions such as North America, South & Central America, South Asia, Asia Pacific, Africa & Middle East, Eastern Europe and Western Europe The Countries under these regions are presented in table below

Table 3.2: Grouping of Countries in Seven Regional Blocks

North America	Africa and Middle East	Western Europe
Bermuda	Botswana	Austria
Canada	Egypt	Belgium
Mexico	Ghana	Britain
United States	Israel	Denmark
South & Central America	Jordan	Finland
Argentina	Kuwait	France
Brazil	Mauritius	Germany
Chile	Nigeria	Greece
Colombia	Oman	Ireland
Costa Rica	Saudi Arabia	Italy
Peru	South Africa	Luxembourg
Venezuela	Tunisia	Netherlands
South Asia	**Eastern Europe**	Norway
Bangladesh	Czech Republic	Portugal
India	Hungary	Spain
Pakistan	Lithuania	Sweden
Sri Lanka	Poland	Switzerland
Asia Pacific	Romania	
Australia	Russia Federation	
China	Slovak Republic	
Hong Kong	Slovenia	
Indonesia	Turkey	
Japan		
Malaysia		
New Zealand		
Philippines		
Singapore		
Korea Republic		
Taiwan		
Thailand		

3.3 Definition of indicators used in the study:

The present study has used six key stock market indicators such as (1) Market capitalization of listed companies as percentage of GDP, (2) Domestic credit to private sector as percentage of GDP, (3) Total value of stocks traded as percentage of GDP (4) Turnover ratio in percentage, (5) Total number of listed domestic companies

and (6) Market concentration For further insight about the stock markets, market capitalization of listed companies and GDP both in constant US $ (at 2000 prices) are used as reference variables while analyzing stock markets The definitions of these eight indicators are given below

(1) **Market capitalization of listed companies (as % of GDP):** Market capitalization (also known as market value) is the share price times the number of shares outstanding Listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year Listed companies do not include investment companies, mutual funds, or other collective investment vehicles This has been taken as a percentage of GDP

(2) **Domestic credit to private sector (as % of GDP):** Domestic credit to private sector refers to financial resources provided to the private sector through loans on purchases of non equity securities, trade credits and other accounts receivable that establish a claim for repayment Total domestic credit has been taken as a percentage of GDP

(3) **Total value of stocks traded (as % of GDP):** Stocks traded refers to the total value of shares traded This indicator complements the market capitalization ratio by showing whether market size is matched by trading Again it is bench marked with size of economy

(4) **Turnover ratio (%):** Turnover ratio implies a percentage of investment that have been "turned over" or replaced with other holdings or investments in a given year It reflects a proportional relationship between total market value and market capitalization

(5) **Total number of listed domestic companies:** Listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year This indicator does not include investment companies, mutual funds, or other collective investment vehicles

(6) **Market concentration (%):** Market concentration shows the market captured by an individual stock market in a class of stock markets To be more specific, it estimates market capitalization of one country's stock market as a percentage of total market capitalization of world or region This shows the

percentage of world/region market capitalization concentrated in an individual country stock market

(7) **Market capitalization of listed companies (constant US $):** Market capitalization is the share price times the number of shares outstanding Data are in constant U S dollars

(8) **GDP (constant US $):** GDP at purchaser s prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products Data are in constant 2000 U S dollars Dollar figures for GDP are converted from domestic currencies using 2000 official exchange rates

3.4 Review of Earlier Studies:

A large number of studies have investigated financial reforms and development of capital markets in different countries Stock market development like economic development is a complex and multi-faceted concept Hence earlier studies have used various approaches to address the issue Financial market growth has been addressed along with money market growth, growth of banking sector, growth with economy and presence of regulatory authorities Some of the relevant studies are reviewed below which can highlight many useful information regarding selection of stock market analysis indicators and the methodology to analyse stock markets across the globe

Nakagawa, R (2007) analyzed development of securities markets in nine Asian economies (South Korea, Taiwan, Hong Kong, Singapore, Malaysia, Thailand, Indonesia, the Philippines, and China) The study focuses on two aspects, namely the history and institutional development of securities markets The data period was 1980 to 2003 and observations are in annually frequency The author focuses on the number of listed companies and market capitalization and ratio of market capitalization to GDP (%), for understanding of the development processes of capital markets in the targeted economies The study concludes that, most economies had an informal capital market in the early period of their history Second, the background of the foundation of their official markets was influenced by experiences of colonization Third, most governments recognized the importance of the capital market for

development and had a positive attitude in promoting the market and fourth, statistics clearly showed that most economies experienced several booms in their capital market from the late 1980s Some economies were found to be affected by the currency crisis of 1997, while some others were not affected

Sarkai, Prabirjit (2007) analyzed the changing state of shareholder protection and its connection with stock market development and capital accumulation Some indicators were chosen to reflect the changing state of shareholder protection and data used are foi 20 countries over the period, 1995-2005 The sample of 20 countries covers 9 developed countries (DCs) and 11 other less developed countries (LDCs) Author found a strong tendency towards convergence across the DC-LDC divide between 1997 and 2002 followed by a slight tendency towards divergence In fact law changes in the DCs with an eye to better corporate governance and improved shareholder protection follow with a lag in LDCs Legal globalisation is thus another facet of the present LPG regime The indicators include per capita GDP, gross capital formation as percentage of GDP, shareholdei protection and stock market turnover Ratio The author has tried to develop a shareholder protection index by averaging all the indicators It appears fiom the analysis that the shareholder protection law and stock market development as indicated by the turnover ratio are not related at the cross-country level even across the developed countries The author also tried to find out whether stock market developments as measured by the turnover ratio have any relationship with fixed capital formation and concluded that in no case there lies a significant relationship between the stock market developments and capital formation The country wise variation in shareholder protection has no relationship with the turnover ratio It cannot be said that the countries belonging to this DC group having a higher shareholder protection tend to have a higher stock market developments, nor can we say that a higher stock market development is associated with a higher rate of capital formation It is also observed that stock market development has by and large no long-term positive relationship with capital accumulation for a number of less developed countries

Augusto de la Torre, et al, (2006), analyze where Latin American capital markets stand after these reforms in the level of development The stock market development indicators used by the study are market capitalization, value traded and capital raised where all are in the percentage of GDP in the period of 1975 2004 A

simple regression has been used between annual inflation rate and the government deficit over GDP to analyse the macroeconomic environment to promote financial development The authors also analysed the descriptive statistics of capital market development in Latin America and its comparativeness with other regions Econometric techniques are used to analyse the underlying facts of Latin American Markets The authors found that the reform of capital markets in Latin American region remains underdeveloped compared to markets in East Asia and developed countries Furthermore, the performance of the stock markets is below expectation given the region's economic and institutional fundamentals The authors discuss alternative ways of interpreting this evidence and conclude that it is difficult to pinpoint which policies should pursued to overcome the lack of development of their markets by Latin American country Moreover, the expectation about the outcome of the reform process may need to be revisited to take into consideration intrinsic characteristics of emerging economies which may limit the scope for developing deep domestic capital markets in a context of international financial integration

Komla Adjasi, et al (2007) examine the economic importance and policy options for promoting development of the stock markets in Africa It seeks to throw light on the link between stock market and economic growth from both corporate finance and macroeconomic perspectives The indicators that are used to capture the development of the stock markets are number of listed companies, market capitalization as a % of GDP, value traded (in percent of GDP) and turnover (percent) Institutional and infrastructural indicators are existence of a market regulator, a governing law nature of clearing and settlement, settlement cycle, existence of an international custodian, foreign participation and exchange control, nature of trading systems, existence of a central depository, number of trading days, and accounting and auditing reporting system The indicators show that the main institutional and infrastructural bottleneck of African stock markets is the use of slow manual systems The paper shows that the stock markets have contributed to the financing of the growth of large corporations in certain African countries Corporate financing patterns in certain African countries suggest that stock markets are an important source of finance Authors also examine the larger-economy wide effects of stock market development in Africa Stock market development has assumed a developmental role in global economics and finance following the impact stock

development and financial Intermediaries, corporate finance decisions, and economic growth The data period spans from 1976 to 1993 The study divided the analysis under three sub heads of low, middle and high income economies The strong correlation between overall stock market development and long run economic growth seems economically important The coefficients indicate that Brazil and Mexico had the same level of stock market development as Malaysia Looking at a sample of thirty industrial and developing economies, they observe that the effect of stock market development on firm debt-equity ratios depends on the initial level of stock market development Firms in countries with underdeveloped stock markets first increase their debt equity ratios as their stock markets develop Firms in countries with relatively developed stock markets substitute equity for debt as stock markets develop further

Mehar, A (2000), in the paper titled "Stock market consequences of macroeconomic fundamentals" tries to explore the importance of monetary and fiscal policy in stock market development analysis The effects of economic changes on market capitalization have been tested in the study The relevant economic factors have been classified in two broad categories (1) demand factors, and (2) supply factors The data period range from 1980 to 2000, annual by frequency The author applies co-integration and causality tests in the model The study concludes that investment decision by the firms and market liquidity are two important determinants of the stock market With some qualifications, the results indicate that monetary and fiscal policies affect the market capitalization The results explain why valuation ratios are negatively affected by the increase in equity trading

Mauro, P (2000), studies the correlation between output growth and lagged stock returns in a panel of emerging market economies and advanced economies It seeks to fill two gaps in the relevant literature First, it examines the extent of this correlation in emerging countries, and compares it to that observed in advanced countries Second, it uses larger group of countries to address the more general question of what type of countries tend to display a stronger association between output growth and stock returns Data on real stock returns and real GDP growth at an annual frequency for a period of 22 years for eight emerging countries and 17 advanced countries are used Results of the study is quite interesting as it concludes that the correlation between real economic growth and real stock returns is found to

be positive in all countries except India and significantly positive in five out of eight emerging markets and ten out of 17 advanced countries There is a positive and significant correlation between output growth and lagged stock returns in several countries, including both advanced countries with highly developed stock markets and developing countries with emerging stock markets and interestingly the correlation is strong even in some countries with relatively small market capitalization Countries with a high market capitalization to GDP ratio, a large number of listed domestic companies and initial public offerings, and English origin of the regulations governing the stock market tend to display a significantly stronger correlation

Fink Gerhard, Haiss, P , Hristoforova, S (2003), examine the relationship between the development of the aggiegate bond markets and real GDP in 13 highly developed economies of USA, Japan, Switzerland and most European Economic Area (EEA) countries The study provides empiiical multi-country time series evidence on the link between bond markets and real GDP growth The causal relationship between the bond market capitalization and GDP growth for the selected countries are studied over a period of time A closer analysis of the financial markets shows that the aggregate bond market capitalization is as important as stock market capitalization and amounts in total to about one-third of the entire financial assets in the USA and EU is from bond market In ten out of the nineteen countries, the volume of debt securities is higher than the stock amounts outstanding measured as a percentage of total financial assets (TFA) There lies a bi-directional causality, or interdependence between the bond sector growth and real growth, in the cases of Japan, Finland and Italy It supports for supply-leading causality from bond market capitalization change to real growth in USA, Great Britain, Germany, Austria, Switzerland, and to a weaker extent in the Netherlands and Spain Finally, authors find no support for the reverse case, i e demand leading causality from real economic activity to the bond market The causality patterns differ fiom country to country due to the heteiogeneity of market structures and the different degree of openness and international integration of the capital markets in our country sample

Dey, Malay K (2007) studied the liquidity of global stock exchanges and how it determines cross sectional returns on stock portfolios of the exchanges Turnover ratio has been used as a measure liquidity which is computed as value of shares traded over the market capitalization The author investigated the relation between the return

on a stock exchange index and the corresponding turnover computed as value of shares traded over market capitalization for the stock exchange portfolio OLS and GLS have been used to estimate portfolio turnover The model suggests a linear relation between turnover and size after adjusting for a deterministic time trend for an individual exchange Liquidity is found to be trend weakly stationary for most stock exchanges However, exchange and time specific factors are more appropriate for modelling liquidity The significant determinants of index return are size, turnover and volatility, although some of the volatility effect may be a spill over from a January effect The turnover return relation is found to be true only in emerging markets and not in developed markets Author found this result confirms existing empirical evidence that high turnover stock portfolios generate superior returns

Gud, Benton E, (1973) studied the changes in stock market indicators, like short interest ratio and signal changes in stock prices in the context of fundamental analysis and technical analysis Author attempted to study the stock price movements through simultaneous relationship between three stock market indicators and stock prices such as the mutual funds' cash ratio, the short interest ratio, and the odd-lot ratio Author has analysed the behaviour of these three indicators during 1955 1970 and the relationships between the chosen indicators and stock prices through a multiple regression model The results confirmed the significant relationship between the technical indicators and stock prices The data revealed that the odd-lot ratio and mutual funds cash ratio have predictive content They are also influenced by the recent behaviour of stock prices Hence, it has been concluded that the technical indicators may be of some, but limited, aid in predicting changes in stock prices

Keith W Chauvin and Mark Hirschey (1997) followed Miller and Modigliani models to study the factors with potential to influence the effects of growth on the current market value of the firm, or the 'value of growth' The study was undertaken for the period from 1974 to 1990 through the application of OLS model Authors conclude that high current market share has no meaningful interactive effect on growth, whereas positive interactive effects of advertising and R&D expenditures are clear It is concluded that high market share offers no guarantee of future success with planned investments On an empirical level, the evidence strongly suggests that advertising-induced and R&D-induced growth is significantly more profitable than growth in general It is also worth noting that the cross-sectional relation between the

market value of the firm and company characteristics is dependent upon market conditions

Zuckerman, E W (2004) analysed the efficiency of the price setting process in the stock market which is an industry based classificatory structure 1995 to 2001 has been taken as study period The market structure has been analysed in the form of volatility and volume The structure is analysed in the context of EMH The paper concludes that the efficiency of the price setting process in the stock market is contingent on the coherence of a stock position in the industry based classificatory structure that guides valuation

Pajuste, A (2002) in his paper "Corporate Governance and Stock Market Performance in Central and Eastern Europe" offers analysis of corporate governance issues behind stock market performance in nine Central and Eastern European countries The study was undertaken for the period 1994 to 2001 Market capitalization, liquidity through turnover ratio increasing ownership concentration and risk aspects have been studied for these nine countries Integration of the markets and its correlation are also studied It has been noted that the CEE countries are becoming more integrated within the European capital markets in a sense that they do react to, especially the negative, market mood in the rest of Europe and the world The increasing correlations over time indicate that cross-country diversification benefits are decreasing The effectiveness (enforcement) of financial regulations has the highest explanatory power of stock market returns in the sample countries The protection of minority shareholders has a significant impact on market activity, measured by market turnover to market capitalization ratio

The findings of these studies provide some useful insights into the structure of the various stock markets of world and their level of development

3.5 Methodology:

The stock markets of the countries are analyzed on the basis of six key indicators explained above One of the objectives of our study is to construct two indices such as Stock Market Development Index and Stock Market Liquidity Index by incorporating the information of the indicators considered under the study In order to develop these two indices, the present study has used the methodology of positive

normalization by giving equal weights to the indicators The average value of the indicators over the period 1988 to 2006 is positively normalized across 65 countries' stock markets and then the index is constructed incorporating their respective weights The formula for positive normalization is constructed as follows

Let X_{ij} be the value of indicator i in j^{th} country Then for each i,

$Min\ (X_i)$ = Minimum value of X_{ij} for a given i

$Max\ (X_i)$ = Maximum value of X_{ij} for a given i

Positive Normalization, $X_{ij} = \dfrac{(X_{ij} - Min(X_i))}{(Max(X_i) - Min(X_i))}$

Then Index for j^{th} country, $I_j = \left(\sum_{i=1}^{m} W_i X_{ij}\right) \times 100$

Where m is the number of indicators included for the index being constructed, W_i is the weight of ith indicator and X_{ij} is the normalized value of ith indicator for j^{th} country

For stock market development index, the indicators and their respective weights are as follows,

- Market concentration (25%)
- Market capitalization as percentage of GDP (25%)
- Total values of stocks traded as percentage of GDP (25%)
- Listed of domestic companies (25%)

Similarly, for stock market liquidity index, the indicators and their respective weights are as follows,

- Market concentration (20%)
- Number of listed domestic companies (20%)
- Total values of stocks traded as percentage of GDP (20%)
- Turnover ratio in percentage (20%)
- Domestic credit to private sector (20%)

For the analysis of stock markets at regional level, the study has used simple average value of the indicators over the period of 1988 to 2006

The two indices, stock market development index and liquidity index are presented in Table 3 3 and 3 4 respectively The development index categorises stock markets as highly developed, moderately developed and less developed stock markets with respect to size Similarly from liquidity point of view, the liquid index is helpful in valuing stock markets as highly liquid, moderately liquid and less liquid stock markets

3.6 Analysis of Stock Market Development Index:

Analysing the value of the index, higher value, larger is the size of stock market and vice versa The development index presented in Table 3 3 and analysed in detail below

3.6.1 Highly Developed Stock market:

The development index presented in Table 3 3 shows that the stock markets of United States, Hong Kong, Switzerland, Britain, Japan, Malaysia, Singapore, India, Korea Republic, South Africa, Netherlands, Canada, Spain, Sweden, Australia, Finland, France, Kuwait, Saudi Arabia and Luxembourg constitutes the top 20 stock markets of the world These country stock markets can be considered as highly developed with respect to the size of stock market Stock market of United States is the biggest in world having largest value of index followed by Hong Kong Stock market of Switzerland took the third largest position in terms of size of stock market in the sample of 65 countries' stock markets Similarly stock markets of Britain, Japan, Malaysia, Singapore, India, Korea Republic and South Africa took 4th, 5th, 6th, 7th, 8th, 9th and 10th position respectively

3.6.2 Moderately Developed stock markets:

The stock markets that are ranked within 21 to 40 are considered as moderately developed stock markets in the view of the present analysis It has been noticed from Table 3 3 that stock markets of Germany, Jordan, Romania, Thailand, China, Israel, Ireland, Chile, Denmark, Italy, Greece, Pakistan, Belgium, Turkey,

Norway, Brazil, Philippines, New Zealand, Egypt, and Portugal are moderately developed stock markets

3.6.3 Less Developed Stock markets:

The stock market development index finds stock markets of Czech Republic, Russia Federation, Mexico, Indonesia, Hungary, Argentina, Peru, Mauritius, Oman, Australia, Slovak Republic, Poland, Sri Lanka, Lithuania, Colombia, Slovenia, Nigeria, Botswana, Ghana, Venezuela, Costa Rica, Tunisia, Bangladesh, Bermuda and Taiwan as the less developed stock markets among the sample of 65 stock markets of the world These stock markets are ranked from 41 to 65 by the development index Stock market of Bermuda and Taiwan could not be ranked due to availability of insufficient data points and hence placed at the bottom of the list of the stock markets

3.7 Analysis of Liquidity Index:

Higher values of index mean highly liquid stock market and lower values of the index mean less liquid stock markets The Liquid index is presented in Table 3 4 and is analysed more clearly below

3.7.1 Highly Liquid stock market:

On the basis of stock market liquidity index, the top 20 stock markets in the sample of 65 countries' stock markets of world is considered as the most liquid stock markets by the present study The stock markets of United States, Hong Kong, Switzerland, Britain, Japan, Korea Republic, Spain, Malaysia, Netherlands, Singapore, Canada, Sweden, Germany, China, South Africa, India, Thailand, Finland, France and Australia are considered as highly liquid stock markets United States is ranked one, hence concluded as highly liquid stock market of world followed by Hong Kong and Switzerland ranked as second and third Similarly Britain, Japan, Korea Republic, Spain, Malaysia, Netherlands and Singapore are ranked as 4th, 5th, 6th, 7th, 8th, 9th, and 10th respectively in the order of liquidity

3.7.2 Moderately liquid stock market:

Stock markets ranked within 21 to 40 is considered as moderately liquid stock market as per the Liquidity index presented in Table 3 4 Stock markets like Pakistan, Saudi Arabia, Kuwait, Italy, Ireland, Denmark, Turkey, Norway, Luxembourg, Jordan, Israel, Portugal, New Zealand, Belgium, Austria, Greece, Czech Republic, Chile, Slovak Republic and Brazil is considered as moderately liquid stock markets of in the sample of 65 stock markets of world

3.7.3 Less liquid stock market:

Less liquid stock markets are ranked from 41 to 65 The stock markets of Romania, Hungary, Egypt, Indonesia, Philippines, Poland, Mexico, Russia Federation, Mauritius, Tunisia, Oman, Bangladesh, Slovenia, Argentina, Peru, Sri Lanka, Colombia, Lithuania, Venezuela, Costa Rica, Nigeria, Botswana and Ghana are concluded as less liquid stock markets according to liquidity index Stock market of Bermuda and Taiwan could not be ranked under liquidity index due to availability of insufficient data points and hence placed at the bottom of the list of the stock markets

3.8 Analysis of Stock markets at various aspects of development and liquidity:

Highly developed stock markets are more likely to be highly liquid and/or moderately developed stock markets are more likely to be moderately liquid but not necessarily Some highly developed stock markets may found to be moderately liquid and some moderately developed stock markets may found to be highly liquid Similarly, some moderately developed stock market may found to be less liquid or some less developed stock market may found to be moderately liquid This can be clearer if we analyse the two indices in different aspects of development and liquidity Keeping these in mind, countries are cross tabulated in a 3×3 development-liquidity matrix This is given in Table 3 5 and further analysed below It is noteworthy that the principal diagonal is heavily populated indicating a strong positive relation between development and liquidity

3.9 Analysis of the Stock Markets at Regional Level:

Although the two indices reflect the relative positions of stock markets of the respective countries with respect to development in terms of size and level of liquidity by incorporating information from the group of indicators But it is also useful to analyse all the indicators individually This analysis will provide more insights about the relative positions of the stock markets at regional level This is particularly relevant since it is not very meaningful to construct the indices developed earlier at regional level since each regional block contains very small number of countries Table 3 6 to 3 12 present the stock markets of the respective countries in seven regional blocks with the average value of the indicators over the period of 1988 to 2006 Note that market concentration at regional level reflects concentration of market capitalisation within the region only

3.9.1 North America:

Looking the stock markets of North America, United States & Canada stands to be having broader stock markets in the region The average market capitalisation (as % GDP) for USA and Canada is 108% and 80 51% respectively Looking at absolute market capitalisation and absolute GDP from Table-3 6, it is clear that the market capitalisation of USA stock market is greater than its economy In case of Canada, the size of market is bit less than size of economy But for Mexico, the stock market is very small than its economy Including the additional measure of market size i e number of listed domestic companies, USA is having an average number of 6929 and Canada 1777 listed domestic companies in the region Market concentration of United States is 92 96% in North America Region This implies that, USA occupies 92 96% of the total market capitalisation of Region Next is Canada with a concentration level of 5 84% Mexico occupies very small position with 1 2% level of concentration On the prospective of size of stock market, USA is having larger market capitalisation as percentage of GDP, largest total values of stocks traded as percentage of GDP, largest average number of domestically listed companies and largest market concentration within the region Next come stock market of Canada But market concentration of Canada is very just 5 84% within the region

From the liquidity point United States is having highest value in term of total values of stocks traded as % of GDP and turnover ratio followed by Canada The domestic credit to private sector for United States is 153 48% of its GDP, followed by Canada with 122 1% and Mexico with 21 52% Hence the stock markets of USA and Canada can be called as liquid We can say Mexico to be less liquid comparatively

3.9.2 South & Central America:

In South & Central America Region, Chile has the biggest stock market with respect to its economy and hence having a highest figure of market capitalisation as percentage of GDP Chile is followed by Brazil, Argentina, Peru, Colombia, Costa Rica and lastly Venezuela In case of total number of listed domestic companies, Brazil occupies the highest position having an average number of 495 companies where as an average of only 253 companies are listed in Chile stock market Peru is having 235 companies higher than Argentina (140), even though Argentina has a bigger market capitalisation than Peru within the region A clear outlook can be explored by looking at absolute market capitalisation and absolute GDP in Table 3 7 The Average market capitalization of Brazil, Chile, Argentina, Peru, Colombia, Costa Rica & Venezuela is 198 17, 63 74, 57 11, 14 02, 15 28, 1 67 and 6 71 billion of US $ respectively Chile's market size is less than half of Brazil Similarly, market capitalisation of Colombia is greater than Peru, Costa Rica and Venezuela Hence, it is clearer that incorporating the size of the economy is making a difference Brazil is having an economy of 607 68 billion dollar (Average) where as Chile has an economy of only 66 21 billion $ Similarly, in case of Argentina, Venezuela, Colombia, Costa Rica and Peru, the economy is $257 48 billion, $112 98 billion, $80 45 billion, $13 98 billion and $49 54 billion respectively Comparing with absolute market capitalisation and GDP, we can conclude that the Brazilian stock market is the highest in size in south & Central America Region But stock market with respective economy is smaller than Chile Similar is the case for Argentina & Venezuela At the same time Brazil has the highest market concentration It captures 55 54% of the total market capitalization of the region Costa Rica is having the least concentration with 0 47%

Although Brazil is having a larger stock market in size and the market is also found to be liquid with higher turnover ratio within the region But in overall, all the

stock markets of the region are having very low turnover ratio and total values of stock traded as percentage of GDP A low total values of stocks traded implies very less equity transitions happening in the stock markets Similar is the case of turnover ratio Looking at the domestic credit to private sectors, Chile has highest credit support by 66 63% followed by Brazil with 53 47% More specifically, Colombia, Costa Rica, Argentina, Peru & Venezuela have low availability of domestic credit i e of 29 06%, 20 39%, 19 92%, 18 88% and 18 49% respectively Hence the stock markets of Argentina, Chile, Colombia, Costa Rica, Peru and Venezuela are found to be less liquid stock markets in the region

3.9.3 South Asia:

In South Asia Region, the stock market of India occupies the highest position as average market capitalisation as percentage of GDP is 34 59 % In case of number of listed domestic companies, Indian market has an average of 4735 domestically listed companies, Pakistan is having an average of 665, Sri Lanka having 219 companies and Bangladesh with 193 average listed domestic companies The absolute market capitalization for India, Pakistan, Sri Lanka, and Bangladesh is $185 51 billion, $13 11 billion, &2 3 billion & $1 46 billion respectively Looking at size of economy, Indian economy is biggest in the region Bangladesh economy is found to have bigger economy than Sri Lanka Though market size is too small, it keeps market capitalization as percentage of GDP at very low level The results are presented in Table 3 8 India has the highest market concentration (i e 91 66%) in the region For Pakistan, it is 6 48% and for Bangladesh it is the lowest concentration at 0 72% level

From liquidity point of view, Pakistan and India stock market is quite liquid in South Asia Region Pakistan stock market is so small in size, but its turnover ratio is quite high i e 166 1% At the same time turnover ratio for India is 80 5% Looking at the total values of stocks traded as percentage of GDP, India and Pakistan has 34 06% and 30 31% respectively Bangladesh and Sri Lanka has very nominal figure of total value of stocks traded The domestic credit to private sector is almost same in all the countries of the region India is the highest in the region with 28 83% of GDP followed by Pakistan, Sri Lanka & Bangladesh with 24 79%, 23 8% & 22 58%

respectively From the above analysis, it is clear that Bangladesh and Sri Lanka stock markets cannot be considered as liquid

3.9.4 Asia Pacific:

Asia Pacific Region presented in Table 3 9, Hong Kong has the highest market capitalisation as a percentage of GDP i e 275 99% followed by Malaysia, 165 11% and Singapore 147 3% These countries stock market is greater than their economies Looking at the number of listed domestic companies Japan, Australia and Korea republic has average of 2457, 1248 and 1090 listed companies respectively The absolute market capitalisation of Hong Kong, Malaysia and Singapore is $486 39 billion, $141 40 billion and $138 29 billion respectively But Japan market capitalisation is highest in the region with $3326 42 billion Austria & Korea Republic is having the market capitalization of $373 89 billion & $256 83billion respectively which is higher than Malaysia & Singapore Thailand & Philippines has the market capitalisation of $73 08 billion & $34 84 billion respectively According to the size of economy, Japan has the biggest economy within the region with $4498 34 billon followed by China, a $1031 42 billion economy Looking sequentially, Korea Republic $447 03 billion and Australia $364 48 billion economy Hong Kong placed as 5th place with a 151 84 billion dollar economy, Malaysia a 76 92 billion dollar economy and Singapore is 75 77 billion dollar economy We can see Japan has the both large size of economy and stock market as well as highest number of listed domestic companies within the region Though its size of stock market is less than the size of economy, market capitalization as percentage of GDP is less than 100% Similarly, for Hong Kong, Malaysia and Singapore, sock market is laiger than its economy Hence Japan has the biggest size of both stock market and economy with in the Region Similarly, China, Australia and Koiea Republic have both bigger size of stock market as well as size of economy In terms of market concentration, Japan is highest in Asia pacific Region Market capitalization of Japan is 62 23% of the total market capitalisation of the Region Hong Kong & China has the market concentration, of 9 1% & 8 33% respectively Next is Australia with 6 99% New Zealand has the least concentration with 0 49% within the region next to Philippines

From the liquidity point of view, Australia, China, Hong Kong, Japan, Malaysia, Singapore, Korea Republic and Thailand can be considered as liquid stock markets on the basis of high turnover ratio Total value of stocks traded as a percentage of GDP is also quite high for Australia, Hong Kong, Japan, Malaysia, Singapore, Korea Republic and Thailand Total values of stocks traded as percentage of GDP is for China and Hong Kong is lower because the size of economy is very large But the turnover ratio is above 100%, which reflects trading as percentage of market capitalization The case is just opposite for Hong Kong However both of the stock markets are liquid by nature Stock markets of Indonesia, New Zealand and Philippines are less liquid which are presented by low total values of stocks traded and turnover ratio The domestic credit to private sector as percentage of GDP is above 100% in China, Hong Kong, Japan, Malaysia, New Zealand, Singapore & Thailand with 100 65%, 149 6%, 197 74%, 149 37%, 100 83%, 106 52% & 108 6% respectively Domestic credit in Japan is highest in the region with closer to 200% of GDP Korea Republic & Australia has 77 94% & 75 56% respectively Indonesia has the least credit support in the region with 37 38% of GDP

3.9.5 Africa & Middle East:

In Africa & Middle East region we have considered 12 (twelve) countries' stock markets Analyzing the size of stock market from the point of view of Market capitalization as percentage of GDP, it has been found that South Africa is having highest market capitalization (% of GDP) in Africa and Middle East region presented in Table 3 10 Second largest figure is for Jordan, then Kuwait followed by Saudi Arabia Including number of listed domestic companies, highest average company are listed in Egypt, followed by South Africa, Israel, Nigeria and Oman with an average number of 769, 598, 528, 175, 138 & 91 respectively Looking at absolute Market capitalisation & GDP of the economy, it has been observed that South Africa is having highest market capitalisation & 2nd highest economy in the region with $251 84 billion market capitalisation and $127 45 billion economy respectively The Size of the market is higher i e almost double in Size of economy Hence, market capitalisation as a percentage of GDP is above 150% The size is complimented by the number of listed domestic companies But Saudi Arabia, which takes the 2nd largest position in Absolute Market capitalisation & 1st position in size of economy

placed in 4th position by Market capitalisation as a percentage of GDP in Africa and Middle East region It is because, size of the market is less than size of the economy i e market capitalisation is $130 98 billion whereas economy is $178 39 billion The average number of listed companies is also quite less i e 7 The highest number of listed company is found in Egypt i e 769 with market capitalisation of $23 02 billion of and $88 34 billion economy Large number of companies with small market size depicts that the market comprises of small companies with small market capitalisation In case of Jordan and Kuwait, size of market & size of economy is almost same or size of market is little bigger than economy In case of number of listed companies, Jordan is higher that Kuwait Botswana, Ghana, Mauritius, Nigeria, Oman, & Tunisia are having stock markets less than their size of economy The number of domestically listed companies is also quite less in supporting small size of stock market In this region, the market is almost 50% concentrated with South Africa & rest of the 50% is distributed between eleven countries South Africa has the concentration of 48 21% 25% of the market is concentrated with Saudi Arabia Out of which the rest 25%, Israel occupies 10 09% & Kuwait 7 23% Botswana, Ghana, & Mauritius are least concentrated with 0 23%, 0 23% & 0 29% respectively

Looking at other indicators, the stock markets of Saudi Arabia is liquid with 93 98% of turnover ratio & 47 31% total values of stocks traded as percentage of GDP In case of South Africa, turnover ratio is comparatively low Similar is the case of Israel for which total values of stocks traded is low Jordan can also be identified as liquid at moderate level In case of availability of credit, South Africa has the domestic credit above 100% of GDP i e , 109 2% Jordan & Israel, has the domestic credit of 75 4% & 74 58% respectively Ghana provides lowest i e , 8 93%, followed by Nigeria 12 31% & Botswana 13 53% respectively Hence Botswana, Tunisia, Oman, Nigeria, Mauritius and Ghana are quite illiquid stock markets by nature

3.9.6 Eastern Europe:

In Eastern Europe region, we have 9 countries under consideration presented in Table 3 11 On the basis of Market capitalisation as percentage of GDP, the stock market of Russian Federation occupies 1st place with an average of 29 38% Then looking at the conjunctive ranks of the stock market within the region, Turkey, Czech

Republic, Hungary, Lithuania, Slovenia, Poland, Solved Republic & Romania occupies the respective positions bench marking with the size of their respective economies Supporting the market size with number of listed domestic companies, it is interesting in finding Romania with highest number of listed domestic companies i e an average of 3230 But size of market in the form of Market capitalisation is very less which implies large number of small companies are listed in the market with very nominal market capitalization Russia Federation has 173 numbers of listed domestic companies on an average Similarly, Turkey, Czech Republic, Hungary, Lithuania, Slovenia, Poland, and Slovak Republic have 220, 418, 45, 145, 151, 52 & 411 average listed domestic companies Relooking it with respect to absolute market capitalisation & GDP, Russian Federation has the highest size of stock market and economy with an average of $163 66 billion and $296 66 billion respectively But size of the stock market is less than size of economy for which market capitalisation as a percentage of GDP approximates around 29 38% Similar is the case for all the stock market of the region The stock market of Turkey is half of the economy Both size of stock market as well as size of economy of Poland is comparatively bigger than Czech Republic, Hungary, Lithuania, Romania, Slovak Republic, and Slovenia 50% of the market is concentrated with Russia Federation Rest of the 50% is distributed among 8 countries of the Region Russian Federation has the market concentration of 54 96% Then almost 27% of the rest are captured by Turkey & Poland with 17 88% & 10 88% respectively Slovak Republic has the least concentration among the Region with 0 78%

Most of the stock markets of Eastern Europe Region are found to be less liquid The stock market of Turkey is liquid with 31 86% total value of stocks traded and 122% of turnover ratio Stock markets of Czech Republic, Hungary, Poland, and Slovak Republic have high Turnover ratio but low total values of stocks traded Czech Republic, Hungary and Russia Federation have little high total values of stocks within the region after Turkey But a 12% figure in stocks traded is not a substantial figure to conclude the markets liquid Lithuania and Slovenia have stock markets with least liquidity Russian Federation is having the largest stock market and economy in the region The Total values of stocks traded as % of GDP is 11 53% and turnover ratio is 30 52% The liquidity of the stock market does not compliment its size In Eastern

Europe Region, none of the country's domestic credit to private sector is above 100% of GDP. Czech Republic has an average of 52.89% which is highest in the region. Slovak Republic's domestic credit to private sector is 43.04% of GDP. Russian Federation being the biggest economy and biggest stock market of the region provides domestic credit of 16 43% of GDP. The lowest figure stands with Romania with 10.09% average in Eastern Europe Region

3.9.7 Western Europe:

In Western Europe, we have considered 17 countries presented in Table 3 12 The size of stock market with respect to economy of Switzerland, Luxembourg and Britain is greater than 100% i.e 171.88%, 153 66% & 129.86% respectively. The same way the size of Netherlands' stock market takes 4th position in Western Europe. Stock markets of Belgium, Finland, France, Ireland, Netherlands, Spain & Sweden are having the size of stock market greater than 50% and less than 100% with respect to their economy In case of listed domestic companies Britain is having highest average number of domestic company i.e. 2067. Spain is having an average of 1132 listed companies. France & Germany have an average of 673 & 655 number of listed companies respectively. Comparing this with absolute value of Market capitalisation of the stock market and GDP, it has been found that Britain, Luxembourg & Switzerland's size of stock market is bigger than the size of their economy. Hence for these countries market capitalisation as percentage of GDP are greater than 100 Stock markets of Finland, Sweden, Ireland & Netherlands are almost closer to the size of their economy. The size of the stock market of Italy is comparatively bigger than stock markets of Austria, Belgium, Denmark, Finland, Greece, Ireland, Luxembourg, Netherlands, Norway, Portugal, Spain & Sweden Looking at absolute market capitalisation, the size of stock market of Luxembourg is the smallest in the region. Though the size of the economy is smaller than its stock market, the ratio of market capitalisation as percentage of GDP becomes greater than 100% In fact, both size of stock market and size of economy of Luxembourg are smallest in the region The market concentration of Western Europe is quite interesting. Only 30% (approximately) of the market is concentrated with Britain. Rest 70% is distributed among 16 countries of the region France occupies 14.58%, Germany occupies 12.86% & Switzerland occupies 8.23% of the market capitalisation of the total market

capitalisation of the region. The stock market of Spain, Netherlands and Italy is approximately 6% of total market capitalisation of Western Europe. Hence the market is not much dominated by few developed stock markets in the Region.

Spain has the highest turnover ratio 166.06%, then Germany with 133.99% followed by Netherlands 101.16% but in case of Total values of stocks traded as percentage of GDP, Switzerland is having the highest value i.e. 153.16% followed by Britain with 82.59% and Netherlands 79.32%. Britain has large stock market in size and an average of 83.59% of total values of stocks traded (%) of GDP and turnover ratio of 80 03% proves the market stands to be liquid. Similarly, Switzerland has the stock market larger than its economy Bigger Stock market is complimented with larger total values of stocks traded, in percentage of GDP which is 153 16%. The turnover ratio also stands to be high with 88 36%. Hence it proves that Switzerland stands to be quite liquid and active stock market In a similar fashion Finland, Netherlands and Sweden are also quite liquid stock markets France and Germany have high turnover ratio but total values of stocks traded are bit less But 36% and 38% of total values of stocks traded as a percentage of GDP can help us in concluding the stock markets to be liquid. Denmark, Greece, Italy and Norway are small stock markets but can be called as liquid. Austria, Belgium and Portugal are stock markets with very low total values of stocks traded. This means lack of enough equity trading within the market Even though turnover ratio is found to be bit high, we cannot conclude these stock markets as liquid. Luxembourg is having a small and less liquid stock market of the region. Britain, Germany, Luxembourg, Netherlands, Sweden & Switzerland has domestic credit to private sector greater than 100% of GDP, such as 127.81%, 104.27%, 100 03%, 113 09%, 10 323% & 142 02% respectively. Switzerland provides highest domestic credit to private sectors in the region followed by Britain & Netherlands Austrian Portugal & Spain is almost closer to 100% with 97.5%, 94 43% of GDP respectively The lowest rate is identified with Greece in the region i e , 48 71% The countries like Belgium, Denmark, Finland, France, Ireland, Italy & Norway has the credit support of 66 91%, 81 77%, 69.32%, 88 86%, 86.53%, 67.35% & 67.35% which shows quite substantial domestic credit supports to private sectors.

3.10 Conclusion:

The present study has analysed stock markets from both of the aspects of development and liquidity The two indices development and liquidity index ranked the stock markets with respect to their development in size and liquidity. Before discussing the indices, all the indicators are analysed individually to trace out the relative position of the stock markets in a more detail fashion. The indices are quite powerful to draw the final conclusion about the stock markets because it incorporates all the relevant information under the two broad heads of development and liquidity. Briefly concluding the findings, it has been observed that most of the highly developed stock markets are highly liquid and less developed stock markets are less liquid. None of the highly developed stock markets are less liquid and less developed stock markets are found to be highly liquid which seems to be quite genuine Stock markets of United States, Hong Kong, Switzerland, Britain, Japan, Korea Republic, Malaysia, India, Netherlands, Singapore, Spain, Canada, Sweden, South Africa, France, Finland and Australia are highly developed and highly liquid stock markets Luxembourg, Kuwait and Saudi Arabia stock markets are highly developed and moderately liquid stock markets Similarly stock market of Germany, Thailand and China is found to be moderately developed and highly liquid stock markets. The moderately developed and moderately liquid stock markets are of countries of Jordan, Israel, Denmark, Ireland, Italy, Greece, Chile, Pakistan, Belgium, Turkey, Norway, Brazil, New Zealand and Portugal. In the similar context the study finds the less developed and less liquid stock markets of countries like Russian Federation, Mexico, Indonesia, Hungary, Argentina, Peru, Mauritius, Oman, Poland, Sri Lanka, Lithuania, Colombia, Slovenia, Nigeria, Botswana, Ghana, Venezuela, Costa Rica, Tunisia, Bangladesh, Bermuda and Taiwan The stock markets of Romania, Philippines and Egypt are moderately developed but stand to be less liquid stock markets Similarly, stock markets of Austria, Czech Republic and Slovak Republic are found to be less developed but moderately developed stock markets in the sample of 65 countries stock markets. It is noteworthy that the principal diagonal is heavily populated indicating a strong positive relation between size of stock market and its level of liquidity These analyses are drawn on the basis of development and liquidity index

Above all these two indices are proved to be quite powerful in capturing the underline structure of the stock markets

A detailed analysis at indicators level finds stock market of United States, Hong Kong, Switzerland, Malaysia, Singapore, South Africa , Britain and Luxembourg have the stock markets greater than their respective economy. The stock markets of Jordan and Netherlands are 90% (approximately) of their economy. Similarly, Chile, Finland, Sweden, Japan & Canada have the stock markets whose size is 80% of the economy, followed by Austria & Kuwait with 75% approximately. Looking at small stock markets Venezuela, Slovak Republic, Romania & Bangladesh have the stock market whose size is less than 10% with the size of economy. Stock markets of Hungary , Pakistan , Botswana , Lithuania , Colombia , Austria , Slovenia , Ghana , Sri Lanka , Poland , Tunisia , Nigeria & Costa pica have the stock markets whose size lies between 10% to 20% of the size of their economy, hence considered to be very small size of stock markets

The sizes of these stock markets are complemented by number of listed domestic companies. Stock market of USA has highest number i e. an average of 6929 listed domestic companies followed by India with an average of 4735. Stock market of Romania of Eastern Europe region has an average of 3230 listed companies. Similarly stock market of Japan, Britain, Canada, Australia, Spain and Korea Republic has above one thousand numbers of listed domestic companies i.e 2457, 2067, 1777, 1248, 1132 and 1090 respectively Stock market of China, Egypt, France, Pakistan, Germany, Hong Kong, Malaysia, South Africa and Israel have average number of listed domestic companies in a range of 500 to 1000 (i e. 810, 769, 673, 665, 655, 642, 636, 598, 528 respectively) which can also be considered as a good number to analyse the size of a stock market The stock markets in which average number of listed companies range from 100 to 500 are stock market of Brazil, Czech republic, Slovak Republic, Thailand, Singapore, Chile, Italy, Indonesia, Sweden, Peru, Greece, Denmark, Switzerland, Turkey, Sri Lanka, Netherlands, Philippines, Bangladesh, Mexico, Nigeria, Russia Federation, Belgium, Norway, New Zealand, Poland, Lithuania, Argentina, Jordan, Portugal, Colombia and Finland. Stock markets with less than an average of 100 listed domestic companies are stock markets of Austria, Oman, Kuwait, Venezuela, Luxembourg, Ireland, Saudi Arabia, Costa

Rica, Slovenia, Hungary, Tunisia, Mauritius, Ghana and Botswana These stock markets are very small in size and very less liquid by nature.

Size of the stock will be more meaningful if it is analysed along with another salient feature of the stock market total values of stocks traded as percentage of GDP and turnover ratio in percentage. The present study has identified liquidity of the stock market on the basis of these two indicators along with domestic credit to private sector as percentage of GDP. Looking at turnover ratio (%), it has been observed that stock markets of United States, Korea Republic, Pakistan, Spain, Chain, Germany, Turkey & Netherlands are liquid stock markets with turnover ratio above 100% The turnover ratio (%) of Saudi Arabia, Switzerland and Italy, Sweden, Thailand, Norway, France, India & Britain lies in 80% to 100% Stock markets like Kuwait, Finland, Japan, Canada, Australia, and Hong Kong & Singapore are having turn over ration greater than 50%. In the similar manner stock markets of Botswana, Ghana, Mauritius, Nigeria, Colombia, Tunisia, Sri Lanka, Venezuela, Lithuania, Peru, Slovenia, Argentina, Oman etc are less liquid stock markets having very low turnover ratio.

Looking at another indicator i e. total values of stocks traded as percentage of GDP, Switzerland, Hong Kong and United States have values greater than hundred Korea Republic, Britain, Netherlands, Singapore, Malaysia, Spain & Sweden has total values of stock traded in the range of 60% to 90% of their GDP. Ghana, Nigeria, Botswana, Bangladesh, Costa Rica, Romania, Tunisia, Colombia, Venezuela, Mauritius, Sri Lanka, Lithuania, Luxembourg, Slovenia, Peru, Argentina, Slovak Republic etc, have very less total values of stocks traded with respect to its GDP.

The present study also analyses market concentration on regional basis. United States in North America region and India in South Asia Region have market capitalisation above 90% of the total market capitalization of the respective region. In fact, in both of the regions, we have considered only 3 to 4 countries Looking at other regions, Brazil in South & Central America, Japan in Asia pacific, South Africa in Africa & middle east region and Russian Federation in Eastern Europe region have market cap 50% of the total market cap of the respective regions. The case is quite different for Western Europe. The maximum market concentration is approximately

30% with Britain followed by France with 15% and Germany 13% concentration approximately.

Another supporting strong feature of financial market is domestic credit to private sector. Taking it as a percentage of GDP, it has been observed that United States, Canada, China, Japan, Malaysia, New Zealand, Singapore, Thailand, South Africa, Britain, Germany, Luxembourg, Hong Kong, Netherlands, Sweden and Switzerland have domestic credit to private sector more than 100% of GDP. Brazil, Chile, Australia, Korea Republic, Israel, Jordan, Kuwait, Mauritius, Saudi Arabia, Tunisia, Czech Republic, Austria, Belgium, Denmark, Finland, France, Ireland, Italy, Norway, Portugal, and Spain have domestic credit support between 50 % to 100% of GDP All the countries of Western Europe Region are providing domestic credit to private sector around 50% and more of their GDP. Peru, Venezuela, Argentina, Botswana, Ghana, Nigeria, Lithuania, Romania and Russian Federation have domestic credit support less than 20% of their respective GDP. Ghana has the least support i.e. 9% of GDP

The analysis of the indicators at each countries stock market level has made the findings of development and liquidity index quite clear The analysis of the stock markets at various aspects has reflected the nature of the 65 stock markets quite elaborately

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Table 3.3 Stock Market Development Index

Rank	Countries	D Index	Rank	Countries	D Index
1	United States	79.92	34	Turkey	8.02
2	Hong Kong	50.34	35	Norway	7.71
3	Switzerland	42.44	36	Brazil	6 76
4	Britain	36 92	37	Philippines	6 53
5	Japan	31 96	38	New Zealand	6.34
6	Malaysia	28 31	39	Egypt	6 31
7	Singapore	26 31	40	Portugal	5.57
8	India	26 10	41	Czech Republic	5 55
9	Korea Republic	23 34	42	Russian Federation	5 46
10	South Africa	22.89	43	Mexico	4 74
11	Netherlands	22 71	44	Indonesia	4 07
12	Canada	22 07	45	Hungary	3.88
13	Spain	20.96	46	Argentina	3.59
14	Sweden	19.27	47	Peru	3.33
15	Australia	18.71	48	Mauritius	3.25
16	Finland	17 54	49	Oman	3 03
17	France	15 63	50	Austria	2.98
18	Kuwait	14.86	51	Slovak Republic	2 77
19	Saudi Arabia	14 24	52	Poland	2.65
20	Luxembourg	14 00	53	Sri Lanka	2.44
21	Germany	13 74	54	Lithuania	2.32
22	Jordan	13.39	55	Colombia	2.14
23	Romania	12.50	56	Slovenia	2 04
24	Thailand	12 19	57	Nigeria	1.68
25	China	10.90	58	Botswana	1.62
26	Israel	10.07	59	Ghana	1.46
27	Ireland	9.96	60	Venezuela	1 33
28	Chile	9.77	61	Costa Rica	1.31
29	Denmark	9.31	62	Tunisia	1 30
30	Italy	8 99	63	Bangladesh	1 12
31	Greece	8 86	64	Bermuda	0 00
32	Pakistan	8.86	65	Taiwan	0.00
33	Belgium	8.50			

Table 3.4 Stock Market Liquidity Index

Rank	Countries	L Index	Rank	Countries	L Index
1	United States	73.75	34	Belgium	18.02
2	Hong Kong	60.39	35	Austria	17 59
3	Switzerland	59.10	36	Greece	16.65
4	Britain	47.58	37	Czech Republic	15.79
5	Japan	46.12	38	Chile	15.57
6	Korea Republic	46.04	39	Slovak Republic	15.34
7	Spain	43 26	40	Brazil	15 20
8	Malaysia	41 62	41	Romania	14 61
9	Netherlands	40 03	42	Hungary	12.98
10	Singapore	37.21	43	Egypt	12 56
11	Canada	35 46	44	Indonesia	12.08
12	Sweden	34 92	45	Philippines	11.59
13	Germany	34 78	46	Poland	11.42
14	China	34 66	47	Mexico	9.62
15	South Africa	32 48	48	Russian Federation	9 09
16	India	32 36	49	Mauritius	8 66
17	Thailand	29.77	50	Tunisia	8 58
18	Finland	29 39	51	Oman	8 30
19	France	28.62	52	Bangladesh	7.79
20	Australia	28.24	53	Slovenia	7.51
21	Pakistan	27 98	54	Argentina	7 21
22	Saudi Arabia	27 30	55	Peru	6.78
23	Kuwait	24 62	56	Sri Lanka	5 77
24	Italy	22 81	57	Colombia	5 59
25	Ireland	22 59	58	Lithuania	5.57
26	Denmark	22 46	59	Venezuela	4.76
27	Turkey	22 05	60	Costa Rica	3 91
28	Norway	21 84	61	Nigeria	3.18
29	Luxembourg	21 45	62	Botswana	2 99
30	Jordan	21 06	63	Ghana	2 42
31	Israel	20 58	64	Bermuda	0.00
32	Portugal	19 80	65	Taiwan	0.00
33	New Zealand	19.51			

Table 3.5: Matrix of Stock Markets of the Countries in Terms of Size and Liquidity

		Development of Stock markets in terms of Size		
		Highly Developed Stock Markets	*Moderately Developed Stock Markets*	*Less Developed Stock Markets*
Liquidity Level of Stock Markets	*Highly Liquid Stock Markets*	United States, Hong Kong, Switzerland, Britain, Japan, Korea Republic, Malaysia, India, Netherlands, Singapore, Spain, Canada, Sweden, South Africa, France, Finland and Australia	Germany, Thailand and China	***
	Moderately Liquid Stock Markets	Luxembourg, Kuwait and Saudi Arabia	Jordan, Israel, Denmark, Ireland, Italy, Greece, Chile, Pakistan, Belgium, Turkey, Norway, Brazil, New Zealand and Portugal	Austria, Czech Republic and Slovak Republic
	Less Liquid Stock Markets	***	Romania, Philippines and Egypt	Russian Federation, Mexico, Indonesia, Hungary, Argentina, Peru, Mauritius, Oman, Poland, Sri Lanka, Lithuania, Colombia, Slovenia, Nigeria, Botswana, Ghana, Venezuela, Costa Rica, Tunisia, Bangladesh, Bermuda, Taiwan

Table 3.6: Stock Markets of Countries of North America Region

Countries	Market Capitalization (% of GDP)	Domestic Credit to Private Sector	Total values of Stocks Traded (% of GDP)	Turn Over Ratio (%)	Listed Domestic Companies	Market Concentration (%)	M.cap, Billions of US $	GDP, Billions of US $
	Average	Average	Average	Average	Average	Average	Average	Average
Bermuda	NA	NA	NA	NA	NA	NA	NA	NA
Canada	80.51	122.1	42 43	60 61	1777	5 84	634.82	654.45
Mexico	26 92	21 52	8 76	35.21	183	1.2	130 18	512 47
United States	108	153.48	125.01	128 99	6929	92 96	10101 26	8756.37

Table 3.7: Stock Markets of Countries of South & Central America Region

Countries	Market Capitalization (% of GDP)	Domestic Credit to Private Sector (% of GDP)	Total values of Stocks Traded (% of GDP)	Turn Over Ratio (%)	Listed Domestic Companies	Market Concentration (%)	M.cap, Billions of US $	GDP, Billions of US $
	Average	Average	Average	Average	Average	Average	Average	Average
Argentina	27.31	18.92	3 52	22 95	140	16 03	57 21	257 48
Brazil	28 44	53.47	12.34	43 15	495	55.54	198.17	607.68
Chile	84 63	66 63	8 38	10 29	253	17 86	63 74	66.21
Colombia	16 24	29.06	1 57	8 74	121	4 28	15 28	80.45
Costa Rica	10 56	20 39	0 95	7.24	68	0 47	1.67	13.98
Peru	22 19	18 88	3.23	20 15	235	3.94	14.02	49.54
Venezuela	8 78	18 49	1 72	16 64	75	1 88	6 71	112.98

Table 3.8: Stock Markets of Countries of South Asia Region

Countries	Market Capitalization (% of GDP)	Domestic Credit to Private Sector (% of GDP)	Total values of Stocks Traded (% of GDP)	Turn Over Ratio (%)	Listed Domestic Companies	Market Concentration (%)	M.cap, Billions of US $	GDP, Billions of US $
	Average	Average	Average	Average	Average	Average	Average	Average
Bangladesh	3 2	22 58	0 9	41 61	193	0 72	1.46	42 35
India	34.59	28 83	34.06	80 53	4735	91.66	185 51	412.85
Pakistan	17 08	24 79	30 31	166 1	665	6.48	13.11	68.35
Sri Lanka	14 96	23.8	2.11	12.76	219	1.14	2.3	14.19

Table 3.9: Stock Markets of Countries of Asia Pacific Region

Countries	Market Capitalization (% of GDP)	Domestic Credit to Private Sector (% of GDP)	Total values of Stocks Traded (% of GDP)	Turn Over Ratio (%)	Listed Domestic Companies	Market Concentration (%)	M.cap, Billions of US $	GDP, Billions of US $
	Average	Average	Average	Average	Average	Average	Average	Average
Australia	75 4	75 56	40 29	57 48	1248	6.99	373.89	364 48
China	27 26	100 65	27 63	150 16	810 .	8 33	445.29	1031.42
Hong Kong	275.99	149 6	133.69	53 72	642	9 1	486.39	151.84
Indonesia	20 56	37.38	8 13	46 23	237	0 8	42 66	156 9
Japan	81 87	197 74	47.62	64 24	2457	62.23	3326 42	4498.34
Malaysia	165 11	149 37	69.54	37.47	636	2.65	141 4	76.92
New Zealand	41 74	100 83	12 89	38.71	155	0.49	26.09	49.45
Philippines	44 45	36 27	11 36	25 04	203	0.65	34.84	70.17
Singapore	147 3	106 52	73 24	51 09	296	2.59	138.24	75 77
Korea Republic	48 36	77 94	89 31	180 47	1090	4 8	256.83	447 03
Taiwan	NA	NA	NA	NA	NA	NA	NA	NA
Thailand	51 59	108 6	38.02	82 85	369	1.37	73.08	115 8

Table 3.10: Stock Markets of Countries of Africa and Middle East Region

Countries	Market Capitalization (% of GDP) Average	Domestic Credit to Private Sector (% of GDP) Average	Total values of Stocks Traded (% of GDP) Average	Turn Over Ratio (%) Average	Listed Domestic Companies Average	Market Concentration (%) Average	M.cap, Billions of US $ Average	GDP, Billions of US $ Average
Botswana	16 72	13.54	0 74	2 91	14	0 23	1 21	5 25
Egypt	26 91	44 18	7	27 88	769	4 41	23.02	88 34
Ghana	14 97	8 93	0 48	3 19	22	0 23	1.22	4 55
Israel	46 78	74 58	23 37	45 96	528	10 09	52 72	101 54
Jordan	92.41	75 44	29 76	24 73	138	1 64	8.59	7.88
Kuwait	75.2	55.21	46 8	65 19	81	7 23	37.77	36.01
Mauritius	32 79	54 26	1 73	5 17	35	0 29	1 51	3 92
Nigeria	10 66	12 31	0 7	4 93	175	1.18	6.15	43.92
Oman	20 39	30.88	5 47	24.9	91	0 98	5 14	17.79
Saudi Arabia	55 06	56 92	47 31	93 98	71	25 07	130 98	178 39
South Africa	158 58	109.2	38 97	32 72	598	48 21	251 84	127 45
Tunisia	11 09	63 88	1 23	9 83	35	0 44	2 21	17.28

Table 3.11: Stock Markets of Countries of Eastern Europe Region

Countries	Market Capitalization (% of GDP) Average	Domestic Credit to Private Sector (% of GDP) Average	Total values of Stocks Traded (% of GDP) Average	Turn Over Ratio (%) Average	Listed Domestic Companies Average	Market Concentration (%) Average	M.cap, Billions of US $ Average	GDP, Billions of US $ Average
Czech Republic	23 24	52 89	12 13	54.47	418	6 41	19.08	56.6
Hungary	18 83	35 83	12 58	56.62	45	4 45	13.24	46.4
Lithuania	16 49	15 98	2 18	19.06	145	1 05	3 13	12 63
Poland	13 71	21 15	5 15	65 19	151	10 88	32.41	154.71
Romania	7.55	10 09	1 11	32 46	3230	2 1	6 25	41.42
Russian Fed	29 38	16 43	11 53	30 52	173	54 96	163 66	296 66
Slovak Rep	7 75	43 04	3 76	79 14	411	0 78	2 32	20 13
Slovenia	15.84	35 43	2 87	20.79	52	1.49	4 44	18.14
Turkey	23 44	21 38	31 04	122 45	220	17 88	53.23	181.61

Table 3.12: Stock Markets of Countries of Western Europe Region

Countries	Market Capitalization (% of GDP)	Domestic Credit to Private Sector (% of GDP)	Total values of Stocks Traded (% of GDP)	Turn Over Ratio (%)	Listed Domestic Companies	Market Concentration (%)	M.cap, Billions of US $	GDP, Billions of US $
	Average	Average	Average	Average	Average	Average	Average	Average
Austria	15 99	97.57	6 53	48 96	99	0.7	44.4	177.46
Belgium	61 75	66 91	11 76	42.87	163	2 42	152.44	214 58
Britain	129.86	127 81	82 59	80 03	2067	29 97	1890 01	1335 1
Denmark	44.88	81 77	26 31	62 38	231	1 39	87 57	146 22
Finland	83 7	69 32	58 28	77 52	104	1 93	121 49	111 3
France	55 75	88 86	36 58	80 76	673	14 58	919.75	1232.91
Germany	35.82	104 27	38 15	133 99	655	12 86	811.18	1763
Greece	43 39	48 71	24 58	43 07	232	1 07	67 73	137 38
Ireland	61 05	86 53	25 98	54 4	71	1 24	78.29	79 05
Italy	31 43	67 35	26 03	87 16	248	6 82	430 17	1030.98
Luxembourg	153.66	100 03	2 46	1 8	74	0 51	31 88	17.34
Netherlands	91.54	113 08	79 32	101.16	219	6 28	396 34	342.06
Norway	33 64	67 52	24 24	81 03	158	1 13	71.48	151.27
Portugal	28 75	94.43	14 98	53 01	136	0 61	38 71	100.37
Spain	51 24	94 6	68 92	160 06	1132	6 51	410.45	532 71
Sweden	83 14	103 23	64.5	86	237	3 75	235 4	224 44
Switzerland	171 88	162 02	153.16	88 36	226	8 23	519 2	233 78

CHAPTER IV

CHAPTER IV

DYNAMIC INTERLINKAGES AND LONG RUN EQUILIBRIUM RELATIONSHIP BETWEEN THE STOCK MARKETS

VECM
VAR

4.1 Introduction

In this chapter, we examine the interlinkages of stock markets in recent years, where the stock markets are classified into seven regional blocks. The study of the existence of interlinkages across capital markets has serious implications for portfolio diversification as well as macroeconomic policies of individual countries. Investors typically wish to hold securities from a variety of firms because such diversification reduces portfolio risk, similarly, investors who buy shares in foreign as well as domestic companies seek to avoid some market risk and reap rewards through global diversification. Diversification pays since stock indices of different countries do not necessarily move together so that stock returns in different markets are less than perfectly correlated. Hence identifying the interdependences between the stock markets becomes an important issue for an investor as well as for policy makers who aim to capture its impacts on capital flows. One of the channel through which stock markets positively affect capital accumulation is through improvements in risk diversification of internationally and financially integrated stock markets. However, it is necessary to recognize that portfolio diversification depends on agents' degree of risk aversion. International diversification is often considered as the best instrument to improve portfolio performance. The integration of financial market has also been held responsible for the contagion effects of financial crisis because of increased spillover effects and existence of persistence of volatility. The process of integration is facilitating market access to participants to various market segments. A large body of literature has focused on various aspects of financial integration from various stand points of economic and financial events. Some earlier studies are found to be focused with testing the time series properties of the stock markets and identifying their interlinking coefficients Some of these studies are reviewed below.

4.2 Review of Literature

Egert, B. and Kocenda, E. (2005) have analyzed contagion and integration between stock markets of Central and Eastern Europe and Western European. The novelty of this paper rests mainly on the use of five-minute tick intraday price data from the mid-2003 to the early of 2005 for stock indices and use of wide range of econometric techniques. The result gives no robust co-integration relationship for any of the stock index pairs or for any of the extended specifications. There are signs of short-term spillover effects both in terms of stock returns and stock price volatility. Granger causality tests show the presence of bidirectional causality for returns as well as volatility series. The results based on a VAR framework indicate a more limited number of short-term relationships between the stock markets. In general, it appears that spillover effects are stronger from volatility to volatility than contagion influence from return to return series.

Cochran, S.J., and Mansur, I. (1991) examine the interrelationships between yields on the U.S. and several foreign market portfolios over the 1980-89 period in his paper "The Interrelationships between U.S. and Foreign Equity Market yields: Tests of Granger Causality" .Tests of Granger causality are used to investigate the effects of uni-directional causality, bi-directional causality, and contemporaneous adjustment in the determination of market rates of return. The results indicate that international equity market returns are largely contemporaneously determined, and the significance of contemporaneous effects varied over time. uni-directional and bi-directional causality were found to be relatively weak.

Eun, C.S. and Shim, S (1989), investigate the international transmission mechanism of stock market movements by estimating a nine-market Vector Auto regression (VAR) system. The data base used in this study consists time series daily of stock market indices at closing time, in terms of local currency units, of the world's nine major stock markets, as calculated by Morgan Stanley Capital International. It covers the period December 31, 1979, through December 20, 1985, with a total of 1560 observations. These stock market indices are transformed to daily rates of return, which are then used in the VAR analysis. Using simulated responses of the estimated VAR

system, this paper is trying to locate all the main channels of interactions among national stock markets and trace out the dynamic responses of one market to innovations to another. Generally, a substantial amount of multi-lateral interaction is detected among national stock markets. Innovations in the U.S are rapidly transmitted to other markets in a clearly recognizable fashion, whereas no single foreign market can significantly explain the U.S market movements. Also, the dynamic response pattern is found to be generally consistent with the notion of informational efficient international stock markets.

Korajczyk, R. A. (1996) measures the deviations of asset returns from an equilibrium model of returns constructed assuming market integration. If equity markets are financially integrated, the price of risk should be the same across markets. If the markets are not financially integrated - possibly because of barriers to capital flows across markets - the price of risk may differ across markets. He uses a multifactor equilibrium Arbitrage Pricing Theory to define risk and to measure deviations from the law of one price. Author finds the market segmentation that tends to be much larger for emerging markets than for developed markets and the measure tends to decrease over time. Different emerging market has different sample period of study. Along several dimensions, the proposed measure yields results that are consistent with reasonable priors about the relations between effective integration and explicit capital controls, capital market development, and economic growth.

Larry, F., Houston J. and Naranjo A. (2003) tried to find out the value of corporate diversification is related to the level of capital market development, international integration and legal systems. The main data source is World scope. World scope has financial and business segment data for more than 8,000 companies located in 49 countries. The firms in the databank represent 86% of global market capitalization. The business segment data starts in 1991. The sample period extends from 1991 through 1995. The results suggest that the financial, legal, and regulatory environments have an important influence on the value of diversification Moreover, the optimal organizational structure and corporate governance may be very different for firms operating in emerging markets than they are for firms operating in more developed and internationally integrated countries.

Philip, R. L. and Milesi-Ferretti, G. M. (2003) analyzes the broad trends in international financial integration for a sample of industrial countries and seeks to explain the cross-country and time-series variation in the size of international balance sheets. The authors study international financial integration using data on countries' portfolios of external assets and liabilities the so called international investment position (IIP). The sample period for data is different for different countries. The authors finds the standard modeling assumption of a common "world interest rate" on international investments is not supported by the data, which show rates of return varying over time and across asset classes. Better information on the composition of international portfolios would allow a more detailed investigation of this topic. Authors believe that the international investment position data provide a useful and fresh perspective on the international diversification literature. The study of higher-frequency data on rates of return would also be useful in modeling the international transmission of business cycle shocks.

Zhiwu, C. and Knez, P. J. (1995), tried to develop a measurement theory of market integration based on two notions of integrated markets and finds two markets cannot be perfectly integrated in any sense if one can construct two portfolios, one from each market, which have identical payoffs but different prices. In that case, the law of one price is violated across the markets. Second they cannot be integrated in a stronger sense if there are cross-market arbitrage opportunities. Authors have formalized the idea that closely integrated markets should assign to similar payoffs prices that are close and have defined two notions of market integration. Such formalization has allowed developing two market integration measures. The weak measure reflects how differently two markets price their common payoffs. Similarly, a strong form integration requires the markets not only to assign the same price to the same common payoff but also to price every conceivable payoff in such a way that no arbitrage profits can be generated across the two markets. Correspondingly, the strong integration measure is generally higher than the weak measure. The both measures indicate the extent that the respective notion of perfect market integration is violated across two markets.

Bekaert, G. and Harvey, C. R (1995) proposed a measure of capital market integration arising from a conditional regime-switching model. The study focuses on

twelve emerging markets namely Chile, Colombia, Greece, India, Jordan, Korea, Malaysia, Mexico, Nigeria, Taiwan, Thailand, and Zimbabwe. These markets account for over 80 percent of the capitalization of all of the markets. Authors find a number of emerging markets exhibit time-varying integration. Some markets appear more integrated than one might expect based on prior knowledge of investment restrictions. Other markets appear segmented even though foreigners have relatively free access to their capital markets. While there is a perception that world capital markets have become more integrated, the country-specific investigation suggests that this is not always the case.

Michael, J. B., Wang, A. W. and Xia Y. (2004), presented a simple valuation model with time-varying investment oppoitunities is developed and estimated. The model assumes that the investment opportunity set is completely described by the real interest rate and the maximum Sharpe ratio, which follow correlated Ornstein-Uhlenbeck processes. The model parameters and time series of the state variables are estimated using US Treasury bonds yields and expected inflation from January 1952 to December 2000. As predicted, the estimated maximum Sharpe ratio is related to the equity premium. In cross-sectional asset-pricing tests, both state variables have significant risk premia, which is consistent with Merton's ICAPM. Returns on the 30 industrial portfolios do not discriminate clearly between the three models. When both sets of portfolios are included as test assets all three models are rejected but the estimated risk premia for both ICAPM state variables are significant.

Oscar, L. A. (1965) studied integration of European capital markets in three broad aspects First, what are the characteristics of integrated capital markets and what is the relationship of integration to efficiency. Second, to what extent the past developments helped or hindered the development of capital market and third what are the prospects for further developments in European capital market.

Mathur, I. and Subrahmanyam, V. (1990) analysed the interdependencies among the stock market indices for four Nordic countries and including U.S. using the concept of Granger causality. The vector autoregressive model indicates that the U.S. market affected only the Danish, but not the Norwegian, Finnish or Swedish markets. The Swedish market was causally prior to both the Norwegian and Finnish markets. The

Norwegian, Danish and Finnish markets did not "Granger cause" any other market. The results from the aggregated model indicate that the stock markets in the four Nordic countries may be less than fully integrated. Full integration implies simultaneous adjustment to new information coming into the markets, thereby not providing any opportunities for abnormal profits associated with lagged information processing. However, from the interdependencies among these markets and the lead-lag structure, the Norway stock market could anticipate stock price changes in the Norwegian market by observing Sweden's stock market and perhaps derive abnormal return.

Buckberg, E. (1995) investigates whether emerging stock markets are now part of the global financial market and characterizes return behavior in these markets. Tests of the conditional International Capital Asset Pricing Model (ICAPM) reveal that eighteen of the twenty largest emerging markets were integrated with the world market between December 1984 and December 1991, but that many of the same markets reject the model when data for 1977-84 are used. These results suggest that large capital inflows from industrial economies, beginning in the late 1980s, caused prices in emerging markets to reflect covariance risk with the world portfolio, thus inducing their consistency with the ICAPM. Stylized evidence from recent market openings suggests that opening expands markets in terms of participants, firms listed, and value, and promotes the capital flows necessary for integration.

Timothy, J. K. (2001) presents a two-country dynamic general equilibrium model in which each country has borrowing and lending subject to shocks, endogenously arising financial institutions, and potentially independent monetary policy. The paper suggests that they need to investigate whether or not a country that is considering dollarization, like Mexico, has financial markets that are well integrated with financial markets in the United States The consequences of dollarization depend crucially on whether or not the financial markets of the two countries are integrated, which within the context of the model boils down to whether or not borrowing and lending take place freely across countries: Under weak conditions Dollarization leads to indeterminacy of equilibrium if financial markets are segmented. Dollarization leads to a unique monotone path converging to the steady state with integrated financial markets. Dollarization leads to a

fall in worldwide seigniorage revenues if financial markets are segmented. When financial markets are segmented, dollarization always leads to a fall in the steady-state utility of borrowers and to a fall in the steady-state utility of lenders if the non dollarized monetary policies were sufficiently similar.

George, M. F., Jeon B.N, Mankiw, N. G and Shiller, R. J. (1989) analyzed the daily movements in the stock price indexes of United States, Japan, Great Britain and Germany during 1986-88 focusing particularly on the correlation of price movements. Secondly, the paper tries to relate stock price movements with interest rates, exchange rates, oil prices and so on. What emerges is a robust finding that the correlations among the world's stock markets increased substantially after October 1987. Comparing the year before the crash with the year after the crash, the authors report that the typical correlation rose from 0.2 to 0.4. They found that relating the stock market to news about fundamentals is hard to do as stock prices appear to have a life of their own. Anyone who has listened to the feeble attempts by the nightly news to explain the day's stock market would probably have anticipated this conclusion.

Bruno, H. Solnik (1974) explains the pricing of European and American securities relative to their international risk level A simple international market structure consistent with the International Asset Pricing Model has been considered and tested on a sample of 299 securities. The empirical findings presented in this paper indicate that national factors are quite important, therefore violating the simple international market structure postulated in the single index market model. By diversifying these domestic factors in international portfolios, it has been possible to show a strong relation between realized returns and international systematic risk. The result indicates that the true measure of risk should be the international risk of an investment, not its national "beta " Although stock prices of each country tend to move together, the international capital market seems to be sufficiently integrated and efficient to induce an international pricing of risk for common stocks. While these results are in favor of the International Asset Pricing Model, they indicate that more efforts should be devoted to the study of international market structure in order to determine the stochastic process followed by security prices across the world.

Onay, C. (2006) examines the long-term financial integration of second-round acceding and candidate countries' with the European Union and the US stock markets during the Accession Process. The low pair wise correlations between these markets imply portfolio diversification opportunities, yet correlation is a short-term measure. The long-term stock market interdependence indicates no long-term relationship between the second-round countries and the EU and US stock markets. Granger causality test presents evidence of a casual flow from European and US equity markets to Croatian stock market and from Turkish Stock market to Bulgarian stock market suggesting a short-term lead-lag relationship amongst. The results indicate that the completion of accession negotiations with Bulgaria and Romania and then ongoing negotiations with Croatia and Turkey did not result in the complete financial integration of these markets with the European Union.

4.3 Methodology

To capture the interdependencies, short term lead-lag and long run equilibrium relationship between the stock markets, the present study has used various time series techniques. The time series properties of the sample of 65 stock markets are tested in various aspects. To trace out the short term lead-lag relationships between the stock markets, the present study has under taken Granger causality test. Similarly to identify the interlinkages and long run equilibrium relationships between the stock markets the study has used variance decomposition technique of VAR model, Vector Error Correction Model and Johansen Maximum Likelihood test statistic. Before estimating the models, the unit root properties of the country bench mark indices are tested by using DF, ADF and PP techniques detailed below

Tools of Time Series Analysis:

Testing for stationarity is the first requirement for time series observations before going for estimation. Broadly a time series where mean, variance and covariance are time invariant is said to be stationary i.e. covariance or weakly stationary. The data which do not posses these properties are called non-stationary. A non-stationary process is also called as a unit root process. Moreover, the econometric models using non-stationary data

are likely to violate the desirable statistical properties of the estimators or may give misleading inferences. Thus, it is necessary to test the stationarity of the time series before attempting any econometric exercise.

A simple first order auto regressive process can be expressed by the following equation:

$$Y_t = \alpha_0 + \alpha_1 t + \beta Y_{t-1} + \varepsilon_t \qquad (4.1)$$

Where $\{Y_t\}$ is the stochastic process α_0, α_1 and β are parameters and ε_t is a random disturbance term with white noise properties. α_0 is called drift or constant or intercept. The nature of the time series described in equation (4.1) depends on the values of the parameters. If $\alpha_1 \neq 0$ and $|\beta|<1$, then Y_t follows a deterministic trend. The presence of auto regressive component βY_{t-1} will mean that there may be short run deviations, but the series will return to trend eventually. A series of this sort is known as a trend stationary (TS) process, as the residual from the regression when regressed on time will be stationary. If $\alpha_0 = 0$, $\alpha_1 = 0$ and $\beta = 1$, the series is said to follow a simple random walk, a unit root process. If $\alpha_0 \neq 0$, $\alpha_1 = 0$ and $\beta = 1$, the series is said to follow a random walk, with drift. Any stochastic process, which becomes stationary after differencing once, is called a difference stationary (DS) process. For example, a simple random walk process is a DS process. Likewise, any time series, which becomes stationary after de-trending is called a (trend stationary) TS process.

In time series literature, there are both formal and informal tests of stationarity. The informal tests include time series plots and use of correlogram. Statistical packages use Box-Pierce Q-statistics and L-jung-Box Q-statistics for testing stationarity of series. These two statistics are based on autocorrelation coefficient of several lag lengths. The formal tests of non-stationarity are also known as unit root test or test of random walk series. These include Dickey-Fuller (DF), augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test to check the presence of unit root in the data. These tests are necessary because the usual student's't' test is inappropriate to test the null hypothesis, $\beta = 1$ in equation 4.1.

Dickey- Fuller and Augmented Dickey-Fuller Test

The standard procedure of unit root test uses Dickey-Fuller test, which made the strict and unrealistic assumption of the error process being independently and identically distributed (iid) $(0, \sigma^2)$ Gaussian processes. This DF methodology confines itself to pure Autoregressive Integrated moving Average (ARIMA: 1, 0, 0) processes. Dickey and Fuller (1979) actually consider three different regression equations that can be used to test for the presence of unit root. The first is a pure random walk model, the second adds an intercept/drift term and the third include both a drift and linear time trend. The basic Dickey-Fuller (DF) test examines whether the value of the parameter is one (β=1) in equation 4.1. It means, whether the underlying first order difference equation has a unit root. Assuming the absence of trend term in equation 4.1 and rewriting it in a modified form we get

$$\Delta y_t = \alpha_0 + \delta \; y_{t-1} + \varepsilon_t \qquad (4.2)$$

where, $\Delta y_t = y_t - y_{t-t}$

The null hypothesis is that the $\{y_t\}$ process has a unit root. More generally, if the given time series follows a pth order auto regressive process [AR(p)] or even auto regressive moving average process [ARMA(p, q)] an extended Dickey-Fuller test called Augmented Dickey-Fuller (ADF) test is suggested. Specifically, if the original time series follows AR (p), it can be represented as

$$y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i y_{t-i} + \varepsilon_t \qquad (4.3)$$

After suitable mathematical manipulation, equation 4.3 can be rewritten as,

$$\Delta y_t = \alpha_0 + \delta y_{t-1} + \sum_{i=2}^{p} \gamma_i \Delta y_{t-i+1} + \varepsilon_t \qquad (4.4)$$

where $\delta = -(1 - \sum_{i=1}^{p} \beta_i)$ and $\gamma_i = \sum_{j=i}^{p} \beta_j$

Equation 4.4 is also recommended if the residual sequence $\{\varepsilon_t\}$ in equation 4.2 is not a white noise, for example when ε_t are not auto-correlated. There are different forms of DF

and ADF tests, which are possible by including trend terms in equation 4.2 and 4.4 and also excluding drift term, α_0, from these equations. The DF test is a special case of ADF test when p = 1. To test the significance of δ in equation 4.2 and 4.4, the usual student's't' statistic critical values cannot be used. Initially, Dickey-Fuller and later Mac Kinnon have developed the appropriate test statistic known as τ statistic, and its critical value using Monte Carlo Simulations. The critical values of τ -statistic is made available under alternative assumptions of drift, trend, sample size and level of significance. They are abbreviated as τ (no drift and no trend), τ_α (only drift) and τ_τ (with both drift and trend). Dickey-Fuller have also provided the critical F-test values, known as ϕ_1, ϕ_2 and ϕ_3, for pair wise joint tests of significance for α_0 and α_1. Thus, the null hypothesis that $\delta = 0$ can be rejected if the computed t-value for the coefficient δ is greater than the critical value τ -value in absolute magnitude. It has been shown that the same DF test critical values are valid for the ADF test as well.

Phillips-Perron (PP) Test

An important assumption of the DF test is that the error terms are uncorrelated or independently and identically distributed. The ADF test adjusts the DF test to take care of possible serial correlation in the error terms by adding the lagged difference terms of the regressand. Phillips and Perron use non parametric statistical methods to take care of the serial correlation in the error terms without adding lagged difference terms. Phillips and Perron (1988) developed a generalization of DF procedure that allows for fairly mild assumption concerning the distribution of the errors. The PP test considers two equations:

$$y_t = a_0^* + a_1^* y_{t-1} + \varepsilon_t \qquad \text{..... (4.5)}$$

and $$y_t = \tilde{a}_0 + \tilde{a}_1 y_{t-1} + \tilde{a}_2 (t - \frac{T}{2}) + \varepsilon_t \qquad \text{..... ..... . (4.6)}$$

where T is the number of observation and ε_t is the disturbance term and $E[\varepsilon_t]$=0 for all t. Phillips-Perron device statistics for the regression coefficients under the null hypothesis that the data are generated by

$$y_t = y_{t-1} + \varepsilon_t \qquad \text{..... (4.7)}$$

The PP test can be applied to situations where the assumption of homoscedasticity and independently identically distributed error term may not be valid. Another advantage of PP test is that it can also be applied to frequency domain approach, which is more recent and an alternative to the usual time domain approach, to time series analysis. The PP test has been shown to follow the same critical values as that of DF test, but has greater power to reject the null hypothesis of unit root. However, the PP test seems to be biased towards rejecting the null hypothesis of a unit root, when the error series follows a negative moving average process. In such situations, it is better to use the ADF test, rather than the PP test.

Granger Causality Test

Christopher A. Sims (1972) has developed a practical technique of testing causality in a bi-variate model. According to Sims, one can regress Y on past values and future values of X and if causality runs from X to Y only, future values of X in the regression should have coefficients insignificantly different from zero. To explain the Granger test, let us consider two variables GDP and exports (X). The test assumes that the information relevant to the prediction of the respective variables, GDP and X is contained solely in the time series data on these variables. The test involves the estimation of following pair of regression.

$$GDP_t = \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{n} \beta_j GDP_{t-j} + \varepsilon_{1t} \qquad \ldots \ldots \ldots \ldots (4.8)$$

$$X_t = \sum_{i=1}^{n} \lambda_i X_{t-i} + \sum_{j=1}^{n} \delta_j GDP_{t-j} + \varepsilon_{2t} \qquad \ldots \ldots \ldots \ldots (4.9)$$

where, it is assumed that the disturbances ε_{1t} and ε_{2t} are uncorrelated. Equation (4.8) postulates that current GDP is related to the past values of itself as well as that of X (exports) and equation (4.9) postulates a similar behavior for X, i.e. exports.

Causality can be unidirectional or bidirectional:

Case I: Unidirectional causality from X to GDP is indicated if the estimated coefficients on the lagged X in equation (4.8) are statistically different from zero as a group

(i.e. $\sum \alpha_i \neq 0$) and the set of estimated coefficients on the lagged GDP in equation (4.9) is not statistically different from zero (i e. $\sum \delta_j = 0$)

Case II: Conversely, unidirectional causality from GDP to X exists if the set of lagged X coefficients in equation (4.8) is not statistically different from zero (i.e. $\sum \alpha_i = 0$) and the set of lagged coefficients of GDP in equation (4.9) is statistically different from zero (i.e. $\sum \delta_i \neq 0$).

Case III: When the sets of X and GDP coefficients are statistically significantly different from zero in both regression, it is called bilateral causality. And if not then the variables are independent or have no causality.

More generally, since the future cannot predict the past (in a two variable case X and Y) if X Granger causes Y, then change in X should precede changes in Y. Therefore, in a regression of Y on other variables (including its own past values) if we include past or lagged values of X and it significantly improves the prediction of Y, then we say that X Granger causes Y. The Granger causality test involves the following steps taking GDP and Exports as variables for illustration. First, regress current GDP on all lagged GDP terms and not including lagged values of X variable. From this obtain the restricted residual of squares (RSS_R). Second, run the regression including the lagged values of X. From this we obtain the unrestricted residual sum of squares (RSS^{UR}). The null hypothesis is H_0: $\sum \alpha_i = 0$. To test this hypothesis we apply F-test.

$$F = \frac{(RSS_R - RSS_{UR})/m}{RSS_{UR}/n-k}$$

Here, m is number of lagged X terms and k is number of parameters estimated in unrestricted regression. If the computed value exceeds the critical value of F at chosen level of significance, we reject the null hypothesis. This is what we can say X causes GDP. The assumption of stationarity for GDP and X should be satisfied. The number of

lagged term should be introduced in the causality tests by using Akaike or Schwarz information criterion (AIC) or (SIC).

Vector Autoregression (VAR) model:

In single equation time series framework, it is possible to study the effect of a shock, contemporaneous or time dependent, in an exogenous variable using intervention and transfer function analysis respectively. Sometimes, the relationship between variables in a dynamic system cannot be represented in a single equation time series model. Further, when we are not confident that a variable is truly exogenous, a natural extension of transfer function analysis is to treat each variable symmetrically. This can be explained with the help of a simple example. Following Enders (1995), let the time path of consumption expenditure (c_t) be affected linearly by the current and past realizations of income (y_t) and vice-versa. This implies the following simple bivariate system between these variables:

$$c_t = b_{10} - b_{12} y_t + \alpha_{11} c_{t-1} + \alpha_{12} y_{t-1} + \varepsilon_{ct} \qquad (4.10)$$

$$y_t = b_{20} - b_{21} c_t + \alpha_{21} c_{t-1} + \alpha_{22} y_{t-1} + \varepsilon_{yt} \qquad (4.11)$$

It is assumed that both c_t and y_t are stationary and the error terms, ε_{ct} and ε_{yt} satisfy the OLS assumptions (white noise properties). The above two equations (4.10) and (4.11) constitute a first order vector auto regression (VAR) because the longest lag length is unity. Such a system is also known as a 'structural' or 'primitive' VAR. This simple two variable first-order VAR is useful for illustrative purpose and can be generalized to a multivariate higher-order system Here the structure of the model incorporates feedback effects since (c_t) and (y_t) are allowed to affect each other. Hence ε_{ct} has an indirect contemporaneous effect on y_t and ε_{yt} has an indirect contemporaneous effect on ct due to the feedback inherent in the system. The reduced form of the above system can be written as:

$$c_t = a_{10} + a_{11} c_{t-1} + a_{12} y_{t-1} + e_{ct}. \qquad (4.12)$$

$$y_t = a_{20} + a_{21} c_{t-1} + a_{22} y_{t-1} + e_{yt}. \qquad (4.13)$$

Where $a_{10} = \frac{b_{10} - b_{12}b_{20}}{1 - b_{12}b_{21}}$. $a_{11} = \frac{\alpha_{11} - b_{12}\alpha_{21}}{1 - b_{12}b_{21}}$. $a_{12} = \frac{\alpha_{12} - b_{12}\alpha_{22}}{1 - b_{12}b_{21}}$

$a_{20} = \frac{b_{20} - b_{21}b_{10}}{1 - b_{21}b_{12}}$. $a_{21} = \frac{\alpha_{21} - b_{21}\alpha_{11}}{1 - b_{21}b_{12}}$. $a_{22} = \frac{\alpha_{22} - b_{21}\alpha_{12}}{1 - b_{21}b_{12}}$

$e_{ct} = \frac{\varepsilon_{ct} - b_{12}\varepsilon_{yt}}{1 - b_{12}b_{21}}$ and $e_{yt} = \frac{\varepsilon_{yt} - b_{21}\varepsilon_{ct}}{1 - b_{21}b_{12}}$

In contrast to the system in equations (4.10) and (4.11), the reduced form model in equations (4.12) and (4.13) is called the 'standard' VAR or simply the VAR model. Since ε_{ct} and ε_{yt} are white-noise processes, it follows that e_{ct} and e_{yt} have zero mean, constant variance and are individually serially uncorrelated. Clearly, there is the well known identification problem in the sense that the coefficients of the structural VAR (10 in number, including the 2 variances of ε_{ct} and ε_{yt}) cannot be obtained from the coefficients of the standard VAR (only 9 in number, including the 2 variances and 1 covariance of e_{ct} and e_{yt}) without imposing identifying restrictions on the parameters of the structural VAR and error variance-covariance terms. To identify both the structural equations, at least two zero restrictions are needed on the parameters of the structural VAR. If one is not interested in the structural model, one may specify and estimate only the standard VAR. This option may be alright for say impulse response, variance decomposition and forecasting purposes, as in the study But, one cannot retrieve the structural model.

Sometimes, it may be necessary to include more than just one lag of the variables in the model. With 'p' lags included, a more general reduced form will be of the following form:

$$c_t = \gamma_1 + \phi_1 c_{t-1} + \ldots + \phi_p c_{t-p} + \varphi_1 y_{t-1} + \ldots + \varphi_p y_{t-p} + \varepsilon_{ct} \tag{4.14}$$

$$y_t = \gamma_2 + r_1 c_{t-1} + \ldots + r_p c_{t-p} + \delta_1 y_{t-1} + \ldots + \delta_p y_{t-p} + \varepsilon_{yt} \tag{4.15}$$

Writing the above equations (4.14) and (4.15) in vector and matrix notation, we get

$$Y_t = V + A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + U_t \tag{4.16}$$

where, $Y_t = \begin{bmatrix} c_t \\ y_t \end{bmatrix}$ $\qquad V = \begin{bmatrix} \gamma_1 \\ \gamma_2 \end{bmatrix}$

$A_1 = \begin{bmatrix} \theta_t & \varphi_t \\ r_t & \delta_t \end{bmatrix}$ $\qquad U_t = \begin{bmatrix} \varepsilon_{ct} \\ \varepsilon_{yt} \end{bmatrix}$

The process in equation (4.16) looks like an autoregressive process, but the variables in the equations, Y_t, V, A_1, Y_{t-1}, U_t are all in a vector form. So this is known as vector autoregressive (VAR) model of order p and this is a bivariate system. Similarly, a system of 'm' variables can be also written as:

$$Y_t = V + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots\ldots + A_p Y_{t-p} + U_t$$

where, $Y_t = (y_{1t}, y_{2t} \ldots\ldots, y_{mt})^T$

$$V = (\gamma_1, \gamma_2, \gamma_3, \ldots\ldots\ldots\ldots \gamma_m)^T$$

$$U_t = (\varepsilon_{1t}, \varepsilon_{2t}, \ldots \ , \varepsilon_{mt})^T$$

$$A_1 = \begin{bmatrix} \theta_{11,t} \ldots\ldots\ldots\ldots\ldots\ldots \theta_{1m,t} \\ \\ \theta_{m1,t} \ldots\ldots\ldots\ldots \ldots\ldots \theta_{mm,t} \end{bmatrix}$$

And $t = 1, 2, 3, 4, \ldots\ldots\ldots\ldots, p$. U_t has the same stochastic properties as the reduced form error in the system of dynamic equation.

Variance Decomposition

While impulse response function traces the effects of a shock of an endogenous variable on all the variables in the system, the variance decomposition splits the variation in an endogenous variable into the component shocks to the endogenous variables in the

VAR system. It gives information about the relative importance of each random innovation in the system.

Consider the standard VAR given in (4.12) and (4.13), re-written as:

$$x_t = A_0 + A_1 x_{t-1} + e_t$$

where, $x_t = \begin{bmatrix} c_t \\ y_t \end{bmatrix}$ $\quad A_0 = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix}$

$$A_1 = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \quad e_t = \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}$$

Now, suppose the coefficients in A_0 and A_1 are known and we want to forecast the values of x_{t+1} conditional on the observed values of x_t. Updating the above equation by one period ahead, as

$$x_{t+1} = A_0 + A_1 x_t + e_{t+1}$$

The conditional expectation of x_{t+1} at time t given the value of x_t is

$$E_t[x_{t+1}] = A_0 + A_1 x_t$$

Hence, the one-step ahead forecast error of x_t is

$$x_{t+1} - E_t[x_{t+1}] = e_{t+1}$$

Similarly, the two-step ahead forecast of x_t

$$x_{t+2} = A_0 + A_1 x_{t+1} + e_{t+2}$$

$$= A_0 + A_1(A_0 + A_1 x_t + e_{t+1}) + e_{t+2}$$

$$= (I + A_1) A_0 + A_1^2 x_t + A_1 e_{t+1} + e_{t+2}$$

$$E_t[x_{t+2}] = (I + A_1) A_0 + A_1^2 x_t$$

The two-step ahead forecast error is

$$x_{t+2} - E_t[x_{t+2}] = e_{t+2} + A_1 e_{t+1}$$

More generally, for the n-step ahead forecast, the conditional expectation is

$$E_t[x_{t+n}] = (I + A_1 + A_1^2 + \ldots + A_1^{n-1}) A_0 + A_1^n x_t$$

Hence, the associated forecast error is:

$$x_{t+n} - E_t[x_{t+n}] = e_{t+n} + A_1 e_{t+n-1} + A_1^2 e_{t+n-2} + \ldots + A_1^{n-1} e_{t+1}$$

The forecast error variance decomposition tells the proportions of the movements in a sequence due to its own shock versus shocks to other variables. Going back to our previous income consumption model, suppose ε_{yt} shocks explain none of the forecast error variance of ε_{ct} at all forecast horizons, then it can be said that (c_t) sequence is exogenous. In such a circumstance, the (c_t) sequence would evolve independently of the ε_{yt} shocks and of (y_t) sequence. On the other hand, if ε_{yt} shocks explain all the forecast error variance in (c_t) sequence at all forecast horizons, then (c_t) will be entirely endogenous.

Choice of Lag Length

Selection of lag length for the VAR model is the next important step. In principle, it is possible to have different lag lengths for different variables both within and across equations. If there are good reasons to do this, one can specify and estimate such a model called the 'near' VAR. The seemingly unrelated regression estimation (SURE) method can be used to get efficient VAR estimates. On the other hand, if all the variables in the VAR model have the same lag length, then the model will be symmetric and can be estimated using ordinary least square (OLS) method. The OLS estimators then will be consistent and asymptotically efficient. Further, in a VAR model, fewer lags are preferred because higher lag length for any variable implies more parameters to be estimated and less degrees of freedom. Thus, it would be convenient to use the optimal and same lag length for all equations. There are various alternative criterions that can be used for selecting the optimal lag length. Hsiao (1981) has developed a systematic autoregressive

method for choosing appropriate lag length. According to him, the appropriate lag length is one where the Akaike's Final Prediction Error (FPE) is lowest. Other criteria such as Akaike information criterion (AIC), Schwarz criterion (SC), Likelihood Ratio (LR) criterion and Hannan-Quinn information criterion (HQ) are also useful for choosing the lag length. Computer packages like EViews have such a provision.

The Cointegration Test

The long run equilibrium relationship between the variables can be detected through cointegration technique. When the variables contain a unit root, cointegration technique of time series is used to establish a long run relationship among them. In general, if two or more variables are integrated of the same order and their linear combination is found to be stationary then the two variables are said to be co-integrated. A principal feature of co integrated variables is that their time paths are influenced by any deviations from long run equilibrium relationship. If the system returns to equilibrium then movement of some variables must respond to the magnitude of disequilibrium. This dynamics is implied by the error correction model, which shows the degree of adjustment of short run deviation from equilibrium. If two variables are cointegrated then the result of their causality will not give valid conclusion. Thus, error correction technique is used. The study of cointegration uses two methods namely Engel-Granger (1987) and Johansen (1988) Maximum Likelihood Procedure Though the present study undertakes multivariate analysis, it has used Johansen Maximum Likelihood Procedure to identify the long run equilibrium relationships between the variables, which is discussed below.

Johansen Maximum Likelihood and Vector Error Correction Model:

Engel-Granger procedure will have problem if there is more than one cointegrating vector in a vector of variables. If the number of variables exceeds two it becomes impossible to use it. So, in a multivariate system, Johansen (1988) Maximum Likelihood procedure is the appropriate method to test the cointegration among a vector of variables. This procedure estimates cointegrating relationships in a system of equation. Thus it makes use of all the available information in the long run and short run fluctuations of each variable and allows for testing of more than one cointegrating vector.

Like Engel-Granger technique, it requires the variables to be integrated of the same order. Although it can detect the difference orders of integration, it is wise not to mix variables of different orders. The second important requirement is selection of lag length as Johansen procedure is quite sensitive to the choice of lag length like Likelihood Ratio or multivariate generalization of the AIC or SBC.

The Johansen test for cointegration begins by considering the unrestricted reduced form of a system of variables, which by assumption can be represented as a finite order Vector Auto Regression (VAR) model.

$$x_t = A_1 x_{t-1} + A_2 x_{t-2} + .. + A_p x_{t-p} + \varepsilon_t \qquad \ldots\ldots\ldots\ldots (4.17)$$

where, $x_t = (n \times 1)$ vector $(x_{1t}, x_{2t}, \ldots, x_{nt})$

$A_t = (n \times n)$ matrix of parameters

$\varepsilon_t =$ is an independently and identically distributed n-dimensional vector with mean 0 and variance Σ_ε

The equation (4.17) can be reformulated as follows

$$\Delta x_t = \sum_{i=1}^{p-1} \Pi_i \Delta x_{t-i} + \Pi x_{t-p} + \varepsilon_t \qquad \ldots\ldots\ldots\ldots (4.18)$$

where, $\Pi = -\ [I - \sum_{i=1}^{p} A_i]$

$$\Pi_i = -\ [I - \sum_{j=1}^{i} A_j]$$

I = (n×n) identity matrix

The equation (4.18) contains information on both the short run and long run adjustment to change in x_t via the estimate of Π_i and Π respectively. Πx_{t-p} in equation 4.18 is the error correction factor. As in Johansen (1988), in order to test restrictions on the cointegrating vector, Johansen defines the two matrices α and β, both of

dimensions $(n \times r)$, where r is the rank of Π. The properties of α and β are such that $\Pi = \alpha\beta$. Hence equation 4.18 can be rewritten as, $\Delta x_t = \sum_{i=1}^{p-1} \Pi_i \Delta x_{t-i} + \alpha\beta\, x_{t-p} + \varepsilon_t$. The matrix β is the matrix of cointegrating parameters and the matrix α is the matrix of weights with each cointegrating vector enters the n equations of the VAR. In a sense, α can be viewed as the matrix of the speed of adjustment parameter. Due to the cross equation restrictions, it is not possible to estimate α and β using OLS. However, with maximum likelihood estimates, it is possible to estimate equation 4.17 as an error correction model, determine the rank of Π and use the r most significant cointegrating vectors to form β'.

In the equation (4.18), the rank of Π is equal to the number of independent co integrating vectors. If rank (Π) = 0, the matrix is null, and there is no cointegration among the set of n variables. It means there is no linear combination of variables that is stationary. Hence, the equation (4.18) will become a usual VAR model in first differences. If rank (Π) = n, the vector process is stationary. And if rank (Π) =1. There is a single co integrating vector and the term Πx_{t-p} is the error correction factor. For the other cases in which 1< rank (Π) < n, there are multiple cointegrating vectors.

The number of distinct cointegrating vectors can be obtained by checking the significance of the characteristic roots of Π. The number of cointegrating vector is equal to the rank of the matrix Π and the rank of matrix is equal to the number of characteristic roots that are different from zero. The Johansen methodology allows determining the number of characteristic roots that are statistically different from zero. If the variables in x_t are not co integrated, the rank of Π is zero and all the characteristic roots (λ_t) will be equal to zero. In practice, we can obtain only estimates of Π and the characteristic roots. The test for the number of characteristic roots that are significantly different from unity can be conducted using the following two test statistics.

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1-\hat{\lambda}_i)$$

$$\lambda_{\max}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1})$$

where, $\hat{\lambda}_i$ = estimated value of characteristic root obtained from the estimated Π matrix

T = no. of usable observation

r = no. of cointegrating vectors

When the appropriate values of r are clear, these statistics are simply referred to as λ_{trace} and $\lambda_{\max}$. The first test statistic tests the number of distinct cointegrating vectors is less than or equal to r against a general alternative. Thus, $\lambda_{trace} = 0$ when all $\lambda_i = 0$. The second test statistic tests the hypothesis that the number of co integrating vectors is r against the alternative of r +1 co integrating vectors. Johansen and Juselius (1990) provide the critical values of λ_{trace} and $\lambda_{\max}$ statistics The estimated values of the above two statistics are compared with the Johansen and Juselius critical value to determine the number of cointegrating vectors exist among the variables. This procedure allows for testing of restricted forms of the co integrating vectors. Restriction can be imposed on the co-integrating vectors or on adjustment coefficients, and accordingly conclude whether restrictions are binding or not by using a statistic proposed by Johansen.

If the test statistics indicate that one cointegrating vector exists, Maximum Likelihood estimates of this vector are given by the first column of β. Hence, the VECM representation which is equivalent to equation (4.18) is given by:

$$\Delta x_t = \sum_{t=1}^{p-1} \prod_i \Delta x_{t-i} + \alpha\, ecm_{t-1} + \varepsilon_t \quad \ldots\ldots\ \ldots\ldots\ \ldots\ \ldots \ (4.19)$$

where, $ecm_{t-1} = \beta x_{t-1}$

$\beta = [\beta_1 \ldots\ldots \beta_n]$

Again if test indicates that two cointegrating vectors exist, then the first two columns of β. is the maximum likelihood estimate of these vectors and VECM is given by:

$$\Delta x_t = \sum_{i=1}^{p-1} \prod_i \Delta x_{t-i} + \alpha_1 ecm_{1t-1} + \alpha_2 ecm_{2t-1} + \varepsilon_t \qquad \text{..... (4.20)}$$

Here, α_1 and α_2 represent the effects of the stationary linear combination of ecm_1 and ecm_2 on the system, otherwise they are called as speed of adjustment parameters. The VECM can be used to test Granger causality among the vectors of variables, by testing the statistical significance of adjustment coefficients and coefficients of the lagged explanatory variables.

4.4 Nature and Data Sources:

The country benchmark index is used as the representative of stock market of the respective countries. We have taken weekly index series and the data period is spanning from 2nd week of August 1995 to 4th week of December 2006, i.e. 594 observations. In order to capture the interlinkages of individual country's stock market with world market, the present study has used Morgan Stanley Capital International (MSCI) index as the representative of world stock market. Log transformation of the indices is taken into consideration to make the series smooth. The indices are collected from Bloomberg. The Descriptions about the country benchmark indices are presented in Appendix A at the last of the thesis.

4.5 Region Wise Analysis

The country bench mark indices are used as the representative of the respective stock markets. The log transformation has been undertaken to make the series smooth. The techniques like correlation coefficient, pair wise granger causality, innovation accounting technique of VAR, Johansen Maximum Likelihood and Vector Error Correction Model has been used to trace out different time series properties of the stock market, the interlinking and long run equilibrium relations between the stock markets across those countries. The stock markets of these regions are explained briefly below.

The unit root properties of the stock market indices are captured by DF, ADF & PP techniques of time series. Methodologically DF includes only one period lag and ADF includes more than one period lag to capture significant past lagged influence. But there

is a chance that unit root property identified by ADF is biased by auto correlation. Overcoming this Phillips and Perron developed the model which captures the unit root properties of the time series unbiased by autocorrelation.

The present study has used pair wise Granger causality to trace out the direction of causality which can reflect the short term lead-lag relationships within the stock markets. In the next attempt, to trace out the dynamic interlinkages between the stock markets, the study has used Variance decomposition technique of VAR model. The optimum lag length for the VAR model has been identified by using 5 lag selection criteria such as LR, FPE, SC, AFC & HQ models. The long run equilibrium relationships and correction of short run error has been estimated through Johansen Maximum likelihood estimation techniques. Models are under taken region wise and the results are discussed below.

4.5.1 North America

(a) Unit Root Property Test

In the North America Region, the unit root properties of the 4 countries' stock market indices are captured by DF, ADF & PP test and are presented in Table 4.1.I and II. Table 4.1.I & Table 4.1 II present the estimated τ-statistic at level and 1st differences respectively. Optimum lag length has been taken for ADF and PP unit root test to get white noise errors. The optimum lag vales are presented in the paranthis adjacent to the ADF and PP critical values in the unit root tables. From the table it has been observed that all the four indices of North America Region are having unit root problems at level and are stationary at 1st difference.

(b) Pair Wise Granger Causality Test

The estimated Granger causality statistics are presented in Table 4 2. Please note that the table presents only the significant statistics. The insignificant statistics are presented in appendix IV, presented at end of chapter IV. Granger causality test identifies existence of bi-directional causality between the stock markets of Canada & Bermuda and USA & Bermuda. The null hypothesis of no causality is rejected at 1% and 5% level

showing the existence of a short term lead-lag relationships between these stock markets. At the same time there lies uni-directional causality between Mexico & Bermuda stock market. Stock market of Mexico influences stock market of Bermuda but Bermuda stock market doesn't Granger cause Mexico. Bermuda is also causally influenced by world stock market i.e. MSCI. Between Canada & world market, world market Granger causes Canada stock market but Canada doesn't cause world market Hence, there lies one way causality effects between these stock markets. Similarly, Canada and Mexico stock market Granger causes USA but USA doesn't Granger cause Canada and Mexico. At the same time, USA doesn't Granger cause MSCI but influenced by world market presented by MSCI by rejecting the null hypothesis at 1% level. Uni directional causality reflects the causal impact of one market to another but never finds any feedback effect.

(c) Variance Decomposition

This innovation accounting technique of vector Autoregressive (VAR) has been used to identify the dynamic interactions between the stock markets of North America Region. The optimum lag length for the VAR model has been identified by using 5 lag selection criteria such as LR, FPE, SC, AFC & HQ models and majority of these criterions has selected 2 as the optimum lag order for VAR model. The variance decomposition of VAR model is presented in the Table 4.3. The model has been optimized for future 10 periods and a random selection of 1, 2, 5 & 10 period values are been presented in the referred table.

The estimated result shows that Bermuda stock market explains its own foecast error vomiance by 100% in 1st period then 98.5%, 96% and 92% in 2nd, 5th, & 10th period ahead respectively. This implies that Bermuda explains majorly its own forecast error variance and left few to be explained by other stock markets of the Region. Comparatively Canada stock market explains Bermuda better than the rest of the stock market of the North America Region but in some time gap i.e 5 & 10th periods ahead. Similarly Canada explains its own forecast error variance by 90% i.e. 97%, 95.5%, 94% & 90% in 1st, 2nd, & 5th & 10th period ahead respectively. Hence little explanatory power is left for other stock markets of the region to explain Canada stock market. Mexico explains 2% to 6% of forecast error variance of Canada but at 5th and 10th period ahead

after Bermuda stock market that explains some forecast error variances of Canada. In case of Mexico, it explains 70-75% of its own forecast error variance and left much to be explained by the stock markets of the region. Stock market of Canada explains the forecast error variance of Mexico by 26%, 27%, 26% & 24% at 1st, 2nd, 5th & 10th period ahead showing strong interdependences between these two stock markets. Coming to world market, it is found that MSCI explains its own forecast error variance by less that 40% in over the period of 10%. Rest of the forecast error variance is explained by Canada explaining nearly 50% Mexico explains around 10% and Bermuda explains about 2% forecast error variance of MSCI. This implies MSCI is dynamically interlinked with the stock markets of Canada, Mexico and Bermuda. USA stock market hardly explains any forecast error variance in MSCI index. But MSCI explains 17%, 21%, 25% & 26.5% forecast error variance of USA stock market where as USA explains 75% of its own forecast error variance in 1st period and 48%,40% & 37% in 2nd, 5th, & 10th period ahead respectively. Canada also explains approximately 30% of the forecast error variance of USA but in 2nd, 5th & 10th period ahead. In 1st period Canada explains 7%. Mexico contributes 3.8%, 4.8% & 6% in 2nd, 5th & 10th period ahead to the forecast error variance of USA. Hence USA stock market is found to be well interlinked with Mexico, MSCI and Canada stock market. Looking at all the stock markets of North America, USA, Mexico and MSCI is found to be well interlinked within the region where as stock market of Bermuda and Canada is less interlinked within the region.

(d) Vector Error Correction Model:

The vector error correction model has been estimated and the results are presented in Table 4.4. The results support that the error correction term (ECT) is significant for Bermuda, Mexico, MSCI & USA stock market. The ECT for Bermuda stock market is found to be significantly contributed by the short-run lagged differences of MSCI only. Similarly, the error correction term (ECT) of Mexico is significantly contributed by short-run lagged differences of Canada, MSCI and USA. The ECT of USA is significantly contributed by the Bermuda, Canada, and MSCI. Looking at the world stock market i.e. MSCI, the ECT is significantly influenced by Canada and USA stock market This shows short term dynamism between these stock markets.

(e) Johansen Maximum Likelihood

In order to capture the long-run equilibrium relationship between the stock markets of North America, the present study uses Johansen maximum likelihood estimate which is otherwise known as JJ multivariate cointegration techniques. The estimated λ-trace statistics & λ max trace statistics are presented in the Table 4.5. The estimated results of λ- trace suggest that there exist only one co-integrating vector between the stock markets of North America region i.e. λ-trace statistics identifies only 1 cointegrating equation at 5% level and λ max eigen value test indicates only 1 cointegrating equation at 5% level. None of the results of λ trace & λ max is able to reject the null hypothesis either at 1% probability level Out of four maximum cointegrating vectors within the region, only one cointegrating vector is found to be statistically significant by rejecting the null hypothesis of r = 0 again the alternative hypothesis of r > 0 and r = 1.

4.5.2 South & Central America

In South & Central America Region, we have considered 7 countries stock markets. The results are presented in Table 4.6 to Table 4.10. The time series properties & estimated results of different models are explained below.

(a) Unit Root Property Test

The unit root results are presented in Table 4.6.I and II. Table 4.6.I Present estimated ι-statistics in level and Table 4.6.II contains the estimated ι statistics in 1st differences. It has been observed that none of the stock markets are stationary at level. In other words all the country bench mark indices non stationary at level. The optimum lags length for ADF & PP that are taken to get white noise residuals. But the null hypothesis of unit root has been rejected at 1% level in 1st difference of the series Hence, the stock indices are used in 1st difference as well as in level as per mythological requirements

(b) Pair wise Granger Causality Test

The estimated results of pair wise Granger causality is presented in Table 4.7. Please note that only significant results are given in the table. It has been observed that

there lies a unidirectional causality between the stock markets of Argentina & Brazil. Argentina Granger causes Brazil stock market but Brazil doesn't Granger causes Argentina. Similar is the case of Argentina with Chile, Colombia, Peru & Venezuela. Argentina stock market Granger causes Chile but Chile does not Granger case Argentina. On the other hand Colombia Granger causes Argentina, but Argentina doesn't cause Colombia. Between Peru & Argentina, Argentina Granger causes Peru but not on the other way round. Similar is the case between Argentina & Venezuela. The uni-directional causation also exists between Brazil & Chile, Colombia & Brazil and MSCI with Brazil. Brazil Granger causes Chile but Chile doesn't Granger cause Brazil. At the sometime, Colombia Granger causes Brazil but Brazil doesn't Granger cause Colombia. There lies no cause & effect relationship between Brazil & Costa Rica. There lies no causality between Stock market of "Brazil & Venezuela", "Chile & Colombia", "Chile & Costa Rica", "Chile & Venezuela", "Colombia & Costa Rica", "Colombia & Venezuela", "MSCI & Costa Rica", Peru & Costa Rica", as well as between "Costa Rica & Venezuela". On these cases the null hypothesis of one stock market does not Granger cause another can't been rejected either in 1% and or 5% level. But Chile stock market is somewhat related to world market in one way as MSCI Granger causes Chile, but Chile doesn't Granger cause MSCI. The one directional causality never shows any feedback relationships between the stock markets The bi-directional Granger causality exists between stock markets of "Peru & Chile", "Peru & Brazil" as well as between "Colombia & MSCI". The bi-directional causality shows short term lead-lag relationships between stock markets of these countries.

(c) Variance Decomposition

Estimated variance decomposition statistics for the stock markets of South and Central America region are presented in Table 4.8 The VAR model is solved with an optimum lag of 2 periods and forecast error variance of the optimal model is decomposed in 10 periods ahead. It has been observed that Argentina explains almost all of its own forecast error variance and left hardly anything to be explained by other stock markets of the region. In 1st period Argentina explains by 100% of its own forecast error variance and in 2rd, 5th, & 10th period ahead it explains 98.4%, 97.6% & 97.6% of its own forecast

error variances respectively. Coming to Brazil stock market it explains its own forecast error variance by 99% in 1st period, but explains 65%, 61% & 61% in 2nd, 5th & 10th period ahead leaving more to be explained by other stock markets of the region. Argentina explains around 20% of forecast error variance of Brazil in 2nd, 5th, & 10th period ahead. The remaining stock markets of the region are contributing very less to the forecast error variance of Brazil. But MSCI explains a considerable part i.e. 13.86%, 14.28% and 14.28% in 2nd, 5th & 10th period ahead. Chile explains its own forecast error variance by 91.6%, 70.87%, 66.8% & 66.74% in 1st, 2nd, 5th &10 periods ahead respectively. Stock market of Argentina, Brazil & MSCI explain a considerable part of forecast error variance of Chile showing interlinkages between these stock markets. Peru is also able to explain some fractions of Chile stock market Hence, stock market of Chile seems to be quite interlinked with the stock markets of its own region as well as world market. Colombia stock market explains most of its own forecast error variance & left very small forecast error variance to be explained by the stock markets of the region. It means, Colombia stock market sounds to be least interlinked with the stock markets of South and Central America Region. Similar is the case of Costa Rica stock market which is also least explained by the stockmarkets at the region as well as world market Coming to MSCI (world index), it explains its own forecast error by 83%,79%,78% & 78.35% in 1st,2nd,5th & 10th period respectively. It explains majority of its own forecast error variances. Argentina explains approximately 15% forecast error variance of world index (MSCI). Looking at Peru, it explains its own forecast error variance by 70 to 80%. Argentina explains 11% to 15% of the forecast error variance of Peru in 1 to 10 periods ahead. MSCI also explains stock market of Peru next to Argentina. Coming to Venezuela, it explains 85% to 95% of its own forecast error Stock market of Argentina explains 5.5% to 6 7% forecast error variance of Venezuela in 2nd to 10th period ahead. Brazil continuously explains around 3% of Venezuela's forecast error variance in 1st to 10th period ahead. Venezuela is seems to be dynamically interlinked with stock market of Argentina and Brazil of its region. Among all the stock markets of the region Argentina, Brazil and Chile stock markets are found to be dynamically interlinked within the region. These stock markets are also found to be interlinked with world market presented my MSCI index.

(d) Vector Error Correction Model (VECM):

The results of VECM model is presented in Table 4.9. It has been observed that the error corrections (ECTs) are significant for Argentina, Brazil, Chile, MSCI and Venezuela. The error correction terms for Colombia, Costa Rica and Peru are not significant. A significant error correction term implies that the short run disequilibrium in these markets can be corrected by the significant contribution of individual stock markets of the region. Analyzing it in country wise, the ECT of Argentina stock market is significantly contributed by lag difference values of Brazil & MSCI. In case of Brazil stock market, the significant ECT is significantly explained by lagged difference values of stock markets of Argentina, Colombia, Venezuela and MSCI. The short term errors in Chile stock market is significantly corrected by lagged differences of Brazil, Peru and Venezuela stock market. There is no significant contribution of world stock market. The short term error correction is insignificant for the stock markets of Columbia, Costa Rica & Peru. But the ECT of Venezuela stock market is significantly explained by lagged differences of Argentina, Brazil Costa Rica stock market and MSCI. In lagged independent variables, world stock market (MSCI) is significantly explaining ECTs of Argentina, Brazil, Costa Rica & Venezuela stock market. This shows the short term dynamism of these stock markets with world market. Stock markets of Argentina, Brazil Chile and Venezuela are found to be dynamically interlinked within themselves within the region.

(e) Johansen Maximum Likelihood Test:

In order to identify the long run equilibrium relationships between the stock markets of the South & Central America Region, the present study uses Johansen Maximum Likelihood technique. The estimated statistics are presented in Table 4.10 Out of eight indices including MSCI, λ trace statistics indicates four cointegrating vectors at 5% level and three cointegrating vector at 1 % level But λ max eigen value indicates only one cointegrating equation at both 5% & 1%level. This shows existence of long run equilibrium relationships between the stock markets of the region. The long run relationships also found to exist between world index represented by MSCI index and the stock markets of South and Central America Region.

4.5.3 South Asia

In South Asia Region we have considered stock markets of four countries. The bench mark index of each country is used as the representatives of their stock markets and MSCI index has been taken as proxy for world market to identify the integration of individual stock markets of the region with world market

(a) Unit root Property Test

The unit root properties of the country bench mark indices of stock markets are presented in Table 4.11.I and II. Tables contain the estimated τ- statistics of unit root test at level & 1st differences respectively Looking at the values of estimated τ-statistics, it has been clear that all the four indices have unit root problems and none of the null hypothesis of unit root gets rejected either at 1st or 5% in level. But in 1st differences the null hypothesis of unit root gets rejected at 1% level of probability. Hence the indices are being used in 1st difference as well as in level as per the methodological requirements of the subsequent models.

(b) Pair wise Granger Causality Test

To capture the cause & effect relationships between the stock market at South Asia Region, the study uses pair wise Granger causality test of the stock markets and the results are presented in Table 4.12. Analyzing the results, it has been found that there lies bivariate Granger causality between Indian & world stock market. The null hypothesis of India doesn't Granger cause MSCI is rejected at 1% level and MSCI doesn't Granger cause India is rejected at 5% level. This shows existence of short term lead-lag relationships between Indian stock market and world market. But there lies uni-directional Granger causality between Indian stock market & the stock market of Pakistan. India Granger causes Pakistan stock market but Pakistan stock market doesn't Granger cause Indian stock market. Similarly India Granger causes Sri Lanka stock market but Sri Lanka stock market doesn't Granger cause India. The one way causality shows no feedback response of Pakistan and Sri Lanka stock markets on Indian market. But Pakistan & world stock market Granger causes each other & world stock market (MSCI) Granger causes Sri Lanka but not another way around. For rest of the pairs of our

model the null hypothesis of no causality could not be rejected between stock markets of the countries like "India & Bangladesh", "MSCI & Bangladesh", "Pakistan & Bangladesh" as well as "Sri Lanka & Bangladesh" stock market. Hence shows no cause effect relationships between these stock markets.

(c) Variance Decomposition

The VAR model for the stock markets of South Asia Region has been solved for an optimum lag length of 3 detected by FPE, AIC and HQ out of the five criteria mentioned above and variance decomposition has been estimated for 10 periods ahead. The selected results for 1st, 2nd, 5th & 10th period ahead are presented in the Table 4.13. It has been observed that the forecast error variance of Bangladesh stock exchange market is hardly explained by the other stock markets of the region. Bangladesh stock market explains 100% of its own forecast error variance in 1st period ahead and explains more than 99% in rest of the periods, hence leaves very less to be explained by other stock markets of the region. Coming to Indian stock markets, it explains 99.8%, 97.7%,97% & 97% in 1st, 2nd, 3rd & 10th period ahead and leaves very less to be explained by other stock markets of the region. MSCI (world market) explains some forecast error variances of Indian market like 1.15%, 1.17% & 1.17% in 2nd, 5th, 10th period ahead respectively. Hence Indian stock market can be influenced with the movements of work financial market but nit substantially. Moving to Pakistan stock market, it explains its own forecast error variance by 98%, 94%. 91 6%, & 91.6% in 1st, 2nd, 5th & 10th period ahead respectively. Indian stock market explains 1 2%, 5.19%, 7.75%, & 7.75% of forecast error variances of Pakistan stock market in 1st, 2nd, 5th & 10th period ahead Hence Pakistan stock market is interlinked with India stock market where Indian market influences Pakistan stock market. One thing that has been observed that Indian stock market explains Pakistan more from 2nd period onwards i.e there exist some lag influences. Other stock markets of the region are hardly linked with Pakistan market Moving to Sri Lanka stock market, it explains almost all of its own forecast error variance around 95% to 98%. Rest of the power is being distributed among the stock markets of the South Asia Region except Bangladesh. MSCI is shown to have some effects on Sri Lanka stock market but its' quite nominal. The influence of India &

Pakistan stock market appears with some period lags over Sri Lankan stock market that too at around 1.5% level which is very nominal. Looking at the Interlinkages MSCI with the stock markets of South Asia Region, MSCI explains its own forecast error variance by 85% to 98% in 1st to 10th periods ahead. After that it is Indian stock market that explain 12.8%, 12.7% of forecast error variance of work market in 2nd, 5th & 10th period ahead. This shows high dynamic interlinkages of Indian stock market with world stock market. Coming to other stock markets of the region, there exist no dynamic interlinkages between the stock markets of the regions except some interlinkages between Indian and Pakistan stock market.

(d) Vector Error Correction Model

The estimated VECM results are presented in Table 4.14. It is found that the error correction term for India is only significant among all the stock markets of the region with a significant contribution of lagged differences of world market (MSCI). None of the error correction terms for the stock market of Bangladesh, Pakistan & Sri Lanka stock markets are significance. Even the error correction term for MSCI is also insignificant. This implies the short run disequilibrium in the stock markets of South Asia region cannot be solved by the contribution of other stock markets of the region. Hence, there lies no dynamic interlinkage between the stock markets of the region. Only Indian stock market is found to be interlinked with world market

(e) Johansen Maximum Likelihood Test

The estimated statistics of Johansen multivariate likelihood test are presented in Table 4.15. The estimated λ trace & λ-max Eigen value identifies no long run equilibrium relationship between the stock markets of the region. The null hypothesis of no cointegration could not be rejected either at 5% or 1% level This shows that there exist no long run equilibrium relationships between the stock markets of South Asia region. In other worlds there lie no long run equilibrium relationships between the stock markets of Bangladesh, India, Pakistan and Sri Lanka. None of these stock markets are also found to have long run equilibrium relationship with world market.

4.5.4 Asia Pacific

In Asia Pacific region, we have considered thirteen countries and the bench mark indices of the stock markets of this region are used as the representatives of their respective country stock markets.

(a) Unit root Property Test

The Unit root properties of the bench mark indices are presented in Table 4.16.I and II that contain the estimated τ statistics values of the indices at level and 1st differences respectively. The null hypothesis of unit root could not be rejected for any of the stock markets of Asia Pacific Region. But in 1st differences all are found to be stationary. Hence the indices are used in level as well as in 1st difference as per the methodological requirements.

(b) Pair wise Granger Causality Test

In order to identify the cause & effect relationships between the stock markets of Asia Pacific Region. Our study used pair wise Granger causality test The results are presented in Table 4.17. It has been observed that there lies univariate Granger causality between the stock markets of Australia & Indonesia. Australia stock market Granger causes Indonesia stock market, but Indonesia doesn't Granger cause Australia. Similarly, unidirectional Granger causality exists between the stock markets of "Australia & Korea Republic", "Australia & MSCI", "New Zealand & Australia" and between "Singapore & Australia". Australia Granger causes Korea republic, but Korea Republic doesn't Granger cause Austria stock market Australia causes MSCI, but MSCI doesn't Granger cause Australia. Singapore Stock Market Granger causes Australia, but not in other way round and New Zealand stock market Granger causes Australia and Australia stock market doesn't Granger cause New Zealand stock market. There lie no cause & effect relationships between stock markets of "Australia & China", "Australia & Hong Kong", "Australia & Japan", "Australia & Malaysia", "Australia & Philippines", "Austria & Taiwan" and "Australia & Thailand". Similarly there lies unidirectional causality between China & Singapore stock market. The null hypothesis i.e. Singapore doesn't Granger causes China is rejected at 1% Probability level. Except that there lies no cause

& affect relationship between "China & Hong Kong", "China & Indonesia", "China & Japan", "China & Korea Republic" , "China & Malaysia", "China & Malaysia", "China & New Zealand", "China & Philippines", "China & Taiwan" and "China & Thailand" stock market. China Granger causes MSCI where as MSCI doesn't Granger cause China. New Zealand also causes China Stock Market. Coming to Hong Kong stock market, there lies unidirectional Granger causality between stock markets of "Hong Kong & Indonesia", "Hong Kong & Malaysia", "Hong Kong & MSCI", "Hong Kong & Philippines", "Taiwan & Hong Kong" and "Philippines & Taiwan". Hong Kong Granger causes Indonesia stock market but Indonesia doesn't Granger cause Hong Kong. Similarly, Malaysia stock market Granger causes Hong Kong, but Hong Kong stock market doesn't Granger cause Malaysia. Hong Kong causes MSCI but MSCI does not cause Philippines. Philippines doesn't Granger cause Hong Kong stock market. Hong Kong also causes Taiwan stock market but not other way round There lies bi-directional causality between stock markets of "Hong Kong & New Zealand" and "Hong Kong & Singapore". In both of the causes null hypothesis of no causality is rejected at 1% probability level. We found no cause & effect relationships between "Hong Kong & Japan", "Korea Republic & Hong Kong", and "Thailand & Hong Kong" stock market. Between Japan & Indonesia, there lie no cause & effect relationships But stock market of Korea Republic Granger causes Indonesia by rejecting the null hypothesis at 1% level. Indonesian stock market also caused by MSCI, Philippines, Taiwan and Thailand stock market. It has been observed that Indonesian stock market is influenced by most of the stock markets of the region and there lies few influence of Indonesian market over other stock markets of the Region. Korea stock market never Granger causes Japan but Japan causes stock market of Korea Republic Similarly Japan also causes New Zealand market. Japan never Grangei Malaysia, but Malaysia stock market Granger cause Japan stock market. There is no cause & effect relationship between Japan & world market (MSCI), Philippines & Japan, Singapore & Japan, Taiwan & Japan and between Thailand & Japan. Stock market Korea Republic is found to be causally related with most of the stock markets of the Region. There lies bi-directional causality between stock markets of "Malaysia & Korea Republic", "New Zealand & Korea Republic" and "Singapore & Korea Republic" stock market. Except that Korea Republic also causes MSCI &

Philippines stock market. There lies no cause & effect relationship between stock market of Korea Republic & Taiwan stock market and between MSCI & Malaysia stock market. Similarly the null hypothesis of no causality could not be rejected in case of "Philippines & Malaysia", "Malaysia & Singapore", "Taiwan & Malaysia" and "Thailand and Malaysia". New Zealand stock market Granger causes world market (MSCI) But MSCI does not Granger cause New Zealand. Singapore Granger causes MSCI but MSCI doesn't Granger cause Singapore stock market. There lies one way causality between Taiwan & MSCI and Thailand stock market & MSCI. New Zealand Granger causes Singapore but Singapore doesn't Granger cause New Zealand. But bi-directional causality exists between "Singapore & Philippines", "Singapore & Taiwan", as well as between "Thailand & Singapore". Unidirectional causality exits between "Taiwan & Philippines", "Thailand and Philippines" and also between "Thailand & Taiwan". No causality exists between Philippines & Thailand as well as Taiwan & Thailand. This shows the existence of quite good short term lead-lag relationships between the stock markets of Asia Pacific Region.

(c) Variance Decomposition

The estimated statistics of Variance decomposition are presented in Table 4.18. The VAR model is optimized with lag of 2. The forecast error variances are distributed for 10 periods ahead and the selected results for 1st 2nd, 5th & 10th period ahead results are presented in the table. Analyzing Individual stock markets of Asia Pacific Region, Australia stock market is explaining its own forecast error variance by 100% in 1st period 85.7% in 2nd 65.76% in 5th & 65.5% in 10th period hence leaves a lot to be explained by other stock markets of the region. Then New Zealand stock explains a substantial part of forecast error variance of Australian by explaining 2% in 2nd, 20.9% in 5th & 20.9% in 10th period ahead. Singapore stock market explains 10.7%, 8.3%, & 8.3% of forecast error variance of Australia stock market in 2nd, 5th & 10th period ahead respectively. Rest of the stock markets is explaining very few for Australia which shows very low interlinkages of Australia stock market with the stock markets of the region. Moving to China stock market, it explains most of its own forecast error variance i.e. 99.7% in 1st period, 94.9% in 2nd period, 92.6% in 5th period and 92.5% in 10th period ahead. Hence

allows very less to be explained by other stock markets of the region. Alternatively we can say China stock market is quite close to external influence of its own region & having very low interlinkages. Hong Kong stock market explains 91.47% of its own forecast error variances in 1st step ahead and explains 58.4%, 51.2% & 51.1% of its own forecast error in 2nd, 5th & 10th period ahead respectively. Singapore stock market explains a substantial part of forecast error variance of Hong Kong stock market i.e. 33%, 28.53% & 28.5% in 2nd, 5th, & 10th period ahead respectively. New Zealand who explains 10.7% & 10.73% forecast error at 5th & 10th period ahead, which implies there lies some lagged interval to transmit the influence of New Zealand over Hong Kong market. Australia Stock market also explains 7.8%, 5.1%, 4.41% & 4.46% of forecast error of Hong Kong stock market. Rest of the stock markets of the region shares very less deterministic power over Hong Kong stock market. This proves a high Interlinkages of Hong Kong stock market with stock markets of Singapore, New Zealand & Australia Some influence of MSCI is also being observed. Indonesia stock market is found to be quite linked with the stock markets of the region. Most of the cases, the stock markets of the region start explaining Indonesia after a period gap i.e. after 5th period onwards. Indonesia stock market explains 98.7% of its own forecast error variance in 1st period and 94.7%, 63.7% & 62.6% in 2nd, 5th & 10th period ahead respectively. Philippines & Singapore stock market explain around 10% of the forecast error variance of Indonesia at 5th & 10th period ahead. Hong Kong & Thailand explain around 3 5% & Korea explains around 2.7% of forecast error variance in 5th & 10th period. Rest of the stock markets explains very negligible part of Indonesia. Japan stock market explains most of its forecast error variance i e. 99.4%, 96.2%, 90.8% & 90.7% in 1st, 2nd, 5th & 10th period ahead. Malaysia explains around 3.5% in 5th & 10th period ahead of the forecast error variances of Japan stock market. Rest of the stock mark of the region explains less than 1% of forecast error variance of Japan. Hence Japan found to be very less interlinked with the stock markets of the Asia pacific region. Korea Republic explains 88.3%, 74 6%, 67.2% & 67% of its own forecast error variance in 1st, 2nd, 5th & 10th period ahead. Singapore stock market explains 12.8%, 12.6%, 12.6% forecast error of Japan in 2nd, 5th & 10th period ahead. Australia explains 7.1%, 6.01%, 6.25% & 6.25% and Hong Kong explains 3.7%, 3.10%, 2.9% & 2.9% in 1st, 2nd, 5th & 10th period ahead. Japan and New Zealand explains around

2% & 4.6% forecast error of Korea Republic in 5th & 10th period. Rest of the stock markets including MSCI explains less than 1% forecast error of the stock market of Korea Republic. Korea stock market is found to be highly interlinked with Singapore. There lie some dynamic interlinkages between stock markets of Korea Republic, Australia, Hong Kong, Japan & New Zealand. Malaysia stock market explains its own forecast error variance by 97%, 92%, 89% & 88% in 1st, 2nd, 5th & 10th period ahead. Japan and Korea stock market explains around 1% to 2% of forecast error variance of Malaysia. Hence, Malaysia stock market is found to be very less interlinked within its own Region. New Zealand is explaining its own forecast error variance by 98% to 86% in 1st to 10th period ahead. It explains 98.4% in 1st period, 93% in 2nd period, 86% in 5th period and 86.4% in 10th period ahead. Hence there lies some to be explained by the Stock markets of the Region. Philippines and Japan stock market explain 2% to 2.4% forecast error of New Zealand stock market in 5th to 10th period ahead These stock markets seem to influence New Zealand in lag intervals. Australia, Hong Kong, Malaysia and Taiwan stock market explains around 1% forecast error in all the periods ahead. This shows New Zealand stock market is somewhat interlinked with the stock markets of Asia Pacific region. Philippines stock market is quite highly interlinked with Singapore and New Zealand stock markets. Singapore stock market explains 18%, 17% and 17% forecast error variances of Philippines stock market in 2nd, 5th and 10th period ahead. This shows close interlinkages of Singapore stock market with the stock market of Philippines. New Zealand also explains around 9% forecast error variances of Philippines in 5th & 10th period ahead Stock market of Australia, Hong Kong, world market (MSCI) and Thailand explains 1% of Philippines stock market. Rest of the stock markets of the region explains less than 1%. Singapore stock market being the financial hub gets highly interlinked with stock market of New Zealand. Singapore stock market explains its own forecast error variance by 94% in 1st period, 81% in 2nd period, 78.7% and 78.6% in 5th and 10th periods respectively. New Zealand is explaining approximately 12% forecast error variance of Singapore in 2nd, 5th and 10th period ahead. Moving to world market, MSCI explains 96% of its own forecast error variance in 1st period, 66.8% in 2nd period, 45% in 5th period and 44% in 10th period. This shows world market represented by MSCI is getting interlinked with the stock markets of the region over a period of time. Other stock markets of Asia

Pacific region are explaining substantial part of forecast error variance of world market. Stock market of Singapore, New Zealand, Australia and Hong Kong are contributing enough explanation to world market. It has been observed that Singapore and New Zealand are explaining MSCI after 5th period onwards, where as the influence of Australia and Hong Kong stock market starts immediately after 1st period. Taiwan stock market explains 75% to 90% forecast error variances of its own market. It explains 89.6%, 80%, 75% and 75% of its own forecast error variances in 1st, 2nd, 5th and 10th period ahead conjunctively. Singapore stock market explains around 9.6% forecast error variance of Taiwan stock market after 2nd period onwards. Korea republic is explaining constantly 3.5% of forecast error variances of Taiwan stock market. Hence Taiwan stock market is found to be more interlinked with stock markets of Singapore, Korea Republic and New Zealand against other stock markets of the Asia pacific Region. Thailand stock market is also highly interlinked with the stock market of Singapore, Korea Republic, Philippines and New Zealand. Thailand Stock market explains its own forecast error variances by 86%, 67%, 58% and 59% in 1st, 2nd, 5th and 10th period ahead and leaves lots to be explained by the stock markets of the Region. Singapore is explaining 21% to 18 % of forecast error variance of Thailand stock market. Philippines stock market explains 3.5 % to 5% forecast error variances of Thailand during 1st to 10th period ahead. Stock market of Korea Republic is explaining 5% to 6% forecast error variances of Thailand stock market. New Zealand is explaining 9% forecast error variance but after 5th period onwards. Hence Thailand stock is found to be interlinked more with Singapore, Philippines, Korea Republic and New Zealand stock market Rest of the stock markets of the region explains Thailand stock market be less than 1% in all the periods ahead. Summarizing the above results, Stock markets of Korea Republic, New Zealand, Australia, Hong Kong, Philippines, Singapore, Indonesia, Taiwan, Thailand and MSCI are found to be dynamically interlinked within Asia Pacific Region. Japan and Malaysia stock market is found to be interlinked with other stock markets of the region with a lower order.

(d) Vector Error Correction Model (VECM):

The VECM estimated results are presented in Table 4.19. Out of the thirteen stock markets of Asia Pacific region, the error correction term of seven stock markets is significant. The stock markets having significant error correction terms are stock markets of Australia, Hong Kong, Korea Republic, New Zealand, Singapore, Taiwan and Thailand. This shows the short run disequilibrium of these markets is significantly corrected by the stock markets of the region. This proved a significant interdependence between the stock markets of the region. The significant ECT of Australia stock market is influenced by the significant presence of New Zealand, Singapore and Thailand stock market. In case of Hong Kong, the short term lagged difference of MSCI, New Zealand, Philippines and Singapore are significantly contributes to the error correction term. Similarly for the stock market of Korea Republic, the short term lagged differences of Australia, China, Japan, New Zealand and Singapore are significantly contributing to the error correction term of Korea Republic. The ECT of New Zealand stock market is significantly explained by the stock markets of Malaysia, MSCI and Taiwan. The ECT of Singapore stock market is significantly explained by Australia, Hong Kong, Japan, Malaysia, New Zealand and Thailand. Coming to the error correction equation of Taiwan stock market, most of the lagged independent variables are found to be insignificant except Malaysia and Singapore stock market. Similar is the case of Thailand. The significant ECT and significant short term lagged differences of the other stock markets of the region shows the existence of a short run dynamism between these stock markets.

(e) Johansen Maximum Likelihood Test.

The long run equilibrium relationships between the stock markets of Asia Pacific region are tested through Johansen Maximum Likelihood techniques. The estimates λ-statistics are presented in Table 4.20. We have thirteen stock markets under Johansen maximum likelihood test. Though the used time series package "Eviews" has the capacity to estimate maximum of eleven endogenous variables in a Johansen maximum likelihood test, we have introduced two indices as exogenous variables to the system of equation. The estimated λ trace value identifies four cointegrating vectors at 1% and 5% probability level and λ max value indentifies two cointegrating vectors at 1% and 5% level and one

at 5% level. This shows the existence of long run equilibrium relationships between the stock markets of the region.

4.5.5 Africa & Middle East

In Africa & Middle East Region, we have considered stock markets of thirteen countries and the bench mark indices of the stock markets are used.

(a) Unit root Property Test

The unit root Properties of the bench mark indices are presented in Table 4.21.I and II where table I contains the estimated t- statistics values of the indices at level and II contains the estimated t- statistics at 1st difference. From the table, it has been observed that all the stock markets of Africa & Middle East Region are having unit root problems at level. The null hypothesis of "unit root" could not be rejected for any of the stock market's bench mark indices of the region at level. But in 1st difference, all the indices are found to be stationary, the appropriate lag values are taken for ADF & PP test to get the white noise errors which are presented in the parentheses along with the estimated t-statistics. Hence, the indices are used in level as well as in 1st difference for further time series analysis as per the requirement of time series methodologies.

(b) Pair wise Granger Causality Test

The estimated results of pair wise Granger Causality is presented in Table 4.22. It has been observed that in most of the cases the null hypothesis of no Granger causality could not be rejected either in 1% or 5% level. But in some of the cases the present study identifies some unidirectional as well be-directional causality. It has been observed that, there lies a bi-directional causality between stock markets of "Jordan & Egypt", "Jordan & Ghana", "MSCI & Israel", and "MSCI & Jordan". There exists a short term lead-lag relationships between these stock markets. Both the stock markets are influencing each other. At the same time some uni directional causality between the stock markets such as, Botswana Granger causes Oman, but Oman does not Granger cause Botswana Stock market. Similarly the null hypothesis of Egypt doesn't Granger because Israel could not be rejecting, but Israel does not Granger because Egypt has been rejected at 1% of

probability. Hence, Israel stock market Granger causes Egypt but Egypt doesn't Granger cause Israel stock market. Mauritius stock market Granger causes Egypt but not on the other way round. Coming to world market, MSCI Granger causes Egypt, but stock market of Egypt does not Granger cause MSCI. Oman Granger causes Egypt but Egypt does not Granger Oman stock market. Between the stock market of Saudi Arabia and Egypt, Saudi Arabia Granger causes Egypt stock market but not on the other way round. Again between South Africa & Egypt, stock market of South Africa Granger causes Egypt but Egypt does not Granger cause stock market of South Africa. Between South Africa & Egypt, only South Africa Granger causes Egypt. Between Ghana & Kuwait, Ghana causes Kuwait and Kuwait doesn't Granger cause Ghana. Similarly, between Jordan and Israel; Jordan Granger causes Israel. Looking at other pairs of Stock markets, Israel Granger causes Mauritius, Oman Granger causes Kuwait, and Saudi Arabia Granger causes Kuwait. There lies no feedback effect between these pairs of markets. Tunisia causes Nigeria where as Nigeria does not cause Tunisia stock market. There lie very few interlinkages among the stock markets of the region in the form of causing/affecting each other.

(c) Variance Decomposition

The VAR model has been solved for an optimum lag length of 3, identified by five criteria's such as LR, FPE, AIC, SC & HR techniques. The estimated statistics of variance decomposition are presented in the Table 4.23. It has been observed that, Botswana explain 100% of its own forecast error variance in 1st step ahead and 99 03%, 96% & 95.7% in 2nd, 5th & 10th period ahead respectively by leaving very less scope for the stock markets of the region to explain the forecast error variance of Botswana stock market. Botswana stock market can be concluded to be very less linked to the stock markets of the region. Egypt stock market explains 99 5%, 93.5%, 85% & 84.7% of its own forecast error variance in 1st, 2nd, 5th & 10th period ahead respectively and hence leaves some of its own forecast error variance to be explained by rest of the stock markets of the region. Among the stock markets, Israel, MSCI, Oman and Saudi Arabia stock markets are explaining around 2% to 3% of Egypt's forecast error variances. This proves some dynamic interlinkages between Egypt & these few stock markets of Africa &

Middle east Region. At the same time stock market of Ghana is found to be very less interlinked with the stock markets of the region. It explains 90% to 99.7% of its own forecast error variance in 1st to 10th period ahead. Botswana explains around 1.5% and stock market of other countries of the region are explaining less than 1% forecast error variance of Ghana. Coming to Israel it explains its own forecast error variance by 99.9%, 93.3%, 89.8% & 89.5% in 1st, 2nd, 5th, & 10th period ahead respectively. Next MSCI explains 4.5%, 4.5% and 5.4% forecast error variance of Israel in 2nd, 5th & 10th period ahead. Jordan is also explaining around 1% of Israel. Hence Israel is found to be bit interlinked with world market more than its regional counter parts. Coming to the stock market of Jordan, it explains 93.3%, 89.3%, 84% & 83% of its own forecast error variance in 1st, 2nd, 5th & 10th period ahead. Israel is explaining 6.3% in 1st, 6.0% in 2nd, 5.7% in 5th and 5 7% in 10th period ahead of the forecast error variance of Jordan. This justifies strong dynamic interlinkages between these stock markets. Kuwait explains 99.2%, 91.3%, 87.3% & 86.9% of its own forecast error variance in 1st, 2nd, 5th & 10th period ahead respectively. Saudi Arabia is explaining some part of forecast error variance of Kuwait i.e. 5.3% in 2nd, 6.24% in 5th & 6.28% in 10th period ahead. Ghana is explaining around 1.6% during 2nd to 10th period; Oman is explaining 1.8 & 1.9% in 5th & 10th period ahead. Rest of the stock markets of the region is explaining less than 1% of forecast error variance of Kuwait Mauritius explains 97.4%, 95 8%, 92 8% & 92.4% of its own forecast error variance in 1st, 2nd, 5th & 10th period ahead respectively and leaves very less scope for rest of the stock markets of the region to explain it. Ghana, Jordan & Kuwait are explaining around 1% of the forecast error variance of Mauritius where as rest of the stock markets of the region are explaining less than 1%. This shows very less interlinkages of Mauritius stock market with stock markets of the region. World market represented by MSCI is explaining its own forecast error variance by 77%, 75%, 71% & 70% in 1st, 2nd, 5th & 10th period ahead. Lots of scopes are left for the stock markets of the region to explain world index. Out of them, Israel & Jordan stock markets are explaining a substantial forecast error variance of MSCI. Israel explain 12%, 12.9%, 12.4% & 12.37% of forecast error variance of MSCI in 1st, 2nd, 5th & 10th period ahead and Jordan is explaining 10.17%, 9.9%, 10.26% & 10.2% forecast error variance of MSCI. Rest of the stock markets is explaining at nominal level of MSCI. Nigeria explains

93%, to 98.8% of its own forecast error variance between 1st to 10th periods. Rest of the countries explain very few forecast error variance of Nigeria stock market, showing very less interdependences of Nigeria stock market with the stock markets of Africa & Middle East region. Oman also explains most of its forecast error variance and shows to be very less interlinked with the stock markets of the region. Similar is the case of Saudi Arabia who explains 90% to 96% of its own forecast error variance in 1st to 10th period ahead. But South Africa explains 60% to 56% of its own forecast error variance during these periods. MSCI explains 21% to 22% of the forecast variance of South Africa stock market. Israel explains 7.6% to 7.5% and Jordan explains 9.4% to 9.2% of forecast error variance of South Africa. Tunisia explains around 91% to 97% of its own forecast error variance. Israel explains 2.2% & 2.4% forecast error variance of Tunisia at 5th & 10th period ahead. MSCI & Nigeria stock market explains around 1.5% & 1 1% forecast error variance of Tunisia but at 5th & 10th period ahead. Hence Tunisia is having very low interdependences among the stock markets of Africa and Middle East region.

(d) Vector Error Correction Model (VECM):

The VECM Estimated results are presented in Table 4.24. The error correction terms (ECT) are significant for the stock markets of Botswana, Israel, Mauritius & Nigeria. This implies that the short term disequilibrium in these stock markets is significantly corrected by the stock markets of the region. In Botswana stock market, the significant ECT is significantly contributed by short term lagged differences of Egypt, Israel, Jordan, Mauritius, Nigeria, Saudi Arabia, MSCI and Tunisia stock market. This shows existence of short term dynamism between the stock markets. The short-term disequilibrium in Israel stock market is corrected by a significant presence of stock market of Botswana and MSCI. Similarly the short-run disequilibrium of Mauritius stock market is significantly corrected by the significance piesence of Botswana stock market & South Africa stock market. Lastly, the ECT of Nigeria stock market is corrected significantly by short term lagged differences of Botswana stock market, & Tunisia stock market. The above estimated VECM statistics shows the existence of very low dynamic interlinkages between the stock markets of Africa and Middle East region.

(e) Johansen Maximum Likelihood Test

The long run equilibrium relationships between the stock markets of Africa and Middle East region are tested through Johansen Maximum Likelihood techniques presented in Table 4.25. Though the used time series package "Eviews" has the capacity to estimate maximum of eleven endogenous variables in a Johansen Maximum likelihood test, we have introduced two indices as exogenous variables to the system of equation. The estimates λ- Trace statistics identifies 4 cointegrating equation that exists between the stock markets of Africa & Middle East Region. The λ-trace identifies 4 cointegrating equation at 5% level and 3 cointegrating equations at 1 % level. The null hypothesis of (r = 0), (r ≤ 1), (r ≤ 2) is rejected against alternative hypothesis of (r > 0), (r > 1), (r > 2) at 1% level and (r ≤3) is rejected against alternative hypothesis of (r > 3) at 5% level. At the same time λ max eigen value test indicates 3 cointegrating equation at 5% and 1% level and one cointegrating equations at 5% level The null hypothesis of (r = 0) and (r = 1) is rejected against alternative hypothesis of (r = 1) and (r = 2) at 1% and 5% level and (r = 2) is rejected against alternative hypothesis of (r = 3) at 5% level. This shows some long run equilibrium relationships exist between the stock markets of Africa and Middle East region.

4.5.6 Eastern Europe

In Eastern Europe region, we have considered 9 (nine) and the country benchmark indices of the stock markets of the countries are used as the representative of the stock markets.

(a) Unit Root Property Test

The unit root properties of the bench mark indices representing the stock markets of the countries are presented in Table 4.26.I and II. Table 4.26 I contains the estimated t-statistics of the indices at level and Table 4.26.II contains the estimated t statistics of 1st difference. The unit root properties of the time series are tested using DF, ADF & PP techniques. From the table it has been observed that all the stock market's bench mark indices of Eastern Europe Region are having unit root at level and the null hypothesis of unit root has been rejected almost at 1% probability level in 1st difference. The

appropriate lag values are taken into account to get a white noise error term. The lag length for ADF & PP test is written along with the estimated critical values in the respective tables of unit root. The indices are used at level as well as in 1st difference for further time series analysis as per the requirements of the methodology.

(b) Pair Wise Granger Causality Test

The estimated Granger causality results are presented in Table 4.27. The presents study has estimated 91 pairs of causality in the stock markets of the region. In some of the cases, the null hypothesis of no causality got rejected either in 1% or 5% of Probability level. Some of the stock markets follow uni-directional causality where some are having both feedback effects. Stock market like Lithuania Granger causes Czech Republic stock market and Czech Republic stock market doesn't Granger cause Lithuania. There exists one-way causality between Lithuania and Czech-Republic stock market. Similarly, Czech Republic Granger causes MSCI but MSCI does not granger cause stock market of Czech Republic. Moving to other pair of stock markets, Russian stock market Granger causes stock market of Czech Republic. Between stock markets of Hungary and MSCI, Hungary Granger causes MSCI stock market but MSCI does not Granger cause stock market of Hungary Similarly stock market of Romania causes stock market of Romania, but on the other way round. Russia Federation also Granger causes Hungary. Lithuania Granger causes Poland, but Poland doesn't Granger causes Lithuania. Similarly Romania causes Lithuania stock market, but not in other way round. Stock market of Russia Federation Granger causes MSCI and MSCI doesn't Granger causes the stock market of Russia. MSCI Granger causes Slovenia stock market but Slovenia does not Granger cause MSCI. Similar one directional causality exist between stock markets of "Turkey & MSCI", "Romania & Poland", "Russian Federation & Poland", "Turkey & Poland", "Romania & Russian Federation", "Romania & Slovenia", "Russian Federation & Slovenia Republic" and also between "Russian Federation & Turkey" There exist one bi-directional causality among the stock markets of the region between Poland & MSCI that mans these two stock markets experiences a feedback effect. This shows existence of few short term lead-lag relationships between the stock markets of Eastern Europe region.

(c) Variance Decomposition

The long run dynamic interlinkages between the stock markets of Eastern Europe Region has been estimated by using variance decomposing technique of VAR model where the VAR model is estimated for an optimum lag length of 2 decided by FPE, LR, AIC, SC & HR. The result of variance decomposition is presented in Table 4.28. Analyzing the forecast error variance of Czech Republic, it explains 100% of its own forecast error variance in 1st period and then explains 94.6%, 91.89% & 91.85% of forecast error variances in 2nd, 5th & 10th period ahead respectively. Hence it explains most of its own forecast error variance. Lithuania stock market explains 3.1%, 3.35% & 3.35% forecast error variance of Czech Republic in 2nd, 5th & 10th period ahead. Then Russia explains around 2 % of forecast error variances in 5th & 10th period ahead. MSCI and rest of the stock markets explain less than 1%. Hence Czech Republic is found to be interlinked with few countries like Lithuania & Russia Federation and also very less interlinked with rest of the stock markets of the region. Hungary stock market is found to be highly interlinked with Czech Republic. Hungary explains its own forecast error variance by 73%, 70%, 68.8% & 68.8% in 1st, 2nd, 5th & 10th period ahead respectively. Czech Republic explains 27%, 25.9%, 25% & 25.03% forecast error variance of Hungary stock market. This shows a high interdependence of Hungary with Czech Republic. Russian Federation, Romania and Lithuania explain 1% to 2% of forecast error variances of Hungary. Lithuania is found to be very less dynamically interlinked with the stock markets of the Region. It explains most of its own forecast error variances i.e 98.3%, 97 2%, 93.9% & 93.9% in 1st, 2nd, 5th & 10th period ahead and leaving very less of its own forecast error variances to be explained by the stock of the Region These shows a weak interdependences of Lithuania stock market with the stock markets of Eastern Europe region. MSCI explains most of its own forecast error variances in 1st period i.e. 99.8% but in 2nd, 5th & 10th period ahead. MSCI explains its own forecast error variance by 69.9%, 67.5% & 67 5% respectively. Hungary stock market explains 11.8%, 11.9% & 12% forecast error variance of MSCI which is quite a substantial in amount. Then Czech Republic explain 9.8%, 8.97% & 8 96% and Poland explains 5.5%, of forecast error variances in 2nd, 5th & 10th period ahead respectively. Russia federation explains around 2.5% of MSCI. Hence, these stock markets of Eastern Europe Region are

found to be interlinked with world index. Poland stock market is found to be highly interlinked with Czech Republic & Hungary stock market. Poland explains 62.49%, 58%, 55.6% & 55.6% of its own forecast error variances in 1st, 2nd, 5th & 10th period ahead. Czech Republic explains 22.1%, 21.3%, 20.9% & 20.9% of forecast error variances of Poland stock market and Hungary explains 15.3%, 14.2%, 13.7% of Poland in 1st, 2nd, 5th & 10th period ahead. Russian federation explains 2.5% forecast error variance of Poland in 5th & 10th period ahead. Stock market of Romania & Turkey also explains around 1% of forecast error variances of Poland in 10th period ahead. Romania stock market is found to be very close market having few interlinkages with the stock markets of Eastern Europe Region. Romania explains around 97% to 99% of its own forecast error variance and rest of the stock market including MSCI explains less than 1% of Romania. Russian Federation also found to be interlinked with some of the stock markets of the Region Russia explains its own forecast error variance by 81.1%, 79.4%, 75%, & 75% in 1st, 2nd, 5th & 10th period ahead. Czech Republic & Hungary explains a substantial forecast error variance of Russia Czech Republic explains around 7.7%, 7.5%, 7.5% & 7.53% and Hungary explains 9.67%, 9.32%, 11.03% & 11.03 of forecast error variance of Russia stock market. Lithuania, Romania, Slovak Republic & Turkey explains around 1% of Russia. Slovak Republic explains its own forecast error variance by 98%, 97%, 93% & 93% in 1st, 2nd, 5th & 10th period ahead. Rest of the stock market explains around 1% of Slovak Republic. Hence, Slovak Republic is found to be very less interlinked with the stock markets of the region as well as world index (MSCI). But Slovenia stock markets is somewhat explained by some of the stock markets of the Region. Slovenia explains around 89% to 94% of its own forecast error variances. Hungary explains around 3 5% to 4.9% of Slovenia. Rest of the stock markets like Czech Republic, MSCI, and Romania & Slovak Republic explains Slovenia around 1%. Similar is the case of Turkey stock market. It explains its own forecast error variance by 83.8%, 82.2%, 78.7% & 78.7% in 1st, 2nd, 5th & 10th period ahead respectively. Czech Republic explains 5.8% to 5 6% Hungary explains 6.2% to 8 5% forecast error of Turkey in 1st to 10th period ahead. Russian Federation explains 1.6%, 2 05%, 3.03% & 3.04% in 1st, 2nd, 5th & 10th period ahead. World index (MSCI) explains around 1.5% of Turkey

stock market. Hence Turkey is found to be quite dynamically interlinked with the stock markets of Eastern Europe region.

(d) Vector Error Correction Model

The VECM estimated results are presented in Table 4.29. Out of 9 stock markets of the region, the error correction Term (ECT) of three stock markets i.e. Russia Federation, Slovak Republic and Turkey is found to be significant. The ECT of MSCI is also found to be significant by the short term lagged differences of the stock markets of Eastern Europe region. This implies, the short run disequilibrium's in these markets are significantly corrected by the effective interactions of the stock markets of the region. The error correction term of Russia federation, is significantly contributed by the short term lagged differences of stock market of Czech Republic, Hungary and MSCI, Romania, Slovak Republic, Slovenia and Turkey stock market. Russia is found to be highly interlinked with the stock markets of the Region. In case of Slovak republic, the ECT is significantly corrected by stock markets of Hungary, MSCI, Poland, Russia and Turkey. Finally the significant ECT of Turkey is found to be corrected by short run lagged differences of stock market of Hungary, MSCI, Poland, Russia Federation and Slovenia. Hence, the short run lagged differences of some of the stock markets of Easter Europe region are significantly contributing to the ECT of Turkey stock market The ECT of MSCI is significantly corrected by the short term lagged differences of stock market of Hungary, Poland, Romania, Russia Federation and Turkey. But the error correction term of most of the stock markets of Eastern European are found to be insignificant. This shows a weak dynamism between the stock markets of the region.

(e) Johansen Maximum Likelihood Test

The long run equilibrium relationships between the stock markets of Eastern Europe are tested through Johansen Maximum Likelihood techniques and are presented in Table 4.30. The λ-trace statistics identifies two cointegrating vectors at 5% level and one cointegrating vector at 1% level. The null hypothesis of ($r = 0$) is rejected at 1% probability level against the alternative hypothesis ($r > 0$) and the null hypothesis of ($r \leq 1$) are rejected at 5% probability level against the alternative hypothesis of ($r > 1$). At the

same time λ-max eigen value indicates no cointegrating vector either at 5% & 1% level. This shows a weak long run equilibrium that exists in the stock markets of Eastern Europe region.

4.5.7 Western Europe

In Western Europe region, we have taken seventeen (17) countries' stock markets and the bench mark indices of the stock market of these countries are used as the representative of the stock markets. The time series properties of these indices are studied under different heads as presented below.

(a) Unit root Property Test

The units root Properties of the bench mark indices are presented in Table 4.31.I and II that contain the estimated ι statistics values at level and first difference respectively. It has been observed that, indices contain unit root at level and become stationary at 1st difference as well as at level as per the methodological requirements of the subsequent time series analysis under the study.

(b) Pair wise Granger causality Test

The test results of pair wise Granger causality are presented in Table 4.32. Among the stock markets of Western Europe region, Spain & Austria causes each other where the null hypothesis no causality is rejected at 1 % level. Similarly, "Greece & Denmark", "France & Finland", "Spain & France", "Sweden & France", "Italy & Germany", "Netherlands & Germany", "Norway & Greece", "Norway & Ireland", "Italy & Portugal" contain bidirectional causality between the pairs. The null hypothesis is rejected at both 1 % & 5% of Probability level. It concludes that these stock markets affect each other through a cause & effect relationships. This also proves the existence of short term lead-lag relationships between the stock markets of the region. But quite a good number of statistics shows the existence of unidirectional causality between these stock markets. These stock markets contain one way causality within the pairs. Austria Granger causes Britain, Denmark, Finland, Greece, Ireland, MSCI, Norway, Sweden, and Switzerland. Moving to Britain, it causes Denmark, France, Greece, Ireland, MSCI,

Norway, Portugal and Sweden. Similarly, Finland, France, Ireland, MSCI, Spain, Sweden, Norway and Switzerland Granger cause Denmark. Coming to Denmark stock market, it causes stock market of Portugal. Finland Granger causes to Greece, MSCI, Norway and Portugal stock market. France stock market is Granger caused by Greece, Ireland, MSCI, Norway, Portugal and Switzerland. Germany stock market is caused by Portugal & Spain stock market. Ireland, Sweden, Switzerland causes stock market of Greece. But Greece causes to MSCI. Ireland stock market is Granger caused by Sweden & Switzerland and also causes to MSCI (World Index). Italy, Netherlands and Portugal stock market granger cause to Luxembourg stock market. Netherlands also Granger causes to Italy & Portugal. Spain, Sweden & Switzerland stock market Granger cause to MSCI but MSCI causes to Norway. But stock market of Spain, Sweden, and Switzerland Granger causes Norway. Again Switzerland causes Portugal, Spain causes Sweden and also Switzerland causes Sweden but Sweden does not Granger cause Switzerland stock market. This shows the existence of quite a number of causality between the stock markets of Western Europe region.

(c) Variance Decomposition

The VAR model is solved with an optimum lag length of order 2 The Results of variance decomposition has been presented in the Table 4.33. Each table contains estimated results of stock markets of 3 countries. Austria stock market is found to be highly closed as it explains 100% of its own forecast variance in 1st, 96.8% in 2nd, 91.9% in 5th & 91.8% in 10th period ahead and leaves very less scope for the other stock markets of the region including world index (MSCI) to explain the forecast error variances of Austria stock market. Its association with MSCI is very negligible. Similar is the case of Belgium stock market that explains 99.7%, 95%, & 91% of its own forecast error variance at 1st, 2nd, 5th & 10th period ahead and hence left very less scope for the stock markets of the region to explain the forecast error variances of Belgium stock market. Belgium also found to be very less explained by MSCI. Britain explains 99%, 78.8%, 76.4% & 76.3% of its own forecast error variance in 1st, 2nd 5th and 10th period ahead. Britain explains most of its forecast error variances in 1st period but in 2nd, 5th & 10th period ahead it explains less than 1st period and hence left some of its own error variances

to be explained by other the stock markets of the region. Among all Western European Markets, Austria explains 19.3% & 18.9% forecast error variances of Britain stock market. Rest of the stock markets of the region explains a negligible part of forecast error variances of Britain stock market. It is also found that Britain is least explained by MSCI. Moving to stock market of Denmark, it is found to be highly interlinked with Britain stock market, then by Sweden stock market Denmark explains its own forecast error variance by 99.8% in 1st, 67.7% in 2nd, 57.6% in 5th & 57.5% in 10th period ahead. In 1st period, Denmark explains all of its forecast error variance. But from 2nd period onwards, stock market of Britain explains a substantial part of forecast error variances of Denmark stock market i.e. 27.4%, 24.6% and 24.5% in 2nd, 5th & 10th period ahead. Sweden also explains around 2% of forecast error variance of Denmark Hence although Denmark is found to be almost close market within the region but having a strong interlinkages with Britain and Austria stock market. Finland is found to be interlinked with stock market of Britain and Austria. Finland explains its own forecast error variance by 70.4%, 63.9%, and 62.2% in 1st, 2nd, 5th & 10th period ahead respectively. Britain explains 29.3%, 26.6%, 26.3% & 26.3% forecast error of Finland. Then Austria explains around 6% forecast error variance of Finland in 2nd, 5th & 10th period ahead respectively. France & Luxembourg explain around 1 % in 5th & 10th period ahead. Rest of the stock markets of the region including MSCI is explaining very minimal forecast error of Finland stock market. Hence Finland is found to be highly interlinked with stock market of Britain & Austria. France stands to be quite close stock market who explains 98.3%, 95.9%, 91.9% & 91% in 1st to 10th period ahead. Finland & Sweden explains around 1% in all the period ahead. MSCI is very nominal in amount shows negligible interlinkages with France stock market. But in an overall sense, France is very less interlinked with the stock markets of the region. In case of Germany, in 1st period, it explains 97.7% of the forecast error of itself, but in 2nd, 5th & 10th period ahead it explains 24.5%, 23.2% & 23.18% respectively. Netherlands explain 72.5%, 68% & 68% forecast error variances of Germany stock market in 2nd, 5th & 10th period ahead respectively. Explaining substantial forecast error variances of Germany proves strong interlinkages of Netherlands stock market with Germany stock market. Finland & Spain explains around 1 % forecast error variances of Germany. Greece stock market stands to be quite open & dynamically interlinked with the stock

markets of the Region even though the extent is not substantial. It explains 90.8%, 80.4% & 76% of its own forecast error variance during 1st, 2nd, 5th and 10th period ahead. Austria explains, 6.5%, 8.9% & 8.9% forecast error variances of Greece in 2nd, 5th & 10th period ahead respectively. Britain explains 6.5% forecast error variance of Greece stock market. Hence Greece stands to be dynamically interlinked with Austria, Britain, & Finland stock market. Ireland also seems to be interlinked with most of the stock markets of the region. It explains its own forecast error variance by 71.8%, 59%, 55% & 55% in 1st, 2nd, 5th & 10th period ahead. Austria explains 13.7%, 14.8% & 14.8% and Greece explains 0.85%, 2.31% & 2.3% forecast error variance of Ireland in 2nd, 5th & 10th period ahead respectively. Britain explains 25.7%, 21.6%, 20.7 & 20.7% in 1st, 2nd, 5th & 10th period ahead respectively. Hence Ireland stands to be dynamically interlinked with Austria & Britain stock market. Its interdependences with MSCI are very nominal. Italy explains its own forecast error variance by 84.3%, 34.5%, 32.5% & 32.5% in 1st, 2nd, 5th & 10th period ahead respectively. Germany explains 12.8%, 5.35%, 5.6% & 5.6% forecast error variance of Italy in 1st, 2nd, 5th & 10th period. Netherlands explain 55.7%, 51.8% & 51.8% forecast error variance of Italy in 2nd, 5th & 10th period ahead. Finland explains around 1.5% in 5th & 10th period. Hence Italy is found to be dynamically interlinked with Germany & Netherlands at a substantial degree. Its association with other stock markets including MSCI is very less Luxembourg explains 94%, 72%, 64.8% & 64.7% of its own forecast error variances in between 1st to 10th period ahead. Germany explains 2.3%, 3.4%, 3.1% & 3.1% of forecast error variance of Luxembourg in 1st, 2nd, 5th & 10th period ahead. But Netherlands explains quite substantial part of forecast error variance i.e. 19.7%, 23.3% in 2nd, 5th & 10th period ahead Denmark, Finland, Ireland & France are explaining about 1.0% of Luxembourg stock market. Hence Luxembourg is found to be highly interlinked with stock market of Germany & Netherlands. Moving to MSCI, it is found to be explaining very little forecast error variances of most the stock markets of the Region, but on the other way, MSCI is being explained significantly by most of the stock markets of the region It explains 96% of its own forecast error variance in 1st period ahead, but in 2nd, 5th & 10th period ahead, it explains its own forecast error variances by 30.8%, 23.9% & 23.8% respectively. Austria explains 18.6% of MSCI in 5th & 10th period ahead. Britain is explaining 53.8%, 41.7% & 41.5%, stock market of Finland

explains 6%, 4.9% & 4.9% and stock market Sweden explains 2.2%, 2.09% & 2.1% in 2nd, 5th & 10th period ahead respectively to the forecast error variances of MSCI. France, Greece, Ireland & Spain are explaining between 1% to 5% forecast error variances of MSCI. Hence, most of the stock markets are dynamically interlinked with world index. Moving to Netherlands stock market, it explains 97.6%, 93%, 90.8% & 90.7% of its own forecast error variance in 1st, 2nd , 5th & 10th period ahead. Finland explains around 4% forecast error variance of Netherlands. Norway explains 94.6%, 63.4%, 45.76% & 45.5% of its own forecast error variance in 1st, 2nd, 5th & 10th period ahead respectively. Hence it leaves much more to be explained by the stock markets of the region. Austria explains a substantial part of forecast error variance of Norway stock market i.e 21.7% & 21.7% in 5th & 10th period ahead. Britain explains 19.9%, 15.3% & 15.3% in 2nd, 5th & 10th period ahead. Denmark is explaining around 2.2% to 2.9% during 1st to 10th period ahead. Similarly, Finland explains 2.8%, 2.2% & 2.2% of forecast error variance. Ireland explains 3.6%, 2.8% & 2.8% and Sweden explains 2.8%, 2.9% & 2.9% forecast error variance of Norway stock market. Greece, Italy & Switzerland are explaining around 1% level. Hence Norway stock market is found to be dynamically interlinked with these stock markets of the region. Portugal explains its own forecast error variance by 84.5%, 56.17%, 52.9% & 52.9% in 1st, 2nd, 5th & 10th period ahead. Portugal seems to be quite open & dynamically interlinked with the stock markets of the region. Germany explains 6.1%, 4.3%, 4.2% & 4.2% of forecast error variances of Portugal in 1st to 10th period ahead. Similarly, Italy explains 3.2%, 3.1%, 3.9% and 3.9%, stock market of Luxembourg explains 2.5% 2 02%, 1.9% & 1 9% forecast error variance of Portugal in 1st, 2nd, 5th & 10th period ahead respectively. Netherlands explaining a substantial part of Portugal's error variance i.e. 28.68%, 28.43% & 28.4% in 2nd, 5th & 10th period ahead respectively. Some of the stock markets like Austria, Denmark & Spain are taking a share of 1% of Portugal. Moving to Spain, it explains 50.1%, 39.1%, 37.9% & 37.9& of its own forecast error variance in 1st, 2nd, 5th & 10th period ahead. Hence more than 50% are left to be explains by other stock markets of the region. Austria & Britain are explaining a substantial part of forecast error variances of Spain stock market. Stock market of Austria explains 1.01%, 19.8%, 19.38% & 19.39% & stock market of Britain explains 40.5%, 31.6%, 30.65% & 30.6% of forecast error variance of Spain in 1st, 2nd, 5th & 10th period

ahead. At the same time, Finland explains 3.7%, 2.9%, 3 08% 3.08%, Greece explains 1.7%, 1.69%, 2.1% & 2.1%, Ireland explains 1.6%, 1.3%, 1.3% & 1.3% of forecast error variance of Spain stock market. Hence Spain stock market is found to be significantly interlinked with the stock markets of the Region. Similar is the case of Sweden. It explains its own forecast error variance by 33 4%, 28.7%, 27.9% & 27.9% in 1st, 2nd, 5th & 10th period ahead. Stock market of Austria, Britain & Finland explains a substantial part of forecast error variances of Sweden. Austria explains 11.7%, 11.4% & 11.5% in 2nd, 5th & 10th period ahead respectively. Britain explains 41.9%, 35%, 33.59% & 33.5% and Finland explains 18.29%, 15.1%, 14.5% & 14.5% and Spain explains 3.8%, 3.8%, 4.3% & 4.2% forecast error variance of Sweden in 1st, 2nd, 5th & 10th ahead respectively. Stock markets of France, Ireland explain 1% forecast error variance of Sweden. Hence Sweden stock market is found to be dynamically interlinked with the stock markets of the region. Moving to Switzerland, it explains its own forecast error variance by 43.8%, 34%, 32.5% & 32.5 in 1st, 2nd, 5th & 10th period ahead respectively. Stock market of Austria & Britain explain a substantial part of forecast error variance of Switzerland i.e. Austria explains, 19.5%, 18.9& & 18.9% in 2nd, 5th & 10th period ahead and Britain explains 46.7%, 36.3%, 34.7% & 34.7% of Switzerland in 1st, 2nd, 5th & 10th period ahead respectively. Ireland takes a share of 2% to 2.1% approximately, and Spain takes a share of 4% in explaining Switzerland. Hence Switzerland stock market is found to be dynamically interlinked with some of the stock markets of the region.

(d) Vector Error Correction Model

The estimated statistics of VECM model are presented in Table 4.34. Most of the error correlation terms of the stock markets of the region are found to be significant implying the short term disequilibrium in these stock markets can be corrected significantly by the interactions of the stock markets of this region. The error correction terms of stock market of Austria, Britain, Denmark, Finland, Germany, Greece, Italy, MSCI, Norway, Portugal, Spain, Sweden and Switzerland are statistical significant within the region. The significant error correction term of Austria is significantly contributed by short term lagged differences of stock market of Britain, Greece, Norway and Sweden. The error correction term of Britain stock market stands to be significant with the

significant lagged differences of stock market of Austria, Denmark, France, Ireland, Netherlands, Sweden & Switzerland. The ECT of Denmark stock market is significantly corrected by the short run lagged differences of stock markets of Austria, France, Ireland, Netherlands, Norway and Switzerland. In case of Finland, the lagged independent variables like stock market of Austria, Britain, France and Germany stands to be significant. In the error correction equation of Germany; the short term lagged differences of Austria, Britain, Denmark, Ireland, Netherlands & Switzerland are found to be significant. Similarly, for stock market of Greece, the short term lagged differences of stock market of Austria, Britain, Finland, Germany, Netherlands, Norway, and Sweden are statistically significant. The lagged independence of stock market of Austria, Britain, Germany, Greece, Netherlands, Portugal and Spain are found to be significantly contributing the ECT of Italy. The ECT of MSCI is significant due to the significant contribution of Denmark, Finland, Germany, Greece, Ireland, Netherlands, Norway and Sweden. In the similar fashion, moving to Norway, the significant lagged difference variables are Austria, Britain, Denmark, Germany, Ireland, Italy, MSCI and Netherlands stock market. The significant lagged difference of stock market of Portugal is Britain, Germany, Netherlands and Norway stock market. The ECT of stock market of Spain is significantly corrected by the short term lagged differences of stock market of Austria, Britain, France and Portugal. Similarly, the ECT of Sweden stock market is significantly corrected by the coefficients of stock markets of Austria, Britain, France, Ireland, Portugal, & Switzerland. Lastly, concluding with Switzerland stock market, it's significant ECT is significantly influenced by stock markets of Austria, Britain, Ireland and stock market of Netherlands This shows the existence of short term dynamism in most of the countries' stock markets of Western Europe Region.

(e) Johansen Maximum Likelihood Test:

The long run equilibrium relationships between the stock markets of Western Europe region are tested through Johansen Maximum Likelihood technique. Though the used time series package has the capacity to estimate at max 11 endogenous equations, the stock market benchmark indices of Belgium, Denmark, France, Luxembourg, Portugal, Norway and Greece are introduced as exogenous to the system of equation

while solving Johansen Maximum Likelihood test. The results of Johansen maximum likelihood test are presented in Table 4.35. The λ-trace statistics suggests two cointegrating vectors at 1% probability level and three cointegrating vectors at 5% probability level. The null hypothesis of (r = 0) and (r ≤ 1) are rejected at 1 % level against the alternative hypothesis of (r > 0) and (r > 1) and the null hypothesis of (r ≤ 2) is rejected at 5% level against the alternative hypothesis of (r > 2). At the same time λ max Eigen statistics suggests only one cointegrating vector at 1% probability level and two at 5% level. The null hypothesis of (r = 0) and (r = 1) is rejected against alternative hypothesis of (r = 1) and (r = 2) at 5% level of probability and null hypothesis of (r = 0) is rejected against alternative hypothesis of (r = 1) at 1% level of probability. This shows existence of some long run equilibrium relationships between the stock markets of the region.

4.6 Conclusion:

The present study has tried to explore the dynamic interlinkages and long run equilibrium relationships between the sample of 65 countries' stock markets clubbed under seven regional boundaries Various time series techniques are used to trace out the lead-lag relationships, dynamic interlinkages and long run equilibrium relationships between the studied stock markets. In order to identify the direction of causality and short term lead-lag relationships between the stock markets within the region, the present study has used pair wise Granger causality test. There lies uni-directional or bi-directional causality between the stock markets of the regions as well as with world market presented by MSCI. To be more focused towards the stock markets carrying bi-directional causality within its regional boundaries are stock markets of Canada ↔ Bermuda and USA ↔ Bermuda of North America, Peru ↔ Brazil, Peru ↔ Chile, MSCI ↔ Colombia of South and South Asia, India ↔ MSCI, Pakistan ↔ MSCI of Central America, New Zealand ↔ Hong Kong, Singapore ↔ Hong Kong, Malaysia ↔ Korea Republic, New Zealand ↔ Korea Republic, Singapore ↔ Korea Republic, Malaysia ↔ New Zealand, Philippines ↔ MSCI, Philippines ↔ New Zealand, Taiwan ↔ New Zealand, Thailand ↔ New Zealand, Singapore ↔ Philippines, Singapore ↔ Thailand of Asia Pacific, Ghana ↔ Jordan, Jordan ↔ Egypt, MSCI ↔ Israel, MSCI ↔ Jordan of Africa and Middle East, Poland ↔

MSCI of Eastern Europe region, Spain ↔ Austria, Greece ↔ Denmark, Spain ↔ France, Sweden ↔ France, Italy ↔ Germany, Germany ↔ Netherlands, Norway ↔ Greece, Greece ↔ Spain, Norway ↔ Ireland and Italy ↔ Portugal of western Europe. There exists feedback transition of cause and effect relationships that can otherwise mean as existence of short term lead-lag relationships between these stock markets. Most of the stock markets also carry uni-directional causality showing one-way causality from one stock market to another without any feedback effects. Within the stock markets of North America, one-way causality flows from Mexico → Bermuda, MSCI → Bermuda, MSCI → Canada, Canada → USA, Mexico → USA and from MSCI → to USA. Similarly, in the stock markets of South and Central America, uni-direction causality flows from Argentina → Brazil, Argentina → Chile, Argentina → Peru, Argentina → Venezuela, Brazil → Chile, Colombia → Brazil, MSCI → Brazil, MSCI → Chile, Colombia → Peru, MSCI → Peru, MSCI → Venezuela and from Peru → Venezuela. In South Asia Region one-way causality moves from India → Pakistan, India → Sri Lanka and from MSCI → Sri Lanka. Similarly in Asia Pacific region, causality from Australia → Indonesia, Australia → Korea Republic, Australia → MSCI, New Zealand → Australia, Singapore → Australia, Singapore → China, Hong Kong → Indonesia, Malaysia → Hong Kong, Hong Kong → MSCI, New Zealand ↔ Hong Kong, Hong Kong → Philippines, Hong Kong → Taiwan, China → MSCI, New Zealand → China, Korea Republic → Indonesia, MSCI → Indonesia, Philippines → Indonesia, Taiwan → Indonesia, Thailand → Indonesia, Japan → Korea Republic, Malaysia → Japan, Japan → New Zealand, Korea Republic → MSCI, Korea Republic → Philippines, Thailand → Korea Republic, New Zealand → Malaysia, New Zealand → MSCI, Singapore → MSCI, Taiwan → MSCI, Thailand → MSCI, New Zealand → Singapore, Taiwan → Philippines, Thailand → Philippines, Singapore → Taiwan, Thailand → Taiwan. Similarly in Africa and Middle East Region, the stock markets of the countries having uni-directional causality are Botswana → Ghana, Botswana → Oman, Israel → Egypt, Mauritius → Egypt, MSCI → Egypt, Oman → Egypt, Saudi Arabia → Egypt, South Africa → Egypt, Ghana → Kuwait, Jordan → Israel, South Africa → Israel, Oman → Kuwait and Saudi Arabia → Kuwait. Similarly in Eastern Europe region, one way causality flows from, stock market of country of Lithuania → Czech Republic, Czech

Republic → MSCI, Russia Federation → Czech Republic, Turkey → Czech Republic, Hungary → MSCI, Romania → Hungary, Russia Federation → Hungary, Lithuania → Poland, Romania → Lithuania, Russia Federation → MSCI, MSCI → Slovenia, Turkey → MSCI, Romania → Poland, Russia Federation → Poland, Turkey → Poland, Romania → Russia Federation, Romania → Slovenia, Russia Federation → Slovak Republic, Russia Federation → Turkey. The stock markets of countries following unidirectional causality in Western Europe region are Austria → Britain, Austria → Denmark, Austria → Finland, Austria → Greece, Austria → Ireland, Austria → Ireland, Austria → MSCI, Austria → Norway, Portugal → Austria, Austria → Sweden, Austria → Switzerland, Spain → Belgium, Britain → Denmark, Britain → France, Britain → Greece, Britain → Ireland, Britain → MSCI, Britain → Norway, Britain → Portugal, Britain → Sweden, Finland → Denmark, France → Denmark, Ireland → Denmark, MSCI → Denmark, Norway → Denmark, Denmark → Portugal, Spain → Denmark, Sweden → Denmark, Switzerland → Denmark, Finland → Greece, Finland → MSCI, Finland → Norway, Greece → France, Ireland → France, MSCI → France, Norway → France, Portugal → France, Switzerland → France, Germany → Italy, Germany → Luxembourg, Portugal → Germany, Spain → Germany, Ireland → Greece, Greece → MSCI, Greece → Portugal, Spain → Greece, Sweden → Greece, Switzerland → Greece, Ireland → MSCI, Ireland → Norway, Ireland → Portugal, Spain → Ireland, Sweden → Ireland, Switzerland → Ireland, Italy → Luxembourg, Netherlands → Italy, Netherlands → Luxembourg, Portugal → Luxembourg, MSCI → Norway, Spain → MSCI, Sweden → MSCI, Switzerland → MSCI, Netherlands → Portugal, Spain → Norway, Sweden → Norway, Switzerland → Norway, Switzerland → Portugal, Spain → Sweden and Switzerland → Sweden. The unidirectional causality shows the impact of one stock market over another without any feedback impact.

Pair wise Granger causality reflects the direction of causality i.e. shows the short term lead-lag relationships between the stock markets But it never highlights the dynamic interlinkages between these stock markets In order to capture the dynamic interlinkages between the stock markets, the present study has used variance decomposition technique and vector error correction model. The estimated statistics variance decomposing suggests the dynamic interactions between the stock market. It has

been identified that stock markets like Bermuda Canada of North America region; Colombia, Costa Rica and to some extent Venezuela of South and Central America, Bangladesh, India, Pakistan and Sri Lanka of South Asia, China, Japan and to some extent stock market of Malaysia in Asia Pacific region, Botswana, Ghana, Israel, Mauritius, Nigeria, Oman, Saudi Arabia and Tunisia of Africa and Middle East region, Lithuania, Romania, Slovak Republic and Slovenia at Eastern Europe, Belgium and France at Western Europe region are quite less dynamically interlinked with the stock markets at their respective regions. These stock markets explain almost 90% of its own forecast error variance and rest 10% of the forecast error variances are explained by other stock markets of the region. But in case of the stock market of Argentina of South and Central America and Czech Republic of Eastern Europe, although it is explaining most of its own forecast error variances, but explains quite substantial forecast error variances of other stock markets of their respective regions. Hence it can be said to be dynamically interlinked with the stock markets of the region. Stock markets like Mexico, USA, Brazil, Chile, Peru, Australia, Hong Kong, Indonesia, Korea Republic, Philippines, Singapore, New Zealand, Taiwan, Thailand, Jordan, Egypt, Kuwait, South Africa, Hungary, Poland, Russia Federation, Turkey, Austria, Britain, Denmark, Finland, Germany, Portugal, Spain, Sweden and Switzerland, Netherlands, Greece, Ireland Luxembourg and Norway are quite dynamically interlinked stock markets in their respective regions. These stock markets explain less of their own forecast error variances and leave most of their own forecast random error distributions to be explained by other stock markets of their respective regions. World market presented by "MSCI" found to be dynamically interlinked with most of these stock markets. MSCI, representing the world index also found to be significant in explaining the forecast error variances of some of these selected stock markets.

A significant error correction term implies that the short term disequilibrium in these countries' stock markets will be corrected significantly by the short term lagged differences of the stock markets of the region. It is found that the error correction terms (ECTs) are significant for the stock markets of Bermuda, Mexico and USA stock market of North America, Argentina, Brazil, Chile and Venezuela of South and Central America region, India in South Asia region, Australia, Hong Kong, Korea Republic, New Zealand,

Singapore, Taiwan and Thailand of Asia Pacific region, Botswana, Israel, Mauritius and Nigeria of Africa and Middle East region, Russia Federation, Slovak Republic and Turkey of Eastern Europe region and Austria, Britain, Denmark, Finland, Germany, Greece, Italy, Norway, Portugal, Spain, Sweden and Switzerland of Western Europe Region. MSCI index is found to be significant in North America, South and Central America, Eastern Europe and Western Europe region. These stock markets are found to be dynamically interlinked with the stock markets of their respective regions.

These estimates never put light on the long run equilibrium relation ships between the stock markets of the region. Hence to identify the long run equilibrium relationships between the stock markets within their respective regions, the present study used Johansen Maximum likelihood estimates. The study identifies only one cointegrating vector suggested by λ trace and λ max eigen value at 5% level for the stock markets of North America showing weak long run equilibrium relations between these stock markets. In case of south and Central America, λ -trace identifies 4 cointegrating vectors at 5% level and 3 cointegrating vectors at 1% level and λ -max suggests only 1 cointegrating vector at 5% level. Hence, the long run equilibrium relation ships between the stock markets of South and Central America seems to be stronger. But there lies no long run equilibrium relationships between the stock markets of South Asia. The stock markets of Asia Pacific tend to be having stronger long run equilibrium relationships within the region as λ-trace statistics suggests 4 and λ-max eigen value identifies 3 cointegrating equations within its regional level. Similar is the case for the stock market of Africa and Middle East. Johansen Maximum likelihood statistics identifies 4 and 3 cointegrating equations suggested by λ trace and λ max eigen values proving a strong long run equilibrium relationship. But the long run equilibrium relationships between the stock markets of Eastern Europe are moderate. λ- trace identifies only 2 cointegrating vectors within the region. A substantial long run equilibrium relationship exits between stock markets of Western European nations λ- trace identifies 2 and 3 cointegrating vectors at 1% and 5% level respectively and λ- max identifies one cointegrating equations at 1% and 2 at 5% level between the stock markets of the region.

TABLES

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APPENDIX-IV

North America

Table 4.1.I: The estimated τ-statistic values from unit root tests (Level)

Variable	Intercept alone			Intercept + Trend		
	DF	ADF	PP	DF	ADF	PP
Bermuda	0.044	0.014 (2)	-0 03 (5)	-2.37	-2.66 (3)	-2.53(4)
Canada	-0.99	-1 13 (4)	-1 04 (5)	-1 77	-1.94 (4)	-1.86 (5)
Mexico	0.16	0 05 (4)	0.11 (4)	-1 61	-1.67 (4)	-1 74 (4)
USA	-2.58	-2.64 (3)	-2 59 (3)	-2.63	-2.63 (3)	-2.60 (3)
MSCI	-1.22	-1 31 (2)	-1 25 (4)	-1 42	-1 50(2)	-1.46 (4)

Note: The critical values for unit root test are: -3.49 and -2.88 (without trend) and -4.04, -3.45 (with trend) respectively for 1% and 5% level.
* and ** implies stationarity at 1% and 5% level.

Table 4.1.II: The estimated τ-statistic values from unit root tests (First Difference)

Variable	Intercept alone			Intercept + Trend		
	DF	ADF	PP	DF	ADF	PP
Bermuda	-22 58*	-13.01*(2)	-22.5* (3)	-22 578*	-13 03* (2)	-22.57* (3)
Canada	17 34*	13.11*(2)	18.01 *(2)	16.71*	13 13*(2)	17.34*(2)
Mexico	19 03 *	16.52*(3)	19 012*(3)	18 63	16 21*(2)	19 11*(3)
USA	20.15*	13 19*(1)	20 61*(1)	20.14*	14.001 *(1)	20 17*(1)

Note: The critical values for unit root test are: -3 49 and -2 88 (without trend) and 4.04, -3 45 (with trend) respectively for 1% and 5% level
* and ** implies stationarity at 1% and 5% level

Table 4.2: Pair Wise Granger Causality test for the Stock markets of Countries of North America

Null Hypothesis:	F-Statistic	Probability
CANADA does not Granger Cause BERMUDA	4 874	0.006
BERMUDA does not Granger Cause CANADA	4.043	0.018
MEXICO does not Granger Cause BERMUDA	3 061	0 047
MSCI does not Granger Cause BERMUDA	7.129	0.000
USA does not Granger Cause BERMUDA	5.009	0.006
BERMUDA does not Granger Cause USA	3.378	0.034
MSCI does not Granger Cause CANADA	2 681	0.051
CANADA does not Granger Cause USA	68.92	0.000
MEXICO does not Granger Cause USA	49.91	0.000
MSCI does not Granger Cause USA	119.14	0.000

Table 4.3: Forecast Error Variance for the Stock markets of Countries of North America

Variance Decomposition of BERMUDA					
Period	BERMUDA	CANADA	MEXICO	MSCI	USA
1	100.0000	0 000000	0 000000	0 000000	0.000000
2	98.45977	0 499716	0.233611	0 613887	0 193013
5	96 19433	2 132149	0 451783	0 793617	0 428124
10	92.99088	4 829669	0.752877	0 530145	0 896425
Variance Decomposition of CANADA					
Period	BERMUDA	CANADA	MEXICO	MSCI	USA
1	2 691875	97 30812	0 000000	0 000000	0.000000
2	3 588509	95 51697	0 596793	0.253329	0.044399
5	3 219251	93.82396	2 361597	0 513435	0.081754
10	2 183858	90 26151	6 706343	0.745183	0 103111
Variance Decomposition of MEXICO					
Period	BERMUDA	CANADA	MEXICO	MSCI	USA
1	0.187754	26 29664	73.51560	0 000000	0 000000
2	0.309208	27 03257	72 65005	6 43E-05	0 008107
5	0.508225	26 23647	73.20955	0.006669	0 039087
10	0 821971	24 53345	74 46271	0.036239	0,145629
Variance Decomposition of MSCI					
Period	BERMUDA	CANADA	MEXICO	MSCI	USA
1	2 002097	55 83705	8 489314	33.67154	0.000000
2	2.655900	53 95263	8 292935	35 05494	0 043595
5	2.690304	51 34692	10 04795	35 87924	0 035589
10	2 226391	47 67757	13 74344	36 33170	0.020900
Variance Decomposition of USA:					
Period	BERMUDA	CANADA	MEXICO	MSCI	USA
1	0.013706	6 773873	0 584998	17 30416	75.32326
2	0.752624	25.30271	3 875274	21.92806	48.14133
5	1.204350	28 26778	4.896907	24.83603	40.79493
10	1.430987	29.25140	6 124609	26.57829	36.61472

Table 4.4: Vector Error Correction Model for the Stock markets of Countries of North America Region

E C T	Δ BERMUDA	Δ CANADA	Δ MEXICO	Δ MSCI	Δ USA
	-0.0311 [-2.347]	0.0129 [0.951]	-0.0726 [-3.281]	-0.0351 [-2.811]	0.1234 [10.81]
	Short-run lagged Differences				
Δ BERMUDA	-	0.0382 (0 041) [0.927]	0.0572 (0.066) [0.856]	0.0591 (0 037) [1.569]	-0.0943 (0.034) [-2.733]
Δ CANADA	-0.1255 (0.068) [-1 836]	-	-0.2342 (0.114) [-2 052]	-0.1244 (0 0942) [-2 093]	0.4103 (0 058) [6.967]
Δ MEXICO	0 0346 (0.032) [1 062]	-0 0033 (0.033) [-0.098]	-	0.0105 (0 031) [0 345]	-0 0491 (0.028) [-1 751]
Δ MSCI	0 4282 (0.1286) [3 328]	0 0049 (0 132) [0 037]	0 6423 (0 215) [2.987]	-	-0 5673 (0.111) [-5.112]
Δ USA	-0 1354 (0.0864) [-1.567]	0 0788 (0.089) [0 885]	-0.5537 (0.144) [-3.834]	-0.1854 (0.081) [-2.281]	-

Note: [ ] presents t-Statistics and ( ) Standard Error.

Table 4.5: Johansen Maximum Likelihood test for the Stock markets of Countries of North America Region

Null Hypothesis	Alternative Hypothesis	λ Trace Value	Critical Values	
			5%	1%
r = 0*	r > 0	51.586	47.21	54.46
r ≤ 1	r > 1	24 295	29.68	35.65
r ≤ 2	r > 2	9 428	15.41	20.04
r ≤ 3	r > 3	0 2691	3 76	6 65
Null Hypothesis	**Alternative Hypothesis**	**λ Max Value**	**Critical Values**	
			5%	**1%**
r = 0*	r = 1	27 291	27.07	32.24
r = 1	r = 2	14 867	20 97	25.52
r = 2	r = 3	9.159	14 07	18.63
r = 3	r = 4	0 269	3 76	6 65

*, (**) denotes rejection of the hypothesis at the 5%, (1%) level respectively
r = No. of Cointegrating Vectors.

South and Central America

Table 4.6.I: The estimated τ-statistic values from unit root tests (Level)

Variable	Intercept alone			Intercept + Trend		
	DF	ADF	PP	DF	ADF	PP
Argentina	-0.23	-0.61 (2)	-0.47 (5)	-1.17	-1.439(2)	-1.38(5)
Brazil	-1.06	-1.07(4)	-1 11(5)	-2.28	-2 50(4)	-2.41(5)
Chile	1.27	0 57(1)	0 96(1)	-1.23	-1.66(1)	-1.52(5)
Colombia	1 72	1.50(1)	1.62(1)	-0 51	-1 14(4)	-0.84(5)
Costa Rica	-1.61	-1.89(2)	-1 69(2)	-1 65	-1.76(7)	-1.60(1)
Peru	3.61	2.95(1)	3 33(1)	1.20	0.83(1)	0 90(2)
Venezuela	-1.32	-1 43(2)	-1 36(5)	-1.86	-2.22(2)	-2.07(5)

*Note: The critical values for unit root test are: -3 49 and -2.88 (without trend) and -4 04, -3 45 (with trend) respectively for 1% and 5% level. * and ** implies stationarity at 1% and 5% level.*

Table 4.6.II: The estimated τ-statistic values from unit root tests (First Difference)

Variable	Intercept alone			Intercept + Trend		
	DF	ADF	PP	DF	ADF	PP
Argentina	-22 83*	-14 94*(1)	-22.83(1)*	-22 85*	-14 96*(1)	-22.85*(1)
Brazil	-25.21*	-16 05*(1)	-25 21*(1)	-25 19*	-15.99*(1)	-25 19*(1)
Chile	-18.67*	-14 05*(1)	-18.65*(1)	-18 89*	-14 24*(1)	-18.88*(1)
Colombia	-21 85*	-14 63*(1)	-21 84*(1)	-21 96*	-14.73*(1)	-21 95*(1)
Costa Rica	-28.65*	-20.22*(1)	-28 69*(1)	-28 68*	-20 27*(1)	-28 72*(1)
Peru	-20 77*	-14.14*(1)	-20 74*(1)	-21.21*	-14 55*(1)	-21 19*(1)
Venezuela	-20 50*	-14 39*(1)	-20 47*(1)	-20 49*	-14 39*(1)	-20.46*(1)

*Note: The critical values for unit root test are. -3.49 and -2.88 (without trend) and -4 04, -3 45 (with trend) respectively for 1% and 5% level * and ** implies stationarity at 1% and 5% level*

Table 4.7: Pair Wise Granger Causality Test for Stock Markets of Countries of South & Central America Region

Null Hypothesis:	F-Statistic	Probability
ARGENTINA does not Granger Cause BRAZIL	38.370	0.000
ARGENTINA does not Granger Cause CHILE	39.582	0.000
COLOMBIA does not Granger Cause ARGENTINA	2.975	0.052
ARGENTINA does not Granger Cause PERU	10.690	0.000
ARGENTINA does not Granger Cause VENEZUELA	17.131	0 000
BRAZIL does not Granger Cause CHILE	4 469	0.012
COLOMBIA does not Granger Cause BRAZIL	6.534	0.002
MSCI does not Granger Cause BRAZIL	14.290	0.000
PERU does not Granger Cause BRAZIL	43.660	0 000
BRAZIL does not Granger Cause PERU	4.822	0 008
MSCI does not Granger Cause CHILE	58.000	0.000
PERU does not Granger Cause CHILE	33 670	0.000
CHILE does not Granger Cause PERU	7.146	0.001
MSCI does not Granger Cause COLOMBIA	3.024	0.049
COLOMBIA does not Granger Cause MSCI	13.470	0.000
COLOMBIA does not Granger Cause PERU	4.993	0.007
MSCI does not Granger Cause PERU	3.112	0 045
MSCI does not Granger Cause VENEZUELA	10.070	0.000
PERU does not Granger Cause VENEZUELA	11 350	0 000

Table 4.8: Forecast Error Variance for the Stock Markets of Countries of South & Central America Region

Variance Decomposition of ARGENTINA:								
Period	ARGENTINA	BRAZIL	CHILE	COLOMBIA	COSTARICA	MSCI	PERU	VENEZUELA
1	100.00	0.000	0.00	0.000	0.000	0.000	0 000	0.000
2	98.41	0 10	0.041	0 901	0.116	0.053	0.225	0.137
5	97.66	0.11	0.097	1 026	0 199	0 473	0.276	0 145
10	97.65	0 11	0.098	1.032	0.199	0.478	0.277	0.146
Variance Decomposition of BRAZIL:								
Period	ARGENTINA	BRAZIL	CHILE	COLOMBIA	COSTARICA	MSCI	PERU	VENEZUELA
1	0 0021	99 99	0.00	0 000	0.000	0 00	0 00	0 000
2	20.96	63 36	0.092	0 049	0.003	13 86	1.59	0 060
5	20 73	61 15	0 286	1 478	0 363	14 28	1 57	0 113
10	20.77	61.10	0.290	1 485	0.363	14 28	1 57	0.115
Variance Decomposition of CHILE:								
Period	ARGENTINA	BRAZIL	CHILE	COLOMBIA	COSTARICA	MSCI	PERU	VENEZUELA
1	0 032	8.356	91 61	0 00	0 00	0 000	0 000	0 000
2	11 17	7.381	70.87	0 049	0 088	8 960	1 392	0.078
5	13 88	7 468	66 87	0 255	0 261	9 088	2.089	0 080
10	13.97	7 453	66 74	0 279	0.261	9.105	2 092	0 081
Variance Decomposition of COLOMBIA:								
Period	ARGENTINA	BRAZIL	CHILE	COLOMBIA	COSTARICA	MSCI	PERU	VENEZUELA
1	1.101	0 091	0 102	98 704	0.000	0 000	0 000	0 000
2	1.087	0 560	0.272	97 921	0.016	0.024	0 016	0.099
5	1.763	0.768	0 296	96 052	0 031	0 773	0 165	0 148
10	1 797	0 768	0.299	95 996	0 031	0 788	0 167	0.151
Variance Decomposition of COSTARICA:								
Period	ARGENTINA	BRAZIL	CHILE	COLOMBIA	COSTARICA	MSCI	PERU	VENEZUELA
1	0 576	0 027	0.441	0 002	98 952	0 000	0.000	0 000
2	0 666	0 186	0 431	0.033	98.566	0 014	0 089	0.011
5	1.091	0.391	0 432	0 280	97 220	0 0348	0.264	0 286
10	1 091	0 391	0 433	0.282	97 219	0 0317	0 264	0.286
Variance Decomposition of MSCI:								
Period	ARGENTINA	BRAZIL	CHILE	COLOMBIA	COSTARICA	MSCI	PERU	VENEZUELA
1	16 157	0.005	0.091	0.070	0 253	83 42	0 000	0 00
2	15 31	0.013	0 234	4 336	0 292	79 00	0 797	0 006
5	15 20	0 479	0.358	4.352	0 311	78 35	0.796	0 134
10	15 211	0 479	0 358	4 354	0 312	78 35	0 796	0 135
Variance Decomposition of PERU:								
Period	ARGENTINA	BRAZIL	CHILE	COLOMBIA	COSTARICA	MSCI	PERU	VENEZUELA
1	11.18	0.944	0 35	0 388	0 030	4.716	82.38	0 00
2	13.31	1.254	0 34	1 308	0 570	4.486	78.61	0 11
5	15 67	1 222	2 08	1 595	0 577	5 155	73.51	0 17
10	15.73	1.221	2 09	1 620	0 578	5 181	73.39	0.17
Variance Decomposition of VENEZUELA:								
Period	ARGENTINA	BRAZIL	CHILE	COLOMBIA	COSTARICA	MSCI	PERU	VENEZUELA
1	0.450	3.00	0 28	0.02	0 28	0.09	0.042	95.80
2	5.530	2.82	0.31	0.14	0.57	0.83	0.732	89.03
5	6.715	3 00	0.41	0 64	0 56	1 34	0 740	86 56
10	6.778	3.00	0 41	0.66	0.56	1.36	0 746	86.45

South & Central gion

E C T	Δ ARGI NTIN	L	Δ CHILE	Δ COLO MBIA	Δ COST A RICA	Δ MSCI	Δ PERU	Δ VENE ZUEL A
	-0 181 [-4 9]	]	0.05 [4 17]	0 016 [0 93]	-0.011 [-0 47]	-0.1 [-6.84]	0.013 [0 6]	0.188 [5.6]
			Short-run lagged Differences					
Δ ARGEN TINA	-	)	0 016 (-0 01) [0 96]	-0 021 (-0 02) [-0 84]	0 026 (-0 03) [0 72]	0 094 (-0 02) [4 4]	0 046 (-0 03) [1.5]	-0.058 (-0 04) [-1.9]
Δ BRAZIL	-0 32 (-0 06) [-4 91]		0 08 (-0 02) [4 15]	-0 02 (-0 03) [-0 66]	-0 057 (-0.04) [-1 303]	-0.16 (-0.02) [-6 3]	0 039 (-0 07) [1.3]	0.28 (-0.05) [4.8]
Δ CHILE	0 009 (-0.12) [0 0]	)]	-	-0.061 (-0.05) [-1 03]	0 013 (-0 08) [0 163]	0.036 (-0 04) [0 7]	-0 11 (-0.07) [-1.6]	-0.121 (-0.11) [-1 9]
Δ COLOM BIA	0 028 (-0 08) [0 34]	)	0 019 (-0 02) [0 71]	-	-0.006 (-0 05) [-0 12]	0 092 (-0.03) [2 8]	0.092 (-0.04) [1.9]	-0.014 (-0 07) [-0 2]
Δ COSTAR ICA	-0 061 (-0 05) [-1 14]	)	0 013 (-0 01) [0 79]	0 012 (-0 02) [0 49]	-	-0.034 (-0 02) [-1 61]	-0.047 (-0 03) [-1.30]	0 12 (-0.04) [2.58]
Δ MSCI	0 707 (-0 16) [4 36]	)]	0 06 (-0 05) [1 15]	-0 073 (-0.07) [-0 94]	0 047 (-0.11) [0 42]	-	-0.099 (-0 09) [-1.07]	-0 497 (-0.14) [-3.40]
Δ PERU	-0 075 (-0 07) [-0 99]	)]	0 034 (-0 02) [2 42]	-0 029 (0 03) [-0 81]	0 058 (-0 05) [1 07]	-0 041 (-0.03) [-1.57]	-	0.06 (-0.06) [0.97]
Δ VENEZU ELA	-0.05 (-0 04) [-1.09]	)]	0 033 (-0 01) [2 21]	0 019 (-0 02) [0 87]	-0 041 (-0.03) [-1 29]	-0 058 (-0 01) [-3 01]	0 034 (-0.02) [1 32]	-

N resents t-Statistic and ( ) Standard Error

Table 4.9: Vector Error Correction Model for the Stock Markets of Countries of South & Central America Region

E C T	Δ ARGENTINA	Δ BRAZIL	Δ CHILE	Δ COLOMBIA	Δ COSTA RICA	Δ MSCI	Δ PERU	Δ VENEZUELA
	-0.181 [-4.9]	0.4 [15.1]	0 05 [4.17]	0 016 [0.93]	-0.011 [-0 47]	-0.1 [-6 84]	0.013 [0.6]	0.188 [5.6]
	Short-run lagged Differences							
Δ ARGENTINA	-	-0 107 (-0 03) [-2.81]	0 016 (-0.01) [0 96]	-0.021 (-0 02) [-0.84]	0.026 (-0.03) [0.72]	0 094 (-0.02) [4 4]	0 046 (-0.03) [1 5]	-0.058 (-0.04) [-1.9]
Δ BRAZIL	-0 32 (-0 06) [-4 91]	-	0.08 (-0 02) [4.15]	-0 02 (-0 03) [-0 66]	-0 057 (-0.04) [-1 303]	-0.16 (-0 02) [-6 3]	0 039 (-0.07) [1 3]	0.28 (-0 05) [4.8]
Δ CHILE	0.009 (-0.12) [0.0]	-0.232 (-0 29) [-0.26]	-	-0.061 (-0.05) [-1 03]	0.013 (-0.08) [0.163]	0.036 (-0.04) [0.7]	-0 11 (-0.07) [-1.6]	-0.121 (-0.11) [-1.9]
Δ COLOMBIA	0 028 (-0.08) [0.34]	0.273 (-0.05) [4.61]	0 019 (-0.02) [0 71]	-	-0.006 (-0 05) [-0 12]	0.092 (-0.03) [2 8]	0 092 (-0.04) [1.9]	-0 014 (-0.07) [-0.2]
Δ COSTARICA	-0.061 (-0.05) [-1.14]	0 051 (-0 03) [1 34]	0.013 (-0.01) [0.79]	0 012 (-0 02) [0 49]	-	-0 034 (-0 02) [-1 61]	-0 047 (-0 03) [-1.30]	0.12 (-0.04) [2.58]
Δ MSCI	0.707 (-0.16) [4 36]	-0.58 (-0.11) [-5 04]	0 06 (-0.05) [1 15]	-0 073 (-0 07) [-0.94]	0 047 (-0 11) [0 42]	-	-0.099 (-0.09) [-1 07]	-0.497 (-0 14) [-3 40]
Δ PERU	-0 075 (-0.07) [-0.99]	0.038 (-0 05) [0 71]	0 034 (-0 02) [2 42]	-0 029 (-0 03) [-0 81]	0 058 (-0 05) [1 07]	-0 041 (-0.03) [-1 57]	-	0.06 (-0.06) [0 97]
Δ VENEZUELA	-0 05 (-0 04) [-1 09]	0 14 (-0.03) [4 24]	0 033 (-0 01) [2.21]	0 019 (-0.02) [0.87]	-0 041 (-0 03) [-1 29]	-0.058 (-0 01) [-3 01]	0.034 (-0.02) [1 32]	-

Note [ ] presents t-Statistics and ( ) Standard Error

Table 4.10: Johansen Maximum Likelihood Test for the Stock Markets of Countries of South & Central America Region

Null Hypothesis	Alternative Hypothesis	λ Trace Value	Critical Values	
			5%	1%
r = 0**	r > 0	183 86	141.2	152 32
r ≤ 1**	r > 1	128 16	109.99	119.8
r ≤ 2**	r > 2	91.46	82 49	90.45
r ≤ 3*	r > 3	62.437	59.46	66.52
r ≤4	r > 4	37.925	39 89	45.58
r ≤ 5	r > 5	21 57	24.31	29.75
r ≤ 6	r > 6	11 61	12 53	16 31
r ≤ 7	r > 7	4.633	4.84	6.51
Null Hypothesis	**Alternative Hypothesis**	**λ Max Value**	**Critical Values**	
			5%	**1%**
r = 0**	r = 1	55 70	47.99	53.9
r = 1	r = 2	36.70	41 51	47.15
r = 2	r = 3	29 02	36.36	41.00
r = 3	r = 4	24 51	30 04	35 17
r = 4	r = 5	16.34	23.8	28.82
r = 5	r = 6	9 96	17 89	22.99
r = 6	r = 7	6 98	11 44	15.69
r = 7	r = 8	4 63	4.84	6.51

*, (**) denotes rejection of the hypothesis at the 5%, (1%) level respectively.
r = No. of Cointegrating Vectors

South Asia

Table 4.11.I: The estimated τ-statistic values from unit root tests (Level)

Variable	Intercept Alone			Intercept and Trend		
	DF	ADF	PP	DF	ADF	PP
Bangladesh	-0 86	-1.37(4)	-1 12(5)	-1 28	-1.76(4)	-1.52(5)
India	0.72	0 50(1)	0 62(1)	-0.72	-0.95(3)	-0.87(3)
Pakistan	0 65	0 30(1)	0.49(1)	-1 79	-1.92(3)	-1 89(5)
Sri Lanka	1.28	0.83(1)	1.08(1)	-1 17	-1 24(1)	-1.3(5)

*Note: The critical values for unit root test are. -3 49 and -2.88 (without trend) and -4.04, -3.45 (with trend) respectively for 1% and 5% level. * and ** implies stationarity at 1% and 5% level.*

Table 4.11.II: The estimated τ-statistic values from unit root tests (First Difference)

Variable	Intercept Alone			Intercept and Trend		
	DF	ADF	PP	DF	ADF	PP
Bangladesh	-23 22*	-14.13[d](1)	-23 21*(1)	-23.22[r]	-14 13*(1)	-23.21*(1)
India	-22 39*	-16.40*(1)	-22 39*(1)	-22 48[k]	-16.50*(1)	-22 48[k](1)
Pakistan	-20 14*	-14.79*(1)	-20 13[r](1)	-20 24*	-14 88[r](1)	-20.22*(1)
Sri Lanka	-20 23*	-15 19[r](1)	-20 22*(1)	-20 42[r]	-15 37*(1)	-20.41*(1)

*Note: The critical values for unit root test are. -3 49 and -2 88 (without trend) and -4.04, -3 45 (with trend) respectively for 1% and 5% level * and ** implies stationarity at 1% and 5% level*

Table 4.12: Pair Wise Granger Causality Tests for the Stock Markets of Countries of South Asia Region

Null Hypothesis:	F-Statistic	Probability
MSCI does not Granger Cause INDIA	3.298	0 038
INDIA does not Granger Cause MSCI	33.979	0 000
INDIA does not Granger Cause PAKISTAN	15.897	0.000
INDIA does not Granger Cause SRI LANKA	3 751	0.024
PAKISTAN does not Granger Cause MSCI	5 913	0 003
MSCI does not Granger Cause PAKISTAN	4 642	0.010
MSCI does not Granger Cause SRI LANKA	5 059	0.007

Table 4.13: Forecast Error Variance for Stock Markets of Countries of South Asia Region

Variance Decomposition of BANGLADESH					
Period	BANGLADESH	INDIA	MSCI	PAKISTAN	SRI LANKA
1	100.00	0.00	0.00	0.00	0 00
2	99.69	0 04	0.01	0 07	0.19
5	99 61	0.08	0.01	0.10	0 20
10	99.61	0.08	0.01	0.10	0 20
Variance Decomposition of INDIA					
Period	BANGLADESH	INDIA	MSCI	PAKISTAN	SRI LANKA
1	0 196	99 804	0 000	0 000	0 000
2	0.314	97 744	1 152	0.185	0.606
5	0 872	97 088	1 170	0.256	0 614
10	0.873	97 087	1.170	0.256	0.614
Variance Decomposition of MSCI					
Period	BANGLADESH	INDIA	MSCI	PAKISTAN	SRI LANKA
1	0 036	2 158	97 806	0 000	0 000
2	0.404	12 870	85.797	0 752	0.177
5	0 699	12 741	84 787	1 291	0 482
10	0 701	12 742	84.783	1 291	0.483
Variance Decomposition of PAKISTAN					
Period	BANGLADESH	INDIA	MSCI	PAKISTAN	SRI LANKA
1	0 050	1.250	0 001	98 700	0 000
2	0 047	5.191	0 387	94 372	0.003
5	0 086	7 746	0.433	91.608	0 127
10	0.088	7 748	0.434	91 603	0.127
Variance Decomposition of SRI LANKA					
Period	BANGLADESH	INDIA	MSCI	PAKISTAN	SRI LANKA
1	0 010	0 223	0.334	0.636	98.796
2	0.119	0 244	1 109	0 963	97.565
5	0 139	1.769	1 513	1.198	95.381
10	0.139	1 770	1.513	1 198	95 379

Table 4.14: Vector Error Correction Model for the Stock Markets of Countries of South Asia Region

E C T	Δ BANGLADESH	Δ INDIA	Δ MSCI	Δ PAKISTAN	Δ SRI LANKA
	-0 0024 [-1.92]	0 0035 [3 69]	0 0002 [0 28]	0.0013 [1.18]	-0 0010 [-1.22]
	Short-run lagged Differences				
Δ BANGLADESH	-	-0.022 (-0.03) [-0.66]	0.021 (-0.01) [1 17]	-0.006 (-0.03) [-0.17]	0.021 (-0.02) [0 84]
Δ INDIA	0.014 (-0.05) [0 27]	-	0 189 (-0 02) [8.23]	0 207 (-0 04) [4.406]	-0.008 (-0 03) [-0.25]
Δ MSCI	0 052 (-0 094) [0 55]	0.162 (-0.076) [2 13]	-	0 119 (-0 085) [1 39]	0 128 (-0.06) [2.11]
Δ PAKISTAN	0.029 (-0 04) [0 64]	0.039 (-0 03) [1.52]	0.043 (-0 02) [2.15]	-	0 032 (-0.02) [1.16]
Δ SRI LANKA	-0.053 (-0.06) [-0 82]	0.079 (-0 05) [1.52]	0.03 (-0 02) [1.62]	0 007 (-0 05) [0.38]	-

Note· [ ] presents t-Statistics and ( ) Standard Error

Table 4.15: Johansen Maximum likelihood Test for the Stock Markets of Countries of South Asia Region

Null Hypothesis	Alternative Hypothesis	λ Trace Value	Critical Values	
			5%	1%
r = 0	r > 0	83.545	87.31	96 58
r ≤ 1	r > 1	54 915	62 99	70.05
r ≤ 2	r > 2	32 284	42 44	48.45
r ≤ 3	r > 3	12.484	25 32	30.45
r ≤ 4	r > 4	4 111	12 25	16 26
Null Hypothesis	**Alternative Hypothesis**	**λ Max Value**	**Critical Values**	
			5%	**1%**
r = 0	r = 1	28 629	37 52	42.36
r = 1	r = 2	22 631	31 46	36 65
r = 2	r = 3	19 801	25 54	30 34
r = 3	r = 4	8 373	18.96	23.65
r = 4	r = 5	4.112	12 25	16.26

*, (**) denotes rejection of the hypothesis at the 5%, (1%) level respectively
r = No. of Cointegrating Vectors.

Asia Pacific

Table 4.16.I: The estimated τ-statistic values from unit root tests (Level)

Variable	Intercept Alone			Intercept + Trend		
	DF	ADF	PP	DF	ADF	PP
Australia	0.252	0 26(1)	0.246(1)	-1 37	-1.4(3)	-1 45(3)
China	-1.059	-1 47(4)	-1 27(5)	-1 53	-1.9(4)	-1.74(5)
Hong Kong	-1.66	-1 84(2)	-1 85(5)	-1 92	-2.1(2)	-2.13(5)
Indonesia	-1.45	-1.52(3)	-1.47(5)	-1 14	-1.2(3)	-1.15(5)
Japan	-1.39	-1 33(3)	-1.37(2)	-0 83	-0.7(2)	-0.78(2)
Korea Republic	-1 15	-1.55(4)	-1 26(5)	-2 03	-2.4(4)	-2.19(5)
Malaysia	-1 55	-1 77(2)	-1.80(5)	-1.54	-1 7(2)	-1.79(5)
New Zealand	-0 55	-0 96(4)	-0 72(4)	-1.55	-1.9(4)	-1 73(4)
Philippines	-1 21	-1 61(4)	-1 44(5)	-0.51	-1.1(4)	-0 86(5)
Singapore	-1.108	-1.281(1)	-1.36(5)	-1.33	-1 4(1)	-1.56(5)
Taiwan	-2.16	-2 02(1)	-2 26(5)	-2 28	-2 1(1)	-2 39(5)
Thailand	-2.04	-2 18(3)	-2 09(5)	-1.88	-2.0(3)	-1 94(5)

*Note: The critical values for unit root test are -3 49 and -2 88 (without trend) and -4.04, -3 45 (with trend) respectively for 1% and 5% level * and ** implies stationarity at 1% and 5% level.*

Table 4.16.II: The estimated τ-statistic values from unit root tests (First Difference)

Variable	Intercept Alone			Intercept + Trend		
	DF	ADF	PP	DF	ADF	PP
Australia	-24 09*	-16 6*(1)	-24 0*(1)	-24.01*	-16.6*(1)	-24.0*(1)
China	-22 04*	-15.8*(1)	-22 4*(1)	-22 03*	-15 8*(1)	-22 3*(1)
Hong Kong	-23.71*	-15 7*(1)	-23.7*(1)	-23.70*	-15 7*(1)	-23.7*(1)
Indonesia	-29 40*	-16 3*(1)	-29 3*(1)	-29 58*	-16.1*(1)	-29 5*(1)
Japan	-25 65*	-16 7*(1)	-25 6*(1)	-25 6*	-16 8*(1)	-25.6*(1)
Korea Republic	-26.28*	-17.0*(1)	-26 2*(1)	-26 34*	-17 9*(1)	-26 3*(1)
Malaysia	-23 36*	-15 0*(1)	-23 3*(1)	-23.3*	-15.1*(1)	-23 4*(1)
New Zealand	-23.80*	-16 0*(1)	-23 8*(1)	-23.1*	-16.0*(1)	-23.8*(1)
Philippines	-23 22*	-14 3*(1)	-23 2*(1)	-23 3*	-14.4*(1)	-23.3*(1)
Singapore	-22 50*	-16 9*(1)	-22.5*(1)	-22 5*	-16.9*(1)	-22.5*(1)
Taiwan	-25 35*	-16 8*(1)	-25.3*(1)	-25.3*	-16 7*(1)	-25 3*(1)
Thailand	-23.13*	-14 3*(1)	-23 1*(1)	-23.2*	-14 7*(1)	-23.2*(1)

*Note: The critical values for unit root test are -3 49 and -2.88 (without trend) and -4 04, -3.45 (with trend) respectively for 1% and 5% level. * and ** implies stationarity at 1% and 5% level*

Table 4.17: Pair Wise Granger Causality for the Stock Markets of the Countries of Asia Pacific Region

Null Hypothesis:	F-Statistic	Probability
AUSTRALIA does not Granger Cause INDONESIA	14.616	0.000
AUSTRALIA does not Granger Cause KOREA REPUBLIC	4.523	0.011
AUSTRALIA does not Granger Cause MSCI	18.323	0.000
NEW ZEALAND does not Granger Cause AUSTRALIA	19.707	0.000
SINGAPORE does not Granger Cause AUSTRALIA	28 770	0.000
SINGAPORE does not Granger Cause CHINA	9 079	0.000
HONG KONG does not Granger Cause INDONESIA	53.100	0.000
MALAYSIA does not Granger Cause HONGKONG	3.884	0.021
HONG KONG does not Granger Cause MSCI	15.028	0 000
NEW ZEALAND does not Granger Cause HONG KONG	39.337	0.000
HONG KONG does not Granger Cause NEW ZEALAND	6.914	0 001
HONG KONG does not Granger Cause PHILIPPINES	3 112	0.045
SINGAPORE does not Granger Cause HONG KONG	20.327	0 000
HONG KONG does not Granger Cause SINGAPORE	6.846	0 001
HONG KONG does not Granger Cause TAIWAN	3.689	0 026
CHINA does not Granger Cause MSCI	3.188	0 042
NEW ZEALAND does not Granger Cause CHINA	3 626	0.027
KOREA REPUBLIC does not Granger Cause INDONESIA	29.188	0.000
MSCI does not Granger Cause INDONESIA	25 768	0 000
PHILIPPINES does not Granger Cause INDONESIA	29.980	0.000
TAIWAN does not Granger Cause INDONESIA	9 683	0.000
THAILAND does not Granger Cause INDONESIA	70.192	0 000
JAPAN does not Granger Cause KOREA REPUBLIC	5 328	0 005
MALAYSIA does not Granger Cause JAPAN	11 532	0 000
JAPAN does not Granger Cause NEW ZEALAND	7 353	0 001
MALAYSIA does not Granger Cause KOREA REPUBLIC	4 744	0 009
KOREA REPUBLIC does not Granger Cause MALAYSIA	3.647	0 027
KOREA REPUBLIC does not Granger Cause MSCI	68 598	0.000
NEW ZEALAND does not Granger Cause KOREA REPUBLIC	17.157	0.000
KOREA REPUBLIC does not Granger Cause NEW ZEALAND	4 185	0 016

Cont...

Table 4.17: Pair Wise Granger Causality for the Stock Markets of the Countries of Asia Pacific Region

Null Hypothesis:	F-Statistic	Probability
KOREA REPUBLIC does not Granger Cause PHILIPPINES	4.996	0.007
SINGAPORE does not Granger Cause KOREA REPUBLIC	60.731	0 000
KOREAREPUBLIC does not Granger Cause SINGAPORE	5.427	0.005
THAILAND does not Granger Cause KOREA REPUBLIC	4.665	0.010
NEW ZEALAND does not Granger Cause MALAYSIA	7.020	0.001
MALAYSIA does not Granger Cause NEW ZEALAND	3.117	0.045
NEW ZEALAND does not Granger Cause MASCI	11.026	0.000
PHILIPPINES does not Granger Cause MSCI	41.332	0 000
MSCI does not Granger Cause PHILIPPINES	4 749	0.009
SINGAPORE does not Granger Cause MSCI	29 75	0 000
TAIWAN does not Granger Cause MSCI	35.878	0 000
THAILAND does not Granger Cause MSCI	37 185	0 000
PHILIPPINES does not Granger Cause NEW ZEALAND	7 100	0 001
NEW ZEALAND does not Granger Cause PHILIPPINES	34 127	0.000
NEW ZEALAND does not Granger Cause SINGAPORE	36 056	0.000
TAIWAN does not Granger Cause NEW ZEALAND	3.128	0.045
NEW ZEALAND does not Granger Cause TAIWAN	9.959	0.000
THAILAND does not Granger Cause NEW ZEALAND	4.113	0 017
NEW ZEALAND does not Granger Cause THAILAND	31 909	0.000
SINGAPORE does not Granger Cause PHILIPPINES	16.124	0 000
PHILIPPINES does not Granger Cause SINGAPORE	5.033	0.007
TAIWAN does not Granger Cause PHILIPPINES	6 878	0.001
THAILAND does not Granger Cause PHILIPPINES	13 105	0 000
SINGAPORE does not Granger Cause TAIWAN	45 192	0 000
THAILAND does not Granger Cause SINGAPORE	6 934	0.001
SINGAPORE does not Granger Cause THAILAND	31 806	0 000
THAILAND does not Granger Cause TAIWAN	4 503	0 011

Table 4.18: Forecast Error Variance for the Stock Markets of the Countries of Asia Pacific Region

Variance Decomposition of AUSTRALIA:													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	100.	0 00	0 000	0 00	0 0	0 000	0 000	0.000	0 000	0 000	0 000	0.000	0 000
2	85.756	0 178	0 019	0.003	0 010	0 057	0.001	0 009	2.025	0.033	10.719	0.366	0.825
5	65.760	0 260	0 401	0 347	0.691	0 221	0 506	0.475	20 988	0.159	8 366	1 016	0.811
10	65.584	0 263	0 411	0.353	0 697	0.226	0.522	0 488	20 994	0 249	8 386	1 017	0.810
Variance Decomposition of CHINA.													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	0.276	99.724	0 000	0 000	0 000	0 000	0 000	0 000	0.000	0.000	0 000	0.000	0 000
2	0.956	94.960	0.011	0 181	0 547	0 327	0 089	0 001	0 179	0 108	1.790	0.052	0 800
5	1 061	92 630	0 026	0 317	0 588	0.393	0 161	0.173	1.180	0 264	1.777	0.311	1 118
10	1 061	92 534	0 029	0 319	0 591	0 396	0 168	0 177	1 188	0 280	1.816	0 315	1.127
Variance Decomposition of HONG KONG.													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	7.89	0.64	91 47	0 00	0 00	0.00	0 00	0 00	0.00	0.00	0.00	0 00	0 00
2	5.10	0 41	58 40	0.46	0.12	0 19	0 71	0 06	1 34	0.08	33 07	0.04	0 02
5	4.46	0 48	51 21	0.57	0 48	0.38	0 67	1.06	10.74	0.73	28.53	0 10	0.58
10	4.46	0.48	51.14	0 58	0.51	0 38	0.68	1.07	10.73	0.74	28 53	0 11	0.59
Variance Decomposition of INDONESIA:													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	0.769	0 297	0 209	98 725	0.000	0.000	0 000	0.000	0.000	0.000	0 000	0 000	0 000
2	1.041	0.548	0.212	94 780	0 092	1 946	0 037	0 016	0 137	0.096	0 467	0.136	0 492
5	1.014	0.403	3 386	63.727	0 144	2 748	0 086	0 334	3.154	10.375	10.695	0.189	3.744
10	1.010	0.401	3 368	62.631	0 363	2 796	0.116	0 373	3.434	10.352	11.087	0 259	3.812

Cont.....

Table 4.18: Forecast Error Variance for the Stock Markets of the Countries of Asia Pacific Region

Variance Decomposition of JAPAN.													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	0.079	0 073	0 159	0.206	99 483	0.000	0 000	0 000	0.000	0 000	0 000	0 000	0.000
2	0 127	0 244	0 194	0.231	96.247	0 455	0.450	0 559	0 032	0 313	0 589	0.552	0.006
5	0.273	0 234	0 280	0.473	90 895	0 629	3 511	0.949	0.279	0.763	0 802	0.580	0.333
10	0.276	0 237	0 287	0.474	90.795	0.641	3.515	0 956	0 300	0.765	0 838	0 583	0.333
Variance Decomposition of KOREA REPUBLIC													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	7.116	0 057	3.725	0 267	0 437	88 399	0 000	0 000	0 000	0 000	0.000	0 000	0.000
2	6 094	0.764	3.109	0 543	0 374	74 649	0 477	0 090	0 409	0 034	12 861	0 041	0 555
5	6 259	0 718	2 929	0.638	2 027	67 259	1 052	0 686	4 622	0.110	12 662	0 302	0 735
10	6.258	0 717	2.927	0 640	2 055	67 195	1 074	0 686	4.631	0.121	12 648	0.306	0.744
Variance Decomposition of MALAYSIA·													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	0 006	0.144	0 202	0 005	1 363	1.122	97.159	0 000	0 000	0 000	0 000	0 000	0 000
2	0 595	0 224	0.223	0 284	1 860	1 757	92 715	0 085	0 821	0.000	0 775	0 000	0.660
5	0.726	0 412	0 309	0 342	2 141	2 257	89.082	0.118	1.964	0 274	1 185	0 285	0.904
10	0 734	0 412	0.319	0 347	2 180	2 268	88 858	0.122	2.025	0 309	1 209	0 300	0 916

Cont.....

Table 4.18: Forecast Error Variance for the Stock Markets of the Countries of Asia Pacific Region

Variance Decomposition of NEW ZEALAND													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	1.1385	0.0090	0 0976	0 0007	0 0905	0.2475	0 0047	0.0092	98 4022	0.0000	0.0000	0 0000	0 0000
2	1 3913	0 0172	0 3447	0 4290	0 0861	0 2349	1 6139	0 8460	93.1225	0 3277	0 0656	1 1410	0.3801
5	1 3182	0 0499	1 2804	0.4261	2 4639	0 8526	1 5879	0 9227	86 5050	2 0431	1.0135	1 0976	0 4389
10	1.3216	0.0503	1 2821	0 4271	2.4865	0 8622	1 5971	0 9237	86.4255	2.0465	1 0286	1.1075	0.4412
Variance Decomposition of PHILIPPINES·													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	0 985	0.210	0 916	0 001	0 232	0 001	0 048	0.040	0.139	97.428	0.000	0.000	0.000
2	0 773	0 267	0 723	0.028	0.240	0 348	0 090	1.216	1 688	75 496	18 306	0 188	0.637
5	1.000	0 486	1 001	0 259	0.658	0 913	0 123	1 223	9 034	66 192	17 065	0 710	1.336
10	1.002	0 486	1.000	0 282	0 749	0 955	0 138	1 235	9 243	65 847	17.012	0 712	1.339
Variance Decomposition of SINGAPORE													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	0.146	0 005	0.147	0.936	0.054	0 138	1.417	0 329	2.128	0.195	94 504	0 000	0.000
2	0.180	0 234	1 310	0.838	0 047	0 732	1.293	0 547	12.332	0 168	81.288	0 056	0.976
5	0 256	0 255	1 580	0.951	0.634	1 040	1.276	1.200	12 205	0 637	78 746	0.112	1.109
10	0.259	0 255	1 578	0.966	0 654	1 062	1 294	1.218	12 187	0 650	78.656	0.114	1 109

Cont.....

Table 4.18: Forecast Error Variance for the Stock Markets of the Countries of Asia Pacific Region

Variance Decomposition of MSCI													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	2.840	0 373	0 031	0.055	0 105	0.133	0 001	96.461	0 000	0.000	0.000	0.000	0.000
2	24.383	0.356	5 668	0 100	0.072	1 120	0.144	66 892	0 065	0.065	0 489	0 543	0.104
5	16 558	0 373	4 292	0 304	0 229	1 081	0.289	45 349	12 021	0.149	18 682	0 567	0 104
10	16.445	0 376	4 281	0 306	0 600	1 100	0.301	44 996	11 975	0 236	18 669	0.591	0.125
Variance Decomposition of TAIWAN.													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	1.684	0 846	1 966	0 276	0 013	3 913	0 003	1 382	0 092	0 007	0 209	89 609	0 000
2	1.483	0 802	1 753	0 252	0 045	3 501	0.139	1 399	0 524	0 265	9 732	80.104	0.002
5	1 502	0 857	1.783	0 584	0 452	3 593	0.343	1 439	3 123	0 789	9 621	75 437	0 479
10	1 509	0 856	1 789	0 586	0 482	3 602	0 350	1 440	3 151	0 798	9 629	75 327	0 481
Variance Decomposition of THAILAND·													
Period	AUSTRALIA	CHINA	HONG KONG	INDONESIA	JAPAN	KOREA REPUBLIC	MALAYSIA	MSCI	NEW ZEALAND	PHILIPPINES	SINGAPORE	TAIWAN	THAILAND
1	0.466	0 251	0 252	0 008	0 005	6.105	0 271	0 000	0 028	5.084	1 056	0.086	86.386
2	0.628	0 281	0 241	0 035	0 059	4.763	0.263	0.213	0.663	4.018	21.220	0 215	67 402
5	0 737	0 251	0.531	0 465	0 632	5 247	0 646	0.396	9.141	3 575	18 782	0.603	58.994
10	0 749	0.251	0.531	0 475	0 668	5 259	0.662	0.402	9.220	3.580	18 742	0 610	58.850

Table 4.19: Vector Error Correction Model for the Stock Markets of the Countries of Asia Pacific Region

ECT	Δ AUSTRALIA	Δ CHINA	Δ HONG KONG	Δ INDONESIA	Δ JAPAN	Δ KOREA REPUBLIC	Δ MALAYSIA	Δ MSCI	Δ NEW ZEALAND	Δ PHILIPPINES	Δ SINGAPORE	Δ TAIWAN	Δ THAILAND
	-0.005 [-2.02]	0 002 [0 194]	-0 024 [-5.69]	-0 007 [-0.74]	0 003 [0 57]	-0 021 [-2.77]	-0 001 [-0.08]	0 001 [0 48]	-0 008 [-2.64]	-0 009 [-1 66]	-0.045 [-8.66]	-0.026 [-4 26]	-0.019 [-3.02]
	Short Term Lag Differences												
Δ AUSTRALIA	-	-0 313 (-0 17) [-1 83]	0 095 (-0.08) [1 09]	-0 058 (-0 18) [-0 31]	0 002 (-0 09) [0.016]	0 171 (-0 13) [2 55]	0 120 (-0.11) [1 05]	0.528 (-0 04) [11.39]	0 084 (-0 05) [1 52]	-0 136 (-0 10) [-1.35]	-0.209 (-0 09) [-2 29]	-0 018 (-0 11) [-0.18]	0 129 (-0 17) [1.11]
Δ CHINA	-0 011 (-0.011) [-1 01]	-	0 013 (-0 022) [0 57]	0 056 (-0 047) [1 19]	-0.023 (-0 024) [-0 97]	0 083 (-0 034) [2 42]	0 020 (-0 029) [0.68]	-0.020 (-0 012) [-1 72]	-0 001 (-0 014) [-0 09]	-0 016 (-0 025) [-0 63]	0 038 (-0.024) [1 61]	0 033 (-0.02) [1.19]	-0.015 (-0.02) [-0.58]
Δ HONG KONG	-0 003 (-0 022) [-0.14]	0 004 (-0 087) [0 04]	-	0 037 (-0 095) [0 38]	-0 036 (-0.048) [-0 75]	0.010 (-0 069) [0 14]	-0 005 (-0 058) [-0.08]	0.136 (-0.024) [5 72]	0.047 (-0 029) [1.62]	-0.017 (-0 051) [-0 32]	0 135 (-0 048) [2.82]	0 041 (-0 057) [0.71]	-0.067 (-0 059) [-1.13]
Δ INDONESIA	-0.009 (-0.008) [-1.03]	0 035 (-0.034) [1.05]	0 015 (-0.017) [0 88]	-	0 008 (-0 018) [0 42]	0.028 (-0 027) [1 03]	0 029 (-0 022) [1 28]	0 003 (-0 009) [0 36]	-0 017 (-0.011) [-1.56]	-0.017 (-0.020) [-0 85]	0.002 (-0 018) [0 11]	-0.016 (-0.022) [-0.71]	-0.016 (-0.023) [-0.78]
Δ JAPAN	-0.006 (-0 019) [-0 29]	0.126 (-0.078) [1.61]	-0 016 (-0.040) [-0 40]	0.036 (-0 085) [0.43]	-	-0.053 (-0 062) [-02 25]	0.092 (-0 052) [1.77]	0 006 (-0.021) [0 29]	-0.001 (-0.026) [-0 05]	0.011 (-0.046) [0 24]	-0 080 (-0.043) [-2 18]	-0.018 (-0.051) [-0 35]	-0 010 (-0.053) [-0.18]
Δ KOREA REPUBLIC	-0.003 (-0 015) [-0.21]	-0 099 (-0 059) [-1 67]	-0 043 (-0 030) [-1 42]	-0 180 (-0 064) [-2.80]	0 038 (-0 032) [1 18]	-	0 054 (-0.039) [1 37]	0.045 (-0.016) [2.79]	0 021 (-0 019) [1.09]	0.031 (-0.034) [0 91]	0 007 (-0.032) [0.22]	0.000 (-0 038) [-0.004]	0.000 (-0.040) [-0.01]

Note [ ] presents t-Statistics and ( ) Standard Error.

Cont.....

Table 4.19: Vector Error Correction Model for the Stock Markets of the Countries of Asia Pacific Region

E C T	Δ AUSTRALIA	Δ CHINA	Δ HONG KONG	Δ INDONESIA	Δ JAPAN	Δ KOREAREPUBLIC	Δ MALAYSIA	Δ MSCI	Δ NEW ZEALAND	Δ PHILIPPINES	Δ SINGAPORE	Δ TAIWAN	Δ THAILAND
	-0.005 [-2.024]	0.002 [0 194]	-0 024 [-5 69]	-0.007 [-0.74]	0 003 [0 57]	-0.021 [-2 77]	-0.001 [-0 08]	0.001 [0 48]	-0 008 [-2 64]	-0 009 [-1 66]	-0.045 [-8.66]	-0.026 [-4 26]	-0 019 [-3 02]
	Short Term Lag Differences												
Δ MALAYSIA	-0.028 (-0 017) [-1.66]	0 032 (-0 067) [0 47]	-0 037 (-0.034) [-1.091]	-0.043 (-0.073) [-0 59]	-0.045 (-0.037) [-1 21]	-0.003 (-0 05)3 [-0 06]	-	0 017 (-0.018) [0 92]	-0.087 (-0 022) [-3 96]	-0 047 (-0 039) [-1.19]	-0.115 (-0.037) [-3.14]	-0.136 (-0 043) [-3.14]	-0 080 (-0.046) [-1.76]
Δ MSCI	-0.017 (-0.039) [-0.44]	-0.029 (-0.156) [-0 186]	-0 149 (-0 079) [-2 18]	0 086 (-0 170) [0 53]	0 145 (-0.086) [1.68]	0 039 (-0 124) [0 31]	-0 085 (-0 104) [-0 814]	-	-0 103 (-0 051) [-2 01]	0.193 (-0 091) [2 11]	-0.106 (-0.086) [-1.23]	0 096 (-0.101) [0 94]	0.043 (-0 106) [0.45]
Δ NEW ZEALAND	0.064 (-0 033) [2.09]	0 064 (-0 130) [0 49]	-0 025 (-0 066) [-2 38]	0.132 (-0 142) [0 93]	0.060 (-0.071) [0 84]	-0 047 (-0 104) [-2 45]	0 157 (-0 087) [1 81]	-0 028 (-0 036) [-0.78]	-	0 089 (-0 076) [1.16]	0 468 (-0.071) [6.54]	-0 059 (-0 085) [-0 69]	-0.032 (-0.089) [-0.35]
Δ PHILIPPINES	0 015 (-0.018) [0 83]	-0.108 (-0 074) [-1 462]	-0 048 (-0 037) [-2 28]	-0 016 (-0.080) [-0 23]	-0.055 (-0 041) [-1 35]	-0 008 (-0 059) [-0.143]	-0 026 (-0 049) [-0 52]	0 016 (-0 020) [0 790]	-0 019 (-0 024) [-0.81]	-	0 005 (-0 041) [0 13]	-0.058 (-0 048) [-1 27]	0.023 (-0 050) [0.44]
Δ SINGAPORE	0 156 (-0 019) [8.37]	0.228 (-0 075) [3 06]	0.635 (-0 038) [16.81]	-0.123 (-0.081) [-1 516]	-0 078 (-0 041) [-1 94]	0 527 (-0.059) [8 87]	0.095 (-0 050) [1 93]	0 042 (-0 020) [2 05]	0 016 (-0.024) [0 64]	0.483 (-0.043) [11.09]	-	0.368 (-0.048) [7.62]	0.603 (-0 051) [11.87]
Δ TAIWAN	0 028 (-0 017) [1.66]	-0 042 (-0 067) [-0.63]	0.022 (-0 034) [0.65]	-0 062 (-0 073) [-0 85]	0.066 (-0 037) [1.80]	-0 030 (-0.053) [-0.56]	-0 001 (-0 045) [-0 01]	0.040 (-0 018) [2 16]	-0 057 (-0 022) [-2 58]	0.044 (-0 039) [1 13]	-0 024 (-0 037) [-0.65]	-	0.050 (-0 046) [1.09]
Δ THAILAND	-0.039 (-0.016) [-2.38]	0 145 (-0 065) [2 25]	0.013 (-0.033) [0 39]	-0.124 (-0.071) [-1 74]	0 007 (-0.036) [0 19]	0 101 (-0.052) [1.94]	0 087 (-0.044) [1 993]	-0 017 (-0 018) [-0 93]	-0.033 (-0 021) [-1.55]	0 083 (-0.038) [2 17]	0 095 (-0.036) [2 64]	-0.007 (-0.042) [-0 16]	-

Note· [ ] presents t-Statistics and ( ) Standard Error.

Table 4.20: Johansen Maximum Likelihood Test the Stock Markets of the Countries of Asia Pacific Region

Null Hypothesis	Alternative Hypothesis	λ Trace Value	Critical Values	
			5%	1%
r = 0**	r > 0	415.389	277.71	293.44
r ≤ 1**	r > 1	313 271	233.13	247.18
r ≤ 2**	r > 2	234.165	192 89	204.95
r ≤ 3**	r > 3	172.324	156.00	168.36
r ≤ 4	r > 4	121 115	124.24	133.57
r ≤ 5	r > 5	80.730	94 15	103.18
r ≤ 6	r > 6	53 651	68 52	76.07
r ≤ 7	r > 7	31.993	47.21	54 46
r ≤ 8	r > 8	16 141	29.68	35.65
r ≤ 9	r > 9	4 216	15.41	20.04
r ≤ 10	r > 10	0 0259	3 76	6 65
Null Hypothesis	**Alternative Hypothesis**	**λ Max Value**	**Critical Values**	
			5%	**1%**
r = 0**	r = 1	102.118	68 83	75.95
r = 1**	r = 2	79 106	62.81	69 09
r = 2*	r = 3	61 841	57.12	62.8
r = 3	r = 4	51 208	51.42	57.69
r = 4	r = 5	40 385	45.28	51.57
r = 5	r = 6	27 08	39 37	45.1
r = 6	r = 7	21.657	33.46	38.77
r = 7	r = 8	15.852	27.07	32 24
r = 8	r = 9	11 923	20.97	25.52
r = 9	r = 10	4 1909	14.07	18 63
r = 10	r = 11	0.0259	3.76	6 65

* , (**) denotes rejection of the hypothesis at the 5%, (1%) level respectively.
r = No. of Cointegrating Vectors.

Africa and Middle East

Table 4.21.I: The estimated τ-statistic values from unit root tests (Level)

Variable	Intercept Alone			Intercept + Trend		
	DF	ADF	PP	DF	ADF	PP
Botswana	-0.89	-1.13 (4)	0.772 (1)	-2.74	-1 79 (1)	-2.14 (1)
Egypt	1.217	1.036 (1)	1.137 (1)	-0.09	-0.39 (1)	-0.27 (5)
Ghana	-0.455	-0 79 (4)	-0 541(5)	-0 62	-1.71 (4)	-1.16 (5)
Israel	-0.495	-0 63 (4)	-0.55 (5)	-1 812	-2.02 (4)	-1 94 (5)
Jordan	-1 426	-1.49 (1)	-1.47 (5)	-1.354	-1.452(1)	-1.44 (5)
Kuwait	0.733	0.708 (1)	0.703 (1)	-0.773	-1.01 (4)	-0.88 (5)
Mauritius	2.684	2 040 (2)	2.407 (1)	0.532	0.256 (2)	0.34 (1)
Nigeria	0 149	0.146 (1)	0.127 (1)	-1.097	-1.53 (4)	-1.32 (5)
Oman	-0 213	-0 679 (4)	-0 477 (5)	-0 585	-0.99 (4)	-0.86 (5)
Saudi Arabia	-0 297	-0.367 (3)	-0 380 (5)	-1.322	-1.64 (4)	-1 45 (5)
South Africa	0.554	0 383 (1)	0 478 (1)	-1.336	-1 72 (3)	-1.63 (5)
Tunisia	2.802	2 287 (1)	2 578(1)	0 989	0 575 (1)	0 807(1)

*Note The critical values for unit root test are -3 49 and -2 88 (without trend) and -4.04, -3 45 (with trend) respectively for 1% and 5% level. * and ** implies stationarity at 1% and 5% level.*

Table 4.21.II: The estimated τ-statistic values from unit root tests (First Difference)

Variable	Intercept Alone			Intercept and Trend		
	DF	ADF	PP	DF	ADF	PP
Botswana	-38 16*	-27.5* (1)	-39 2*(1)	-38 13*	-27 5*(1)	-39.2*(1)
Egypt	-22 60*	-15 6*(1)	-22.* (1)	-22.76*	-15.7*(1)	-22.7*(1)
Ghana	-15 18*	-9 94*(1)	-14 8*(1)	-15 1*	-9.94*(1)	-14.8*(1)
Israel	-25.86*	-15.6*(1)	-25 8*(1)	-25 84*	-15 6*(1)	-25.8*(1)
Jordan	-22.37*	-17 0*(1)	-22 3*(1)	-22 3*	-17 0*(1)	-22.3*(1)
Kuwait	-23 35*	-16 8*(1)	-23.3*(1)	-23 40*	-16 1*(1)	-23 4*(1)
Mauritius	-20 46*	-15 8*(1)	-20 4*(1)	-20 67	-16 7*(1)	-20 7*(1)
Nigeria	-23.36*	-14.8*(1)	-23 3*(1)	-23 37*	-14.8*(1)	-23 3*(1)
Oman	-20 73*	-13 7*(1)	-21 9*(1)	-20 7*	-13 7*(1)	-20 6*(1)
Saudi Arabia	-22 72*	-15 6*(1)	-22 7*(1)	-22 71*	-15 5*(1)	-22 7*(1)
South Africa	-22 62*	-16 2*(1)	-22 6*(1)	-22 6*	-16 6*(1)	-22 6*(1)
Tunisia	-21 142*	-14 18*(1)	-21 1*(1)	-21 5*	-14 3*(1)	-21 3*(1)

***Note:** The critical values for unit root test are. -3 49 and -2.88 (without trend) and -4 04, -3.45 (with trend) respectively for 1% and 5% level * and ** implies stationarity at 1% and 5% level.*

Table 4.22: Pair Wise Granger Causality Test for the Stock Markets of Countries of Africa & Middle East Region

Null Hypothesis:	F-Statistic	Probability
BOTSWANA does not Granger Cause GHANA	4.906	0.008
BOTSWANA does not Granger Cause OMAN	3.731	0.025
ISRAEL does not Granger Cause EGYPT	14.358	0.000
JORDAN does not Granger Cause EGYPT	6 348	0.002
EGYPT does not Granger Cause JORDAN	6 174	0 002
MAURITIOUS does not Granger Cause EGYPT	4.806	0.009
MSCI does not Granger Cause EGYPT	7 848	0 000
OMAN does not Granger Cause EGYPT	8 276	0 000
SAUDI ARABIA does not Granger Cause EGYPT	10.415	0.000
SOUTH AFRICA does not Granger Cause EGYPT	6.580	0.001
JORDAN does not Granger Cause GHANA	5 516	0.004
GHANA does not Granger Cause JORDAN	3 145	0 044
GHANA does not Granger Cause KUWAIT	3.500	0 031
JORDAN does not Granger Cause ISRAEL	5 272	0 005
ISRAEL does not Granger Cause MAURITIOUS	2 852	0 059
MSCI does not Granger Cause ISRAEL	20.483	0 000
ISRAEL does not Granger Cause MSCI	4.831	0.008
SOUTH AFRICA does not Granger Cause ISRAEL	3 532	0 030
MSCI does not Granger Cause JORDAN	6.134	0.002
JORDAN does not Granger Cause MSCI	3.819	0 023
OMAN does not Granger Cause KUWAIT	6.735	0 001
SAUDI ARABIA does not Granger Cause KUWAIT	24 179	0 000
TUNISIA does not Granger Cause NIGERIA	2.848	0.059

Table 4.23: Forecast Error Variance for the Stock Markets of Countries of Africa & Middle East Region

Variance Decomposition of BOTSWANA													
Period	BOTSWANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURITIOUS	MSCI	NIGERIA	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	100	0 000	0 000	0 000	0 000	0.000	0 000	0 000	0 000	0 000	0 000	0.000	0.000
2	99.03	0 093	0 17	0 17	0 031	0 034	0 22	0 011	0 042	0 13	0 0121	0 037	0.063
5	96 17	0 188	0 61	0 57	0 48	0 29	0 401	0 334	0 2	0 14	0.145	0 107	0.333
10	95 716	0 213	0 72	0 56	0.54	0 36	0 431	0 394	0 25	0 162	0 147	0 121	0.36
Variance Decomposition of EGYPT													
Period	BOTSWANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURITIOUS	MSCI	NIGERIA	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0 408	99 59	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0.000	0.000	0.000
2	0 399	93 49	0 058	3 02	0 278	0 015	1 436	0 003	0 018	0 675	0 27	0 2	0 113
5	0 38	85	0 532	2 95	0 736	0 511	1 722	2 215	0 792	2 28	2.433	0.237	0 199
10	0 383	84 78	0 539	2 947	0 737	0 523	1 747	2 304	0 826	2 292	2 442	0 237	0 234
Variance Decomposition of GHANA													
Period	BOTSWANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURITIOUS	MSCI	NIGERIA	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0.22	0 029	99 74	0 000	0 000	0 000	0.000	0 000	0 000	0 000	0 000	0 000	0.000
2	1 553	0 168	96 66	0 44	0 38	0 289	0 042	0 057	0 024	0 08	0 185	0 14	0 042
5	1 267	0 17	93 06	0 8	0 77	0 711	0 176	0 648	0 531	0 117	0 442	0 953	0.34
10	1.457	0 169	91 81	0 8	0 74	0 867	0 251	1 024	0 748	0 116	0.73	0 907	0.351
Variance Decomposition of ISRAEL													
Period	BOTSWANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURITIOUS	MSCI	NIGERIA	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0 0094	0 057	0 085	99 9	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000
2	0 178	0 046	0 294	93 36	1 137	0 048	0 169	4.54	0 012	0 004	0 025	0 178	0 036
5	0 382	0 203	0 548	89 82	1 088	0 045	0 935	5 4	0 737	0 451	0.299	0 244	0.512
10	0 471	0 214	0 563	89 5	1 087	0.048	0 993	5 43	0 082	0 46	0 326	0.25	0.564

Cont.....

Table 4.23: Forecast Error Variance for the Stock Markets of Countries of Africa & Middle East Region

Variance Decomposition of JORDAN													
Period	BOTS WANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURI TIOUS	MSCI	NIGERI A	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0.029	0 012	0 296	6 325	93 346	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000
2	0 48	0 012	1 182	6.041	89 38	0 016	0.096	2.09	0 067	0 296	0 004	0 149	0 173
5	0.78	1 85	1.528	5 795	84 16	0 55	0 255	2 89	0 109	0 972	0 318	0 294	0 476
10	0.934	1 874	1 562	5 774	83 69	0 587	0 331	2 91	0 131	0 973	0 407	0 293	0 518
Variance Decomposition of KUWAIT													
Period	BOTS WANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURI TIOUS	MSCI	NIGERI A	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0 26	0 013	0 28	0 118	0 023	99 29	0 000	0 000	0 000	0 000	0 000	0.000	0 000
2	0.256	0 119	1 69	0 118	0 258	91 31	0 388	0 062	0 003	0 307	5 386	0 0828	0 0081
5	0.32	0 259	1 66	0 374	0 35	87 33	0 605	0 536	0 03	1 838	6 246	0.3004	0 122
10	0 342	0 293	1 67	0 414	0 357	86 93	0 61	0 63	0 073	1 932	6 285	0 3054	0.1381
Variance Decomposition of MAURITIOUS													
Period	BOTS WANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURI TIOUS	MSCI	NIGERI ·A	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0.048	0 026	0 664	0 132	0 978	0 664	97 487	0 000	0 000	0.000	0 000	0 000	0 000
2	0 056	0.221	0.725	0 598	1 360	0 639	95 843	0.030	0 467	0 017	0.006	0 036	0 003
5	0.138	0.380	1 149	0 750	1 357	1 093	92 806	0 896	0 802	0 186	0.019	0 038	0 384
10	0.148	0 398	1 270	0 766	1 351	1 103	92 450	0 978	0 872	0 199	0 023	0 041	0 400
Variance Decomposition of MSCI													
Period	BOTS WANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURI TIOUS	MSCI	NIGERI A	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0 003	0 110	0.283	12 166	10 177	0 073	0 000	77 185	0.000	0 000	0 000	0 000	0 000
2	0 036	0 125	0 562	12 944	9 964	0.349	0 151	75 030	0.445	0 313	0.008	0 060	0.013
5	0.480	0 499	1 736	12 414	10 263	0 816	0 246	71 166	0.495	0 896	0.489	0 431	0 070
10	0 629	0 499	1.855	12 371	10 220	0.820	0 259	70 865	0 501	0 898	0.543	0 457	0.083

Cont.....

Table 4.23: Forecast Error Variance for the Stock Markets of Countries of Africa & Middle East Region

Variance Decomposition of NIGERIA													
Period	BOTSWANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURITIOUS	MSCI	NIGERIA	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0 081	0.138	0.204	0 003	0 276	0 298	0 063	0 114	98 823	0 000	0 000	0 000	0.000
2	0.117	0.269	0 571	0 089	0 295	0.437	0.068	0 126	97 259	0 056	0.003	0.025	0.686
5	0.273	0.300	0 641	0 366	0 539	1.101	0 391	0 342	93 482	0 411	0 288	0.198	1.668
10	0.358	0 311	0 662	0.367	0 546	1.114	0.407	0.377	93 117	0.462	0 306	0 206	1.766
Variance Decomposition of OMAN													
Period	BOTSWANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURITIOUS	MSCI	NIGERIA	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0.544	0 116	0 475	0 848	0 116	0 241	0 401	0 177	0 197	96 886	0 000	0 000	0 000
2	0 622	0 119	0 546	0.871	0 120	0 362	0 392	0 207	0 325	96 093	0.293	0 008	0.042
5	1.178	0 620	0 740	0 942	0 481	0 608	0 624	0 798	0 377	90 464	1 225	1 260	0 683
10	1 287	0 627	0 743	0 942	0 503	0 628	0 621	0 880	0 392	90 071	1 289	1 263	0.755
Variance Decomposition of SAUDI ARABIA													
Period	BOTSWANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURITIOUS	MSCI	NIGERIA	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0.026	0 006	0 011	0 544	1 363	0 113	0 001	0 345	0 012	0.984	96 595	0 000	0 000
2	0.115	0.060	0 189	0 590	1 625	0 313	0.232	0 349	0 449	1 270	94 093	0 155	0 560
5	0.228	0.123	0 269	1 372	1 830	0 518	0.441	0 460	0 775	1 746	91 025	0 180	1.032
10	0 262	0 127	0 325	1 369	1 831	0 574	0.445	0.501	0 786	1 765	90 798	0 182	1 035
Variance Decomposition of SOUTH AFRICA													
Period	BOTSWANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURITIOUS	MSCI	NIGERIA	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0 007	0 207	0 033	7 661	9 479	0 016	0 070	21.826	0 174	0 153	0 046	60 327	0 000
2	0.055	0 203	0 219	7.917	9 253	0 092	0 110	22 203	0 516	0 462	0.049	58 916	0 005
5	0.234	0 509	0 673	7 593	9 284	0 484	0 145	22.169	1 334	0 587	0 470	56 379	0 139
10	0 341	0 512	0 769	7.594	9 248	0 519	0 147	22 068	1 343	0 609	0 553	56 122	0 175
Variance Decomposition of TUNISIA													
Period	BOTSWANA	EGYPT	GHANA	ISRAEL	JORDAN	KUWAIT	MAURITIOUS	MSCI	NIGERIA	OMAN	SAUDI ARABIA	SOUTH AFRICA	TUNISIA
1	0 066	0 128	0 010	0 766	0 039	0 073	0 001	0 599	0 570	0 071	0 406	0 021	97 250
2	0 154	0.207	0 010	0 829	0 083	0 210	0.147	0 656	0 571	0 124	0 398	0 158	96.454
5	0.159	0 436	0 072	2 230	0.114	0.483	0 163	1 581	1.107	0 572	0 609	0 292	92.182
10	0.168	0 468	0 090	2 426	0 124	0 512	0.195	1 669	1 136	0 603	0 666	0 308	91 636

Table 4.24: Vector Error Correction Model for the Stock Markets of Countries of Africa & Middle East Region

E C T	Δ BOTSWANA	Δ EGYPT	Δ GHANA	Δ ISRAEL	Δ JORDAN	Δ KUWAIT	Δ MAURITIOUS	Δ MSCI	Δ NIGERIA	Δ OMAN	Δ SAUDI ARABIA	Δ SOUTH AFRICA	Δ TUNISIA
	-2.90 [-19.21]	-0 10 [-0 68]	-0 16 [-1 20]	-0 29 [-2 30]	0 19 [1 20]	-0 09 [-1 12]	0.13 [2 19]	0.00 [0.05]	-0 25 [-2 09]	0.09 [0.06]	-0.99 [-0. 04]	0.06 [0.79]	0.08 [1.83]
	Short-run lagged Differences												
Δ BOTSWANA	-	0 073 (-0 1) [0 61]	0 0846 (-0.056) [1 54]	0.24 (-0 09) [2 50]	-0.124 (-0 12) [-0 98]	0 064 (-0 062) [1 02]	-0 106 (-0.047) [-2.23]	0.001 (-0 06) [0 02]	0.194 (-0.09) [2 056]	-0.011 (-0.08) [-0 14]	0.037 (-0 103) [0.362]	-0.058 (-0.09) [-0 61]	-0.058 (-0.03) [-1.68]
Δ EGYPT	0.193 (-0.04) [4.477]	-	-0 012 (-0 024) [-0.94]	0 027 (-0 038) [0.75]	-0 007 (-0 074) [-0.19]	-0.011 (-0.021) [-0.48]	0.002 (-0 018) [0 15]	-0 096 (-0 025) [-0 38]	0 028 (-0 03) [0.78]	-0.344 (-0.023) [-0.13]	-0.011 (-0.034) [-0.28]	-0.017 (-0 036) [-0 41]	-0.017 (-0.04) [-1.65]
Δ GHANA	0 011 (-0 097) [0.117]	0 060 (-0 094) [0 645]	-	-0 078 (-0 078) [-1 09]	0 202 (-0 097) [2 102]	-0 096 (-0 047) [-2 031]	-0 052 (-0 036) [-0 145]	0 073 (-0 051) [1 49]	-0 140 (-0 071) [-1 861]	0 068 (-0 062) [1 10]	0 098 (-0.077) [1.264]	0.093 (-0 070) [1.295]	-0.070 (-0.02) [-0 29]
Δ ISRAEL	0.191 (-0.05) [3.36]	0.2151 (-0.012) [3 71]	-0 075 (-0 02) [-0 78]	-	-0 131 (-0 033) [-2 25]	0 003 (-0.029) [0 13]	0 0047 (-0.029) [0.06]	-0 1165 (-0 033) [-3.63]	0 007 (-0 045) [0 05]	-0 0047 (-0 038) [-0 110]	-0.07 (-0 024) [-1 731]	-0.1106 (-0 045) [-2 526]	-0 079 (-0 04) [-1.36]
Δ JORDAN	-0.229 (-0.045) [-5.22]	0.004 (-0 043) [0 010]	-0 048 (-0 02) [-1.39]	0.0213 (-0 038) [0 61]	-	-0.048 (-0.022) [-1 77]	0 0265 (-0 013) [1 53]	-0 028 (-0 024) [-1.16]	-0 011 (-0 039) [-0.31]	0.0275 (-0.025) [0 74]	0.058 (-0.037) [1.57]	-0 022 (-0.034) [-0.64]	-0 003 (-0 01) [-0.05]
Δ KUWAIT	-0.1073 (-0.08) [-1.333]	-0 042 (-0.080) [-0 52]	0 0661 (-0 03) [1 70]	-0 02 (-0 064) [-0 34]	-0 017 (-0.087) [-0 23]	-	-0.02 (-0 039) [-0 62]	-0 094 (-0.049) [-2 08]	0.029 (-0 06) [0.32]	0.019 (-0 058) [0.31]	0.014 (-0.067) [0.146]	-0 063 (-0.063) [-0.99]	-0.07 (-0.02) [-0 88]

Note: [ ] presents t-Statistics and ( ) Standard Error

Cont.....

Table 4.24: Vector Error Correction Model for the Stock Markets of Countries of Africa & Middle East Region

E C T	Δ BOTSWANA	Δ EGYPT	Δ GHANA	Δ ISRAEL	Δ JORDAN	Δ KUWAIT	Δ MAURITIOUS	Δ MSCI	Δ NIGERIA	Δ OMAN	Δ SAUDI ARABIA	Δ SOUTH AFRICA	Δ TUNISIA
	-2.90 [-19 21]	-0.10 [-0 68]	-0.16 [-1.20]	-0.29 [-2.30]	0 19 [1.20]	-0 09 [-1.12]	0 13 [2 19]	0.00 [0 05]	-0 25 [-2 09]	0.09 [0 06]	-0 99 [-0. 04]	0.06 [0.79]	0.08 [1.83]
	Short-run lagged Differences												
Δ MAURITIOUS	-0 432 (-0.11) [-3.90]	0 2689 (-0 118) [2 37]	-0.083 (-0 052) [-1 62]	-0.023 (-0 08) [-0.26]	0 104 (-0 11) [0 88]	-0.119 (-0 057) [-2 07]	-	0 035 (-0.062) [0 57]	-0.083 (-0.092) [-0 90]	0 0547 (-0 07) [0 71]	-0 071 (-0 096) [-0 74]	0.099 (-0 087) [1 12]	0.029 (-0.03) [0.91]
Δ MSCI	-0 21 (-0 09) [-2 16]	-0 137 (-0 09) [-1.41]	0 04 (-0.04) [0 095]	0.319 (-0.07) [4 07]	0.33 (-0.14) [3 25]	-0.018 (-0 057) [-0.35]	-0.018 (-0 038) [-0 46]	-	0 008 (-0 08) [0 11]	-0 022 (-0 06) [-0.33]	-0.024 (-0 082) [-0 35]	0.113 (-0.07) [1.47]	-0.008 (-0.026) [-0.29]
Δ NIGERIA	0.159 (-0 05) [3.17]	-0 030 (-0.05) [-0 59]	-0 015 (-0 02) [-0.43]	0 0463 (-0.04) [1 22]	-0.012 (-0 05) [-0 195]	0 0045 (-0 02) [0 174]	0 020 (-0 02) [1 05]	0 060 (-0.028) [2 14]	-	-0 03 (-0 03) [-1 04]	0.066 (-0.04) [1.52]	0.057 (-0 03) [1.45]	0 034 (-0.01) [0.22]
Δ OMAN	-0.027 (-0.063) [-0.425]	0 081 (-0 06) [1 27]	0 002 (-0 030) [0 05]	0.017 (-0 051) [0.33]	0 085 (-0 067) [1 27]	-0.007 (-0 033) [-0 27]	0 013 (-0 025) [0 519]	0.038 (-0 035) [1 075]	-0 030 (-0.052) [-0 57]	-	0 032 (-0.054) [0 58]	0.063 (-0 050) [1.25]	0.011 (-0.018) [0.60]
Δ SAUDI ARABIA	0.125 (-0.05) [2.51]	0.046 (-0 050) [0 91]	-0 013 (-0 023) [-0 56]	0.028 (-0 04) [0 70]	-0 009 (-0.05) [-0 16]	0 125 (-0.02) [4 81]	0.003 (-0 020) [0 14]	0 001 (-0 028) [0 02]	0 004 (-0 042) [0 16]	0 011 (-0 034) [0.31]	-	0 004 (-0 039) [0.097]	-0.002 (-0.014) [-0 15]
Δ SOUTH AFRICA	-0.059 (-0 067) [-0.87]	0 083 (-0 068) [1.28]	-0.014 (-0 032) [-0 42]	-0 048 (-0.054) [-0 88]	-0 044 (-0 071) [-0.61]	0 019 (-0 035) [0 54]	0.020 (-0 027) [2 73]	-0 034 (-0.038) [-0 92]	-0.034 (-0 056) [-0 63]	0.020 (-0.046) [0 44]	0.066 (-0 058) [1 13]	-	0.015 (-0.019) [0 79]
Δ TUNISIA	-0.816 (-0.15) [-5.31]	0 132 (-0.15) [0.861]	-0.072 (-0 07) [-1.09]	-0 165 (-0.12) [-1 34]	0 139 (-0 162) [0.88]	0 042 (-0 08) [0.52]	0 031 (-0.06) [0 53]	-0 057 (-0 08) [-0.66]	-0 328 (-0 12) [-2.57]	-0 041 (-0 10) [-0 38]	0.186 (-0 13) [1.43]	-0.086 (-0 12) [-0 73]	-

Note: [ ] presents t-Statistics and ( ) Standard Error.

Table 4.25: Johansen Maximum Likelihood Test for the Stock Markets of Countries of Africa & Middle East Region

Null Hypothesis	Alternative Hypothesis	λ Trace Value	Critical Values	
			5%	1%
r = 0**	r > 0	430 014	277 71	293.44
r ≤ 1**	r > 1	301.885	233 13	247 18
r ≤ 2**	r > 2	217 095	192.89	204.95
r ≤ 3*	r > 3	158.229	156	168.36
r ≤ 4	r > 4	115 101	124 24	133.57
r ≤ 5	r > 5	76 994	94.15	103.18
r ≤ 6	r > 6	51 985	68.52	76.07
r ≤ 7	r > 7	32 303	47.21	54 46
r ≤ 8	r > 8	17.801	29.68	35.65
r ≤ 9	r > 9	7 7208	15.41	20 04
r ≤ 10	r > 10	0.601	3 76	6 65
Null Hypothesis	**Alternative Hypothesis**	**λ Max Value**	**Critical Values**	
			5%	**1%**
r = 0**	r = 1	128 129	68 83	75.95
r = 1**	r = 2	84 789	62.81	69.09
r = 2*	r = 3	58 866	57.12	62.8
r = 3	r = 4	43.127	51 42	57 69
r = 4	r = 5	38 107	45 28	51 57
r = 5	r = 6	25 008	39 37	45 1
r = 6	r = 7	19 681	33 46	38 77
r = 7	r = 8	14 502	27.07	32 24
r = 8	r = 9	10.080	20.97	25.52
r = 9	r = 10	7 119	14 07	18 63
r = 10	r = 11	0.601	3 76	6.65

*, (**) denotes rejection of the hypothesis at the 5%, (1%) level respectively
r = No of Cointegrating Vectors.

Eastern Europe

Table 4.26.I: The estimated τ-statistic values from unit root tests (Level)

Variable	Intercept Alone			Intercept and Trend		
	DF	ADF	PP	DF	ADF	PP
Czech Republic	1.00	0.71(1)	0.86(1)	-0 24	-0.77(3)	-0.55(5)
Hungary	-2 03	-1.95(1)	-2.03(1)	-2.49	-2.69(4)	-2 59(5)
Lithuania	2 71	2.19(1)	2.47(1)	-0.54	-0 91(4)	-0.75(5)
Poland	-1.41	-1 51(1)	-1.55(5)	-1 84	-1.99(3)	-2.01(5)
Romania	0 64	0.62(2)	0.60(2)	-1 34	-1 40(1)	-1 36(1)
Russian Fed	-0 19	-0.57(2)	-0.46(5)	-1.32	-1.75(2)	-1.62(5)
Slovak Republic	0.40	0.33(1)	0.37(1)	-0.84	-1.02(4)	-0.92(5)
Slovenia	0 06	-0.28(3)	-0.16(5)	-2 208	-2.76(4)	-2.53(5)
Turkey	-1 85	-1 87(1)	-1 86(1)	-2.01	-2.43(4)	-2.14(5)

*Note· The critical values for unit root test are -3 49 and -2.88 (without trend) and -4.04, -3.45 (with trend) respectively for 1% and 5% level * and ** implies stationarity at 1% and 5% level.*

Table 4.26.II: The estimated τ-statistic values from unit root tests (First Difference)

Variable	Intercept Alone			Intercept and Trend		
	DF	ADF	PP	DF	ADF	PP
Czech Republic	-20 9*	-14 6*(1)	-20 9*(1)	-21 07*	-14 72*(1)	-21.06*(1)
Hungary	-24.5*	-14.8*(1)	-24 5*(1)	-24.58*	-14 87*(1)	-24 58*(1)
Lithuania	-20 3*	-13 4*(1)	-20 3*(1)	-20 77*	-13 79*(1)	-20.74*(1)
Poland	-23.5*	-15 9*(1)	-23 5*(1)	-23 49*	-15 97*(1)	-23.49*(1)
Romania	-21 9*	-16 3*(1)	-21.9*(1)	-22 05*	-16 47*(1)	-22 06*(1)
Russian Fed	-22 0*	-14 3*(1)	-22 0*(1)	-22 06*	-14.36*(1)	-22 05*(1)
Slovak Republic	-23.2*	-15 1*(1)	-23.2*(1)	-23 46*	-15.28*(1)	-23 46*(1)
Slovenia	-21.1*	-15.8*(1)	-21.1*(1)	-21 17*	-15.8*(1)	-21.1*(1)
Turkey	-24 6*	-15 5*(1)	-24.6*(1)	-24.72*	-15 56*(1)	-24.72*(1)

*Note. The critical values for unit root test are: -3 49 and -2.88 (without trend) and -4 04, -3.45 (with trend) respectively for 1% and 5% level. * and ** implies stationarity at 1% and 5% level*

Table 4.27: Pair Wise Granger Causality Tests for the Stock Markers of Countries of Eastern Europe Region

Null Hypothesis:	F-Statistic	Probability
LITHUANIA Does not Granger Cause CZECH REPUBLIC	7.89	0.00
CZECH REPUBLIC Does not Granger Cause MSCI	31.20	0 00
RUSSIAN Fed Does not Granger Cause CZECH REPUBLIC	5 56	0.00
TURKEY Does not Granger Cause CZECH REPUBLIC	3 03	0.05
HUNGARY Does not Granger Cause MSCI	87 96	0 00
ROMANIA Does not Granger Cause HUNGARY	3 62	0.03
RUSSIAN Federation Does not Granger Cause HUNGARY	7 28	0.00
LITHUANIA Does not Granger Cause POLAND	7 03	0 00
ROMANIA Does not Granger Cause LITHUANIA	5 67	0 00
POLAND Does not Granger Cause MSCI	92 32	0 00
MSCI Does not Granger Cause POLAND	3 55	0 03
RUSSIAN Federation Does not Granger Cause MSCI	51 88	0 00
MSCI Does not Granger Cause SLOVENIA	5 83	0.00
TURKEY Does not Granger Cause MSCI	19 04	0 00
ROMANIA Does not Granger Cause POLAND	5 46	0 00
RUSSIAN Federation Does not Granger Cause POLAND	8 52	0.00
TURKEY Does not Granger Cause POLAND	4 62	0 02
ROMANIA Does not Granger Cause RUSSIAN Federation	5.34	0.01
ROMANIA Does not Granger Cause SLOVENIA	3 31	0 04
RUSSIAN Fed Does not Granger Cause SLOVAK REPUBLIC	4 70	0.01
RUSSIAN Federation Does not Granger Cause TURKEY	6 06	0 00

Table 4.28: Forecast Error Variance for the Stock Markers of Countries of Eastern Europe Region

Variance Decomposition of CZECH REPUBLIC.										
Period	CZECH REPUBLIC	HUNGARY	LITHUANIA	MSCI	POLAND	ROMANIA	RUSSIAN FEDERATION	SLOVAK REPUBLIC	SLOVENIA	TURKEY
1	100 00	0.00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0.00
2	94 65	0 02	3 15	0 23	0 00	0 44	0.59	0.02	0.78	0 11
5	91.89	0 23	3 35	0 37	0 01	0 47	2 03	0 07	0 94	0.65
10	91 85	0 24	3 35	0 37	0 01	0.47	2 04	0 07	0.94	0 65
Variance Decomposition of HUNGARY.										
Period	CZECH REPUBLIC	HUNGARY	LITHUANIA	MSCI	POLAND	ROMANIA	RUSSIAN FEDERATION	SLOVAK REPUBLIC	SLOVENIA	TURKEY
1	27 00	73.00	0 00	0 00	0.00	0 00	0 00	0 00	0 00	0.00
2	25.98	70 11	1 00	0.05	0 00	1 08	1 33	0 05	0.14	0.27
5	25.04	68 88	1 06	0 25	0 23	1 14	2 39	0 22	0 17	0.60
10	25 03	68 87	1.07	0 25	0 23	1 14	2 40	0 23	0 18	0.60
Variance Decomposition of LITHUANIA										
Period	CZECH REPUBLIC	HUNGARY	LITHUANIA	MSCI	POLAND	ROMANIA	RUSSIAN FEDERATION	SLOVAK REPUBLIC	SLOVENIA	TURKEY
1	0 86	0 82	98 31	0 00	0 00	0 00	0 00	0 00	0 00	0 00
2	1 41	0 83	97 26	0 00	0 08	0 13	0 12	0 06	0 09	0.25
5	1 87	0.90	93 98	0 37	0 13	1 93	0 24	0.13	0 14	0 76
10	1.87	0 80	93 97	0 38	0 13	1 94	0 24	0 13	0.14	0 76

Cont.....

Table 4.28: Forecast Error Variance for the Stock Markers of Countries of Eastern Europe Region

Variance Decomposition of MSCI·										
Period	CZECH REPUBLIC	HUNGARY	LITHUANIA	MSCI	POLAND	ROMANIA	RUSSIAN FEDERATION	SLOVAK REPUBLIC	SLOVENIA	TURKEY
1	0 06	0 05	0 03	99 86	0 00	0 00	0 00	0 00	0 00	0.00
2	9 81	11.87	0 40	69 95	5 58	0.35	2 43	0.04	0 28	0.08
5	8 97	11 96	1 42	67.59	5 54	0 67	2 72	0.46	0 29	0 39
10	8.96	12.01	1 42	67 52	5 53	0 67	2 73	0 47	0 29	0.41
Variance Decomposition of POLAND										
Period	CZECH REPUBLIC	HUNGARY	LITHUANIA	MSCI	POLAND	ROMANIA	RUSSIAN FEDERATION	SLOVAK REPUBLIC	SLOVENIA	TURKEY
1	22.12	15 31	0 06	0 72	62 49	0 00	0 00	0 00	0.00	0 00
2	21 37	14 23	1 89	0 81	58 16	1 34	· 1 18	0 17	0 54	0.32
5	20 92	13 75	1 93	0 81	55 67	1 59	2 51	0 53	0 69	1.59
10	20 92	13 75	1 93	0 81	55 66	1 59	2 52	0 53	0 69	1.59
Variance Decomposition of ROMANIA										
Period	CZECH REPUBLIC	HUNGARY	LITHUANIA	MSCI	POLAND	ROMANIA	RUSSIAN FEDERATION	SLOVAK REPUBLIC	SLOVENIA	TURKEY
1	0 272	0 069	0 071	0 038	0 265	99 285	0 000	0 000	0 000	0 000
2	0 283	0 399	0 077	0.125	0 505	98 343	0 183	0 044	0 097	0.041
5	0 318	0 423	0 224	0 148	0 520	97 551	0.186	0 461	0.241	0.156
10	0 318	0.424	0 224	0 148	0 521	97 549	0 186	0 461	0.247	0 156

Cont.....

Table 4.28: Forecast Error Variance for the Stock Markers of Countries of Eastern Europe Region

Variance Decomposition of RUSSIAN FEDERATION										
Period	CZECH REPUBLIC	HUNGARY	LITHUANIA	MSCI	POLAND	ROMANIA	RUSSIAN FEDERATION	SLOVAK REPUBLIC	SLOVENIA	TURKEY
1	7 77	9.67	0 02	0 61	0.80	0 01	81.11	0.00	0.00	0.00
2	7.50	9.32	0.93	0 66	0 95	0 97	79 42	0 04	0.12	0.08
5	7.54	11 03	1 37	0 63	0 94	1 34	75 03	1 04	0.39	1.05
10	7.53	11 03	1 67	0 63	0 94	1.34	75 02	1 05	0.39	1.05
Variance Decomposition of SLOVAK REPUBLIC										
Period	CZECH REPUBLIC	HUNGARY	LITHUANIA	MSCI	POLAND	ROMANIA	RUSSIAN FEDERATION	SLOVAK REPUBLIC	SLOVENIA	TURKEY
1	0 12	0 83	0 22	0 27	0 99	0 11	0 22	98.21	0.00	0 00
2	0 45	1 82	0 53	0 27	0 10	0 15	0 22	97 16	0 03	0 08
5	1 63	1 18	0 69	0 36	0.11	0 73	1 26	93 86	0 05	0 11
10	1.64	1 19	0 70	0 36	0 11	0 73	1 27	93 82	0 05	0.12
Variance Decomposition of SLOVENIA										
Period	CZECH REPUBLIC	HUNGARY	LITHUANIA	MSCI	POLAND	ROMANIA	RUSSIAN FEDERATION	SLOVAK REPUBLIC	SLOVENIA	TURKEY
1	1 52	3 52	0 09	0 16	0 11	0 49	0 00	0 06	94 28	0 00
2	1 49	4 26	0 03	0 04	0 23	0 94	0 00	0 19	92 93	0.00
5	1.55	4.95	0 03	1 39	0 43	1.39	0 13	1 01	89 09	0 04
10	1.55	4 96	0 04	1 39	0 43	1 38	0 13	1 39	89 05	0.05
Variance Decomposition of TURKEY										
Period	CZECH REPUBLIC	HUNGARY	LITHUANIA	MSCI	POLAND	ROMANIA	RUSSIAN FEDERATION	SLOVAK REPUBLIC	SLOVENIA	TURKEY
1	5 85	6 21	0 15	1.27	0 33	0 01	1 69	0 27	0 34	83 88
2	5 82	6 07	0 28	1 54	0 54	0 31	2 05	0 34	0 77	82 29
5	5 62	8 56	0 28	1 70	0 51	0 39	3 03	0 43	0 75	78.73
10	5 61	8 56	0 28	1 70	0 51	0 39	3.04	0 43	0.75	78.71

Table 4.29: Vector Error Correction Model for the Stock Markets of Countries of Eastern Europe Region

E C T	Δ CZECH REPUBLIC	Δ HUNGARY	Δ LITHUANIA	Δ MSCI	Δ POLAND	Δ ROMANIA	Δ RUSSIAN Federation	Δ SLOVAK REPUBLIC	Δ SLOVENIA	Δ TURKEY
	-0.004 [-0.307]	-0.023 [-1 24]	-0 016 [-0.47]	0 037 [4 73]	0 056 [0 184]	0 001 [0 055]	0 238 [8 05]	0.056 [3.95]	0.035 [0.818]	-0.179 [-5 94]
	Short-run lagged Differences									
Δ CZECH REPUBLIC	-	0.068 (-0 074) [0 922]	0 015 (-0 026) [0 55]	-0 012 (-0 031) [-0 39]	0 044 (-0 071) [0 19]	0 091 (-0 082) [1 11]	-0 279 (-0 119) [-2 35]	-0 001 (-0 057) [-0 012]	-0.135 (-0 05) [-0 69]	0.23 (-0.12) [1 94]
Δ HUNGARY	-0 002 (-0.043) [-0 031]	-	0.036 (-0 022) [1 62]	0 058 (-0 027) [2 18]	-0 093 (-0 060) [-1 54]	-0 073 (-0 070) [-1 05]	-0 509 (-0 102) [-5 01]	-0 119 (-0 049) [-2 44]	0 005 (-0 043) [0 107]	0.26 (-0.11) [2.54]
Δ LITHINIA	0 293 (-0 084) [3 49]	0 319 (-0 123) [2 59]	-	0 018 (-0 052) [0 357]	0 255 (-0 118) [2 16]	-0 169 (-0 136) [-1 23]	-0 004 (-0 197) [-0 018]	0 037 (-0 094) [0 39]	-0 052 (-0.083) [-0.62]	0 38 (-0 20) [1.72]
Δ MSCI	-0 100 (-0 071) [-1 39]	-0 074 (-0 104) [-0 71]	-0 051 (-0 037) [-1 38]	-	0 303 (-0 10) [3 03]	-0 058 (-0.116) [-0 49]	• 0 679 (-0 168) [4 04]	0 200 (-0 088) [2 49]	0 074 (-0.071) [1 04]	-0.41 (-0 17) [-2 39]
Δ POLAND	-0 150 (-0 039) [-0.29]	-0 022 (-0 057) [-0 39]	0 000 (-0 020) [-0 94]	0 162 (-0 024) [6 85]	-	0.027 (-0 063) [0 43]	0 172 (-0 091) [1 59]	0 088 (-0.043) [2 72]	0.056 (-0.038) [1 46]	-0 34 (-0 09) [-3 72]
Δ ROMANIA	-0 026 (-0 025) [-1 06]	-0 068 (-0 036) [-1 88]	-0.023 (-0 284) [-1 80]	-0 032 (-0 52) [-2 09]	-0 100 (-0 035) [-2 87]	-	-0.183 (-0 058) [-3 14]	-0 532 (-0.028) [-0 54]	-0 068 (-0.025) [-2.44]	-0 009 (-0.06) [-0.15]

Note [ ] presents t-Statistics and ( ) Standard Error

Cont.....

Table 4.29: Vector Error Correction Model for the Stock Markets of Countries of Eastern Europe Region

	Δ CZECH REPUBLIC	Δ HUNGARY	Δ LITHUANIA	Δ MSCI	Δ POLAND	Δ ROMANIA	Δ RUSSIAN Federation	Δ SLOVAK REPUBLIC	Δ SLOVENIA	Δ TURKEY
E C T	-0 004 [-0.307]	-0.023 [-1.24]	-0 016 [-0 47]	0 037 [4 73]	0 056 [0 184]	0 001 [0 055]	0 238 [8 05]	0 056 [3.95]	0.035 [0 818]	-0.179 [-5.94]
	Short-run lagged Differences									
Δ RUSSIAN FED	0.025 (-0.022) [1 11]	0 025 (-0 032) [0 76]	-0 027 (-0.145) [-2 38]	0 098 (-0 360) [7 22]	0 125 (-0 031) [4 03]	-0 044 (-0 036) [-1 22]	-	0.059 (-0 025) [2 38]	0 049 (-0 022) [2.24]	-0 124 (-0.053) [-2 34]
Δ SLOVAK REPUBLIC	-0 633 (-0.040) [-0 41]	0 031 (-0.058) [0 54]	-0 031 (-0 021) [-1 49]	0 045 (-0 024) [1 85]	0 142 (-0 056) [2 55]	-0 662 (-0 064) [-0 25]	0 487 .(-0.093) [4 33]	-	0 024 (-0 039) [0 61]	-0.127 (-0 095) [-1 32]
Δ SLOVENIA	-0 086 (-0 044) [-1 97]	-0 051 (-0 064) [-0.79]	0 008 (-0 023) [0 34]	-0 005 (-0 027) [-0.17]	-0 029 (-0 061) [-0 46]	-0 036 (-0 071) [-0 51]	0 263 (-0 103) [2 54]	0 123 (-0 049) [0 51]	-	-0 405 (-0.105) [-3.84]
Δ TURKEY	-0 618 (-0 024) [-0 66]	-0 006 (-0 035) [-0 16]	0 030 (-0 254) [2 36]	-0 045 (-0 489) [-3 77]	-0 116 (-0 034) [-3 43]	-0 028 (-0 039) [-0 75]	-0 341 (-0 057) [-5 99]	-0.098 -0 027) [-3 62]	-0 043 (-0.024) [-1.77]	-

Note· [ ] presents t-Statistics and ( ) Standard Error

Table 4.30: Johansen Maximum Likelihood Test for the Stock Markets of Countries of Eastern Europe Region

Null Hypothesis	Alternative Hypothesis	λ Trace Value	Critical Values	
			5%	1%
r = 0**	r > 0	287 44	263 42	279.07
r ≤ 1*	r > 1	226 11	222 21	234 41
r ≤ 2	r > 2	169 86	182 82	196.08
r ≤ 3	r > 3	120 35	146 76	158 49
r ≤ 4	r > 4	93 85	114 9	124 75
r ≤ 5	r > 5	68.612	87 31	96 58
r ≤ 6	r > 6	47 23	62 99	70.05
r ≤ 7	r > 7	28 84	42 44	48.45
r ≤ 8	r > 8	16 52	25 32	30 45
r ≤ 9	r > 9	6 31	12 25	16 26
Null Hypothesis	**Alternative Hypothesis**	**λ Max Value**	**Critical Values**	
			5%	**1%**
r = 0	r = 1	61 33421	66 23	73.73
r = 1	r = 2	56 24134	61 29	67 88
r = 2	r = 3	49 50943	55 5	62 46
r = 3	r = 4	26 50635	49.42	54.71
r = 4	r = 5	25 23882	43 97	49 51
r = 5	r = 6	21 38161	37 52	42 36
r = 6	r = 7	18 38402	31 46	36 65
r = 7	r = 8	12 31917	25 54	30 34
r = 8	r = 9	10 21402	18 96	23 65
r = 9	r = 10	6 313393	12 25	16 26

*, (**) denotes rejection of the hypothesis at the 5%, (1%) level respectively.
r = No of Cointegrating Vectors

Western Europe

Table 4.31.I: The estimated τ-statistic values from unit root tests (Level)

Variable	Intercept Alone			Intercept + Trend		
	DF	ADF	PP	DF	ADF	PP
Austria	1.4742	1.218(1)	1.358(1)	-0 290	-0.44(1)	-0.49(5)
Belgium	-0 291	-0 29(1)	-0 28(1)	-0.79	-0 78(1)	-0 78(1)
Britain	-1 82	-1 82(1)	-1.81(1)	-1 76	-1 76(1)	-1 75(1)
Denmark	-0 63	-0.72(3)	-0 65(3)	-1 63	-1 73(3)	-1 67(3)
Finland	-1.56	-1.58(1)	-1.60(5)	-1 36	-1 50(4)	-1.44(5)
France	-2 13	-2 14(1)	-2 133(5)	-1.86	-1 86(1)	-1 85(1)
Germany	-1 94	-2 03(1)	-1 95(2)	-1 88	-1 97(1)	-1 90(2)
Greece	-1 45	-1.47(1)	-1.49(5)	-1 37	-1 43(1)	-1 45(5)
Ireland	-1 318	-1 40(1)	-1 36(5)	-1.77	-1 93(2)	-1 89(5)
Italy	-2 33	-2 52(1)	-2 34(4)	-2.11	-2 31(1)	-2 15(4)
Luxembourg	0 031	-0 70(4)	-0 369(5)	-0 595	-1 21(4)	-0 933(5)
Netherlands	-2 25	-2 127(2)	-2 25(2)	-2.468	-2 38(2)	-2 472(2)
Norway	-0 036	-0 349(2)	-0 272(5)	-0 803	-1 19(4)	-1 037(5)
Portugal	-1 88	-2 056(2)	-1 98(5)	-1 959	-2.13(2)	-2 043(5)
Spain	-1.72	-1 82(1)	-1 75(5)	-1 69	-1 93(4)	-1 77(5)
Sweden	-1 604	-1 65(1)	-1 63(5)	-1 53	-1 56(1)	-1 58(5)
Switzerland	-2 28	-2 267(1)	-2 28(2)	-2 10	-2 18(1)	-2 1167(2)

Table 4.31.II: The estimated τ-statistic values from unit root tests (First Difference)

Variable	Intercept Alone			Intercept + Trend		
	DF	ADF	PP	DF	ADF	PP
Austria	-22 1*	-16 2*(1)	-22 1*(1)	-22.2*	-16 9*(1)	-22 2*(1)
Belgium	-24 5*	-18 51*(1)	-24 54*(1)	-24 53*	-18 5*(1)	-24 5*(1)
Britain	-24 8*	-17 46*(1)	-24 80*(1)	-24 79*	-17.4*(1)	-24 7*(1)
Denmark	-24 3*	-16 93*(1)	-24 37*(1)	-24 35*	-16 9*(1)	-24 5 (1)
Finland	-23 8*	-16 57*(1)	-23 85*(1)	-23 85*	-16 8*(1)	-23 5*(1)
France	-24 8*	-17 73*(1)	-24 81*(1)	-24 8*	-17 7*(1)	-24 3*(1)
Germany	-22 6*	-16 18*(1)	-22 66*(1)	-22 65*	-16 1*(1)	-22 5*(1)
Greece	-22 4*	-17 0*(1)	-22 4*(1)	-22 39*	-17 0*(1)	-22 3*(1)
Ireland	-22 5*	-15 9*(1)	-22 5*(1)	-22 4*	-15.9*(1)	-22 4*(1)
Italy	-21 2*	-15 3*(1)	-21.27*(1)	-21 30*	-15 4*(1)	-21 3*(1)
Luxembourg	-21.4*	-14 5*(1)	-21 4*(1)	-21 51*	-14 6*(1)	-21 5*(1)
Netherlands	-23 5*	-15 9*(1)	-23 05*(1)	-23 07*	-16.6*(1)	-23 7*(1)
Norway	-23 3*	-15.15*(1)	-23 43*(1)	-23 44*	-15.7*(1)	-23 4*(1)
Portugal	-19 7*	-14 6*(1)	-19 71*(1)	-19 72*	-14 8*(1)	-19 2*(1)
Spain	-22 6*	-16 17*(1)	-22 68*(1)	-22.68*	-16 1*(1)	-22 6*(1)
Sweden	-24 3*	-16 5 (1)	-24 3*(1)	-24 32*	-16 5*(1)	-24 3*(1)
Switzerland	-23 8*	-17 4*(1)	-23 8*(1)	-23.8*	-17.7*(1)	-23 8*(1)

Table 4.32: Pair wise Granger Causality Tests for the Stock Markets of Countries of Western Europe Region.

Null Hypothesis:	F-Statistic	Probability
AUSTRIA does not Granger Cause BRITAIN	76.590	0 000
AUSTRIA does not Granger Cause DENMARK	36 496	0 000
AUSTRIA does not Granger Cause FINLAND	23.487	0.000
AUSTRIA does not Granger Cause GREECE	33 437	0 000
AUSTRIA does not Granger Cause IRELAND	58.889	0 000
AUSTRIA does not Granger Cause MSCI	26.385	0 000
AUSTRIA does not Granger Cause NORWAY	16 122	0 000
PORTUGAL does not Granger Cause AUSTRIA	3.981	0 019
SPAIN does not Granger Cause AUSTRIA	4 845	0.008
AUSTRIA does not Granger Cause SPAIN	75 881	0 000
AUSTRIA does not Granger Cause SWEDEN	48 800	0 000
AUSTRIA does not Granger Cause SWITZERLAND	78 319	0 000
SPAIN does not Granger Cause BELGIUM	2 956	0 053
BRITAIN does not Granger Cause DENMARK	17 184	0 000
BRITAIN does not Granger Cause FRANCE	3 363	0 035
BRITAIN does not Granger Cause GREECE	6 601	0 001
BRITAIN does not Granger Cause IRELAND	6 440	0 002
BRITAIN does not Granger Cause MSCI	52 533	0 000
BRITAIN does not Granger Cause NORWAY	16 464	0 000
BRITAIN does not Granger Cause PORTUGAL	3 539	0 030
BRITAIN does not Granger Cause SWEDEN	5 000	0 007
FINLAND does not Granger Cause DENMARK	61 030	0.000
FRANCE does not Granger Cause DENMARK	3 985	0.019
GREECE does not Granger Cause DENMARK	32 393	0 000
DENMARK does not Granger Cause GREECE	2 998	0 051
IRELAND does not Granger Cause DENMARK	76 800	0 000
MSCI does not Granger Cause DENMARK	9 590	0 000
NORWAY does not Granger Cause DENMARK	4 685	0 010
DENMARK does not Granger Cause PORTUGAL	3 853	0 022
SPAIN does not Granger Cause DENMARK	15 392	0 000
SWEDEN does not Granger Cause DENMARK	14 182	0 000
SWITZERLAND does not Granger Cause DENMARK	27 196	0 000
FINLAND does not Granger Cause FRANCE	3 502	0 031
FINLAND does not Granger Cause GREECE	6 115	0.002
LUXEMBOURG does not Granger Cause FINLAND	3 431	0 033
FINLAND does not Granger Cause MSCI	19 866	0 000
FINLAND does not Granger Cause NORWAY	77 148	0 000

Cont.....

Table 4.32: Pair wise Granger Causality Tests for the Stock Markets of Countries of Western Europe Region.

Null Hypothesis:	F-Statistic	Probability
FINLAND does not Granger Cause PORTUGAL	3 382	0.035
GREECE does not Granger Cause FRANCE	3 931	0.020
IRELAND does not Granger Cause FRANCE	3.079	0.047
MSCI does not Granger Cause FRANCE	3 671	0 026
NORWAY does not Granger Cause FRANCE	4.726	0.009
PORTUGAL does not Granger Cause FRANCE	3 188	0 042
SPAIN does not Granger Cause FRANCE	5 112	0 006
FRANCE does not Granger Cause SPAIN	3 351	0.036
SWEDEN does not Granger Cause FRANCE	4 913	0 008
FRANCE does not Granger Cause SWEDEN	3 664	0.026
SWITZERLAND does not Granger Cause FRANCE·	4 411	0 013
ITALY does not Granger Cause GERMANY	2 868	0.051
GERMANY does not Granger Cause ITALY	4 490	0 012
GERMANY does not Granger Cause LUXEMBOURG	21 501	0 000
NETHERLANDS does not Granger Cause GERMANY	38 431	0 000
GERMANY does not Granger Cause NETHERLANDS	4 117	0 017
PORTUGAL does not Granger Cause GERMANY	7 827	0 000
SPAIN does not Granger Cause GERMANY	3 041	0 049
IRELAND does not Granger Cause GREECE	3 207	0 041
GREECE does not Granger Cause MSCI	58 256	0 000
NORWAY does not Granger Cause GREECE	6 653	0 001
GREECE does not Granger Cause NORWAY	39 515	0.000
GREECE does not Granger Cause PORTUGAL	2 986	0 051
SPAIN does not Granger Cause GREECE	8 351	0 000
SWEDEN does not Granger Cause GREECE	4 988	0 007
SWITZERLAND does not Granger Cause GREECE	7 341	0.001
IRELAND does not Granger Cause MSCI	18 238	0 000
NORWAY does not Granger Cause IRELAND	3 203	0 041
IRELAND does not Granger Cause NORWAY	11 374	0 000
IRELAND does not Granger Cause PORTUGAL	3 830	0 022
SPAIN does not Granger Cause IRELAND	8 510	0 000
SWEDEN does not Granger Cause IRELAND	3 494	0 031
SWITZERLAND does not Granger Cause IRELAND	7 309	0 001
ITALY does not Granger Cause LUXEMBOURG	12 142	0 000
NETHERLANDS does not Granger Cause ITALY	36 138	0.000
PORTUGAL does not Granger Cause ITALY	13 636	0 000

Cont.....

Table 4.32: Pair wise Granger Causality Tests for the Stock Markets of Countries of Western Europe Region.

Null Hypothesis:	F-Statistic	Probability
ITALY does not Granger Cause PORTUGAL	3 527	0 030
NETHERLANDS does not Granger Cause LUXEMBOURG	91 175	0.000
PORTUGAL does not Granger Cause LUXEMBOURG	17 758	0 000
MSCI does not Granger Cause NORWAY	6 683	0 001
SPAIN does not Granger Cause MSCI	32 301	0 000
SWEDEN does not Granger Cause MSCI	37 844	0 000
SWITZERLAND does not Granger Cause MSCI	32 512	0 000
NETHERLANDS does not Granger Cause PORTUGAL	11.725	0 000
SPAIN does not Granger Cause NORWAY	14 149	0 000
SWEDEN does not Granger Cause NORWAY	16 601	0 000
SWITZERLAND does not Granger Cause NORWAY	12 023	0.000
SWITZERLAND does not Granger Cause PORTUGAL	5 380	0 005
SPAIN does not Granger Cause SWEDEN	9.146	0 000
SWITZERLAND does not Granger Cause SWEDEN	7 185	0 001

Table 4.33: Forecast error Variance for the Stock Markets of Countries of Western Europe Region

Variance Decomposition of AUSTRIA·

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	100 00	0 00	0 000	0 000	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 000
2	96 810	0 156	0 660	0 367	0 03	0 044	0 059	0 982	0 171	0 460	0 027	0 01	0 074	0 051	0 00	0 04	0 18	0 001
5	91 920	0 162	0 984	0 411	0 06	0 192	0 140	0 950	0 270	0 632	0 224	0 06	0 380	0 456	1 270	1 55	0 12	0 199
10	91 833	0 163	0 986	0 416	0 07	0 193	0 142	0 954	0 274	0 643	0 225	0 06	0 420	0.459	1 27	1 58	0 13	0 20

Variance Decomposition of BELGIUM

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 210	99 790	0 000	0 000	0 00	0 000	0 000	0 000	0 000	0 000	0 000	0 00	0 000	0 000	0 00	0 00	0 00	0 000
2	0 257	95 002	0 577	0 371	0 04	0 101	0 974	0 647	0 079	0 190	0 179	0 08	0 000	0 213	0 47	0 67	0 03	0 079
5	0 284	91 201	0 979	0 667	0 20	0 144	1 093	0 883	0 117	0 365	0 271	0 40	0 116	0 590	1 05	0 96	0 09	0 615
10	0 317	91 130	0 987	0 667	0 26	0 149	1 092	0 885	0 118	0 366	0 271	0 40	0 132	0 590	1 05	0 96	0.06	0 615

Variance Decomposition of BRITAIN- UK

Period	AUSTRIA	BELGIUM	BRITAIN-UK	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 731	0 001	99 268	0 000	0 00	0 000	0 000	0 000	0 000	0 000	0 000	0 00	0 000	0 000	0 00	0 00	0 00	0 000
2	19 391	0 143	78 855	0 178	0 07	0 077	0 083	0 188	0 090	0 034	0 102	0 02	0 003	0 098	0 34	0 01	0 00	0 317
5	18 925	0 219	76 426	0 223	0 28	0 562	0 122	0 427	0 118	0 269	0 115	0 26	0 177	0 361	0 79	0 12	0 16	0 424
10	18 930	0 222	76 319	0 224	0 28	0 567	0 123	0 434	0 122	0 270	0 116	0 26	0 218	0 367	0 79	0 13	0 18	0 425

Cont…..

Table 4.33: Forecast error Variance for the Stock Markets of Countries of Western Europe Region

Variance Decomposition of DENMARK

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GRECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 062	0 004	0 106	99 828	0 00	0 00	0 000	0 00	0 00	0 000	0 000	0 000	0 000	0 000	0.000	0 00	0 00	0 000
2	0 051	0 186	27 43	67 742	0 77	0 24	0 000	0 25	0 55	0 003	0 021	0 023	0 199	0 001	0 002	0 19	2 29	0 032
5	9 262	0 717	24 65	57 690	0 87	0 64	0 039	0 37	0 63	0 260	0 150	0 377	0 390	0.658	0 325	0 44	2 39	0 111
10	9 278	0 725	24 59	57 573	0 88	0 64	0 046	0 38	0 64	0 300	0 150	0 377	0 420	0 661	0.343	0 45	2 40	0 122

Variance Decom osition of FINLAND

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GRECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 023	0 000	29 32	0 205	70 4	0 00	0 000	0 00	0 00	0 000	0 000	0 000	0 000	0 000	0 000	0 00	0 00	0 000
2	5 977	0 236	26 67	0 590	63 9	0 78	0 007	0 11	0 00	0 241	0 794	0 000	0 035	0 033	0 438	0 00	0 03	0 112
5	5 837	0 316	26 29	0 637	62 3	1 07	0 026	0 44	0 21	0 420	1 069	0 026	0 218	0 106	0 542	0 11	0 20	0 149
10	5 837	0 316	26 28	0 638	62 2	1 08	0 027	0 44	0 21	0 421	1 069	0 026	0 259	0 108	0 543	0 11	0 21	0 150

Variance Decomposition of FRANCE

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GRECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 000	0 211	0 162	0 396	1 00	98 30	0 000	0 00	0 00	0 000	0 000	0 000	0 000	0 000	0 000	0 00	0 00	0 000
2	0 344	0 263	0 177	0 457	0 98	95 96	0 063	0 20	0 07	0 052	0 149	0 002	0 034	0 010	0 449	0 00	1 34	0 015
5	0 938	0 258	0 871	0 514	1 29	91 92	0 081	0 91	0 36	0 127	0 217	0 014	0 268	0 670	0 471	0 16	1 36	0 112
10	0 973	0 258	0 873	0 515	1 31	91 22	0 082	0 93	0 36	0 128	0 218	0 014	0 273	0 671	0 481	0 10	1.39	0.112

Cont.....

able 4.33: Forecast error Variance for the Stock Markets of Countries of Western Europe Region

Variance Decomposition of GERMANY

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 637	0 052	0 02	0 023	0 573	0 90	97 781	0 00	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 00	0 000
2	0 376	0 057	0 07	0 827	0 246	0 43	24 490	0 13	0 080	0 316	0 259	0 065	72 495	0 079	0 027	0 091	0 01	0 016
5	0 759	0 082	0 09	0 812	1 254	0 73	23 205	0 37	0 260	0 850	0 279	0 439	68 163	0 217	0 209	1 423	0 33	0 504
10	0 761	0 086	0 10	0 816	1 257	0 74	23 186	0 37	0 270	0 850	0 280	0 441	68 106	0 220	0 220	1 430	0 33	0.519

Variance Decomposition of GREECE

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 070	0 294	6 68	0 070	1 744	0 32	0 003	90 8	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 00	0 000
2	6 584	0 747	6 35	0 105	2 407	0 62	0 179	80 4	0 076	0 119	0 056	0 003	0 211	0 875	0 465	0 162	0 36	0 250
5	8 929	0 822	6 41	0 200	2 282	0 60	0 203	76 7	0 140	0 181	0 157	0 007	0 406	0 896	0 682	0 295	0 72	0 269
10	8 970	0 821	6 40	0 207	2 282	0 60	0 208	76 6	0 142	0 192	0 157	0 008	0 483	0 896	0 687	0 299	0 73	0 270

Variance Decomposition of IRELAND

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 237	0 095	25 7	0 370	0 522	0 13	0 035	1 03	71 83	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 00	0 000
2	13 78	0 551	21 6	0 400	0 540	0 39	0 030	0 85	59 14	0 028	0 342	0 134	0 336	0 262	0 239	0 125	0 58	0 604
5	14 79	0 559	20 7	0 521	0 599	0 42	0 039	2 31	55 48	0 169	0 349	0 163	0 429	0 297	0 605	0 863	0 85	0.774
10	14 79	0 560	20 7	0 524	0 602	0 42	0 041	2 30	55 40	0 175	0 349	0 165	0 482	0 302	0 611	0 872	0 86	0 773

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able 4.33: Forecast error Variance for the Stock Markets of Countries of Western Europe Region

Variance Decomposition of NETHERLANDS

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 016	0 428	0 065	0 312	0 304	0 05	0 074	0 307	0 034	0 190	0 617	0 020	97 57	0 000	0 000	0 000	0 000	0 000
2	0 075	0 429	0 189	0 310	1 458	0 17	0 783	0 841	0 035	0 816	0 624	0 130	93 02	0 191	0.116	0 526	0 264	0 017
5	0 424	0 431	0 230	0 324	1 475	0 35	0 940	0 980	0 172	0 838	0 633	0 214	90 80	0 293	0 200	0 800	0 260	0 626
10	0 428	0 431	0 233	0 324	1 477	0 35	0 943	0 980	0 174	0 837	0 634	0 215	90 77	0 295	0 201	0.806	0 260	0 635

Variance Decom osition of NORWAY·

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 331	0 336	0 120	2 909	0 081	0 10	0 010	0 005	1 127	0 034	0 053	0 200	0 005	94 68	0 000	0 000	0 000	0 000
2	0 650	0 249	19 93	2 869	2 883	0 08	0 165	0 576	3 686	1 197	0 038	0 147	0 469	63 41	0 000	0 612	2 881	0 146
5	21 778	0 251	15 36	2 249	2 285	0 51	0 145	1 115	2 828	1 208	0 068	0'321	0 464	45 78	0 411	0 933	2 909	1 374
10	21 748	0 258	15 31	2 289	2 284	0 52	0 166	1 111	2 844	1 262	0 069	0 320	0 542	45 59	0 432	0.949	2 915	1.382

Variance Decomposition of PORTUGAL

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 374	0 081	0 179	0 151	0 483	0 19	6 133	0 023	0 003	3 225	2 504	0 024	1 841	0 276	84 513	0 000	0 000	0 000
2	0 264	0 192	0 578	1 185	0 706	0 13	4 341	0 340	0 201	3 163	2 026	0 049	28 68	0 599	56 171	0 806	0 253	0 306
5	1 332	0 277	0 740	1 244	0 819	0 19	4 263	0 476	0 307	3 966	1 929	0 155	28 43	0 607	52 998	1 284	0.452	0 527
10	1 352	0 280	0 742	1 248	0 822	0 19	4 261	0 476	0 312	3 964	1 928	0 155	28 41	0 608	52 962	1 289	0 452	0 536

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Table 4.33: Forecast error Variance for the Stock Markets of Countries of Western Europe Region

Variance Decomposition of SPAIN

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	1 01	0 003	40 556	0 195	3 700	0 14	0 581	1 744	1 62	0 00	0 153	0 025	0 001	0 095	0 043	50 126	0 000	0 00
2	19 843	0 208	31 610	0 168	2 937	0 40	0 490	1 690	1 33	0 11	0 731	0 233	0 028	0 248	0 773	39 135	0 024	0 02
5	19 380	0 240	30 658	0 436	3 083	0 86	0 503	2 167	1 37	0 22	1 014	0 328	0 097	0 413	1 087	37 955	0 107	0 06
10	19 398	0 240	30 616	0 440	3 081	0 87	0 504	2 167	1 37	0 23	1 013	0 328	0 143	0 417	1 087	37 903	0 118	0 06

Variance Decomposition of SWEDEN

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 300	0 003	41 903	0 307	18 29	0 41	0 075	0 225	0 82	0 00	0 001	0 002	0 128	0 103	0 108	3 861	33 465	0 00
2	11 735	0 216	35 030	0 283	15 16	1 04	0 067	0 474	0 83	0 26	0 356	0 031	0 195	0 621	0 566	3 882	28 777	0 50
5	11 491	0 337	33 592	0 422	14 53	1 38	0 087	0 815	1 05	0 83	0 674	0 051	0 310	0 751	0 772	4 300	27 937	0 65
10	11 516	0 337	33 550	0 425	14 51	1 37	0 089	0 817	1 04	0 838	0 674	0 051	0 359	0 754	0 773	4 296	27 909	0 65

Variance Decom osition of SWITZERLAND·

Period	AUSTRIA	BELGIUM	BRITAIN	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	IRELAND	ITALY	LUXEMBOURG	MSCI	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND
1	0 218	0 283	46 700	0 144	0 203	0 24	0 102	0 976	2 04	0 01	0 017	0 208	0 054	0 118	0.019	4 653	0 208	43 8
2	19 527	0 433	36 318	0 145	0 222	0 25	0 174	0 930	2 29	0 12	0 156	0 554	0 091	0 109	0 363	4 035	0 218	34 0
5	18 970	0 453	34 757	0 192	0 587	0 69	0 312	1 416	2 72	0 63	0 193	0 796	0 236	0 138	0 871	4 086	0 364	32.5
10	18 993	0 456	34 704	0 197	0 589	0 69	0 316	1 415	2 72	0 63	0 195	0 795	0 304	0.140	0 872	4 079	0 372	32 5

able 4.34: Vector Error Correction Model for the Stock Markets of Countries of Western Europe Region

	Δ AUSTRIA	Δ BELGIUM	Δ BRITAIN	Δ DENMARK	Δ FINLAND	Δ FRANCE	Δ GERMANY	Δ GREECE	Δ IRELAND	Δ ITALY	Δ LUXEMBOURG	Δ MSCI	Δ NETHERLANDS	Δ NORWAY	Δ PORTUGAL	Δ SPAIN	Δ SWEDEN	Δ SWITZERLAND
ECT	-0 04 [-2.1]	-0 03 [-0 9]	-0 08 [-4 7]	0 09 [5 52]	0 08 [2 2]	0 01 [0 6]	-0 07 [-4 5]	0 07 [2 3]	0 07 [1 4]	-0 06 [-3 4]	-0 02 [-1 41]	0 07 [7 8]	0 039 [1 47]	0 13 [7 5]	-0 06 [-3 2]	-0 04 [-2 6]	-0 08 [-2 6]	-0 089 [-4 02]
									Short-Run Lagged Difference									
Δ AUSTRIA	-	0 039 (-0 01) [0 6]	0 43 (-0 04) [8 8]	-0 107 (-0 03) [-2 87]	0 37 (0 08) [4 4]	-0 07 (-0 05) [-1 2]	0 13 (-0 03) [3 75]	0 33 (-0 07) [4 5]	0 28 (-0 04) [1 2]	0 11 (-0 03) [2 8]	0 02 (-0 04) [0 564]	-0 01 (-0 02) [-0 6]	-0 033 (-0 05) [-0 56]	-0 15 (-0 04) [-3 7]	0 03 (-0 04) [0 87]	0 52 (-0 05) [9 3]	0 46 (-0 05) [8 1]	0 53 (-0 04) [11.0]
Δ BELGIUM	-0 03 (-0 03) [-1 4]	-	0 05 (-0 03) [0 5]	-0 04 (-0 02) [-1 6]	-0 06 (-0 06) [-0 9]	0 01 (-0 04) [0 4]	0 03 (-0 02) [1 2]	0 07 (-0 05) [1 5]	0 06 (-0 03) [1 7]	0 02 (-0 02) [0 8]	0 09 (-0 03) [0 28]	0 03 (-0 01) [0 1]	0 01 (-0 04) [0 45]	0 04 (-0 03) [1 4]	-0 025 (-0 03) [-0 76]	0 04 (-0 03) [1 9]	0 039 (-0 04) [0 9]	0.04 (-0 03) [1 12]
Δ BRITAIN	0 2 (-0 13) [2 4]	0 07 (-0 18) [0 6]	-	-0 03 (-0 08) [-0 36]	-0 41 (-0 2) [-2 9]	0 04 (-0 1) [0 3]	0 29 (-0 08) [3 59]	-0 37 (-0 17) [-2 1]	-0 23 (-0 1) [-2 1]	0 35 (-0 08) [4 4]	0 06 (-0 11) [0 64]	-0 04 (-0 07) [-0 2]	-0 15 (-0 13) [-1 14]	-0 37 (-0 09) [-4 9]	0 36 (-0 1) [3 6]	0 26 (-0 11) [**2.2**]	0 343 (-0 13) [2 6]	0 53 (-0 11) [4 76]
Δ DENMARK	-0 05 (-0 04) [-1 5]	0 08 (-0 06) [0 8]	-0 1 (-0 04) [-2 4]	-	-0 06 (-0 09) [-0 7]	-0 03 (-0 06) [-0 5]	-0 08 (-0 08) [-2 09]	0 09 (-0 07) [0 2]	0 01 (-0 04) [0 5]	-0 04 (-0 04) [-0 3]	0 138 (-0 05) [2 93]	0 06 (-0 02) [2 7]	-0 049 (-0 06) [-0 77]	-0 08 (-0 04) [-2 6]	-0 08 (-0 04) [-1 89]	-0 04 (-0 01) [-0 7]	-0 03 (-0 06) [-0 6]	-0 03 (-0 05) [-0 63]
Δ FINLAND	-0 03 (-0 03) [-0 4]	0 02 (-0 08) [0 6]	-0 9 (-0 27) [-1 7]	0 19 (-0 25) [0 76]	-	0 72 (-0 04) [1 8]	-0 03 (-0 02) [-1 54]	0 14 (-0 05) [2 9]	0 05 (-0 03) [0 4]	-0 08 (-0 06) [-0 6]	-0 01 (-0 03) [-0 39]	0 06 (-0 4) [4 39]	0 09 (-0 04) [2 39]	0 49 (-0 27) [1 8]	0 03 -0 03 [1 15]	-0 33 (-0 35) [-0.9]	-0 02 (-0 03) [-0 4]	-0 03 (-0 03) [-1 05]
Δ FRANCE	-0 08 (-0 03) [-0 8]	0 042 (-0 04) [1 7]	-0 9 (-0 9) [-1 6]	0 59 (-0 7) [2 1]	-0 24 (-0 06) [-3 6]	-	-0 01 (-0 02) [-0 43]	-0 08 (-0 05) [-1 4]	-0 03 (-0 03) [-0 9]	-0 04 (-0.1) [-1 7]	0 05 (-0 03) [1 8]	-0 03 (-0 05) [-0 19]	-0 12 (-0 04) [-2.8]	0 04 (-0 09) [1 5]	-0 02 (-0.03) [-0 36]	-0 09 (-0 7) [-2 6]	-0 12 (-0 02) [-2 9]	-0 06 (-0 06) [-1.7]

Note· [ ] presents t-Statistics and ( ) Standard Error

Cont…..

Table 4.34: Vector Error Correction Model for the Stock Markets of Countries of Western Europe Region

	Δ AUSTRIA	Δ BELGIUM	Δ BRITAIN	Δ DENMARK	Δ FINLAND	Δ FRANCE	Δ GERMANY	Δ GREECE	Δ IRELAND	Δ ITALY	Δ LUXEMBOURG	Δ MSCI	Δ NETHERLANDS	Δ NORWAY	Δ PORTUGAL	Δ SPAIN	Δ SWEDEN	Δ SWITZERLAND
ECT	-0 04 [-2 1]	-0 02 [-0 9]	-0 08 [-4 7]	0 09 [5 52]	0 08 [2 2]	0 01 [0 6]	-0 07 [-4 5]	0 07 [2 3]	0 07 [1 4]	-0 06 [-3 4]	-0 02 [-1 41]	0 07 [7 8]	0 03 [1 47]	0 13 [7 5]	-0 06 [-3 2]	-0 048 [-2 6]	-0 06 [-2 6]	-0 08 [-4 02]
									Short-Run Lagged Difference									
Δ GERMANY	-0 02 (-0 06) [-0 3]	-0 17 (-0 07) [-2 3]	0 01 (-0 04) [0 2]	-0 06 (-0 05) [-1 38]	-0 27 (-0 11) [-2 3]	-0 03 (-0 0) [-0 1]	-	-0 19 (-0 09) [-2 0]	-0 11 (-0 06) [-1 8]	0 179 (-0 05) [3 4]	0 13 (-0 05) [2 34]	-0 08 (-0 07) [-3 01]	-0 33 (-0 07) [-4 19]	-0 15 (-0 05) [-2 8]	0 14 (-0 05) [2 4]	0 04 (-0 09) [0 6]	-0 03 (-0 07) [-0 3]	0 07 (-0 06) [0.11]
Δ GREECE	-0 05 (-0 02) [-2 1]	0 07 (-0 03) [2 17]	-0 02 (-0 02) [-1 1]	0 02 (-0 02) [1 09]	-0 02 (-0 05) [-0 5]	-0 03 (-0 03) [-1 1]	-0 01 (-0 02) [-0 85]	-	0 04 (-0 02) [1 6]	-0 05 (-0 02) [-2 25]	-0 05 (-0 02) [-2 07]	0 03 (-0 01) [3 05]	0 08 (-0 03) [2 32]	0 02 (-0 02) [0 91]	0 03 (-0 02) [1 1]	-0 01 (-0 03) [-0 59]	-0 03 (-0 03) [-1 1]	0 01 (-0 02) [0 52]
Δ IRELAND	-0 05 (-0 05) [-1 8]	-0 03 (-0 06 [-0 46]	-0 08 (-0 04 [-1 6]	0 21 (-0 04 [4 30]	0 11 (-0 10) [1 08]	0 04 (-0 07 [0 6]	-0 09 (-0 04) [-2 11]	0 108 (-0 09) [1 18]	-	-0 036 (-0 04) [-0 78]	0 09 (-0 05) [1 7]	0 16 (-0 02) [6 41]	0 05 (-0 07) [0 68]	0 35 (-0 04) [7 1]	-0 04 (-0 05) [-0 82]	-0 12 (-0 06) [-1 62]	-0 17 (-0 07) [-2 4]	-0 247 (-0 06) [-4 12]
Δ ITALY	0 056 (-0 05) [1 4]	0 112 (-0 06) [1 6]	0 006 (-0 04) [0 1]	-0 001 (-0 04) [-0 02]	0 103 (-0 10) [1 08]	0 021 (-0 07) [0 2]	0 071 (-0 04) [1 65]	0 037 (-0 08) [0 41]	0 04 (-0 05) [0 9]	-	0 002 (-0 05) [0 03]	0 021 (-0 02) [0 86]	0 200 (-0 07) [2 83]	0 163 (-0 04) [3 49]	0 027 (-0 052) [0 51]	0 028 (-0 06) [0 45]	0 059 (-0 06) [0 8]	0 020 -(0 05) [0 34]
Δ LUXEMBOURG	-0 03 (-0 04) [-0 8]	0 05 (-0 05) [1 3]	-0 07 (-0 03) [-0 1]	0 04 (-0 03) [1 26]	-0 19 (-0 08) [-1 4]	0 01 (-0 05) [0 3]	-0 02 (-0 03) [-0 5]	0 02 (-0 07) [0 3]	-0 03 (-0 04) [-0 7]	-0 03 (-0 03) [-0 8]	-	0 01 (-0 02) [0 7]	-0 11 (-0 05) [-1 79]	0 02 (-0 03) [0 73]	-0 03 (-0 04) [-0 82]	-0 09 (-0 05) [-1 8]	-0 06 (-0 05) [-1 13]	-0 27 (-0 47) [-0 57]
Δ MSCI	-0 13 (-0 08) [-1.5]	-0 06 (-0 16) [-0 6]	-0 09 (-0 07) [-1 2]	0 134 (-0 07) [1 9]	0 15 (-0 16) [0 6]	0 03 (-0 11) [0 7]	-0 17 (-0 06) [-1 56]	0 17 (-0 14) [1 2]	0 133 (-0 08) [1 5]	-0 08 (-0 07) [-1 1]	-0 093 (-0 08) [-1 16]	-	0 17 (-0 11) [1 55]	0 224 (-0 05) [2 96]	0 03 (-0 08) [0 45]	-0 03 (-0 07) [-0 24]	-0 06 (-0 18) [-0 51]	-0 02 (-0 09) [-0 12]
Δ NETHERLAND	-0 08 (-0 05) [-1 5]	-0 08 (-0 06) [-1 2]	-0 18 (-0 09) [-3 8]	0 16 (-0 04) [3 7]	0 14 (-0 1) [1 3]	0 03 (-0 07) [0 4]	0 7 (-0 04) [16 8]	0 28 (-0 09) [2 3]	0 08 (-0 05) [1 5]	0 5 (-0 04) [7 7]	0 27 (-0 05) [5 18]	0 16 (-0 02) [6 8]	-	0 25 (-0 04) [5 3]	0 24 (-0 05) [4 6]	-0 1 (-0 06) [-1 8]	-0 12 (-0 06) [-1 7]	-0 18 (-0 09) [-3 28]

Note [ ] presents t-Statistics and ( ) Standard Error.

Cont.....

Table 4.34: Vector Error Correction Model for the Stock Markets of Countries of Western Europe Region

	Δ AUSTRIA	Δ BELGIUM	Δ BRITAIN	Δ DENMARK	Δ FINLAND	Δ FRANCE	Δ GERMANY	Δ GREECE	Δ IRELAND	Δ ITALY	Δ LUXEMBOURG	Δ MSCI	Δ NETHERLANDS	Δ NORWAY	Δ PORTUGAL	Δ SPAIN	Δ SWEDEN	Δ SWITZERLAND
ECT	-0.04 [-2 1]	-0 02 [-0 9]	-0 08 [-4 7]	0 09 [5 52]	0 08 [2 2]	0 01 [0 6]	-0 07 [-4 5]	0 07 [2 3]	0 07 [1 4]	-0 06 [-3 4]	-0 02 [-1 41]	0 07 [7 8]	0 03 [1 47]	0 13 [7 5]	-0 06 [-3 2]	-0 048 [-2 6]	-0 06 [-2.6]	-0 08 [-4 02]
											Short-Run Lagged Difference							
Δ NORWAY	-0 12 (-0 05) [-2 4]	0 03 (-0 03) [0 6]	-0 06 (-0 04) [-1 4]	0 11 (-0 04) [2 78]	0 13 (-0 09) [1 3]	0 04 (-0 06) [0 6]	-0 05 (-0 04) [-1 2]	0 29 (-0 08) [3 4]	0 12 (-0 05) [2 4]	-0 01 (-0 04) [-0 39]	-0 05 (-0 05) [-1 04]	0 12 (-0 02) [5 48]	-0 02 (-0 06) [-0 3]	-	-0 13 (-0 04) [-2 71]	-0 05 -0 05 [-0 5]	-0 06 -0 06 [-0 09]	-0 09 -0 05 [-1.75]
Δ PORTUGAL	-0 02 (-0 04) [-0 47]	0 04 (-0 05) [0 8]	0 05 (-0 04) [1 4]	0 01 (-0 03) [0 28]	0 13. (-0 07) [1 5]	0 14 (-0 06) [1 7]	0 06 (-0 03) [1 2]	0 08 (-0 07) [1 5]	0 02 (-0 04) [0 5]	0 09 (-0 04) [2 4]	0 04 (-0 04) [0 96]	-0 07 (-0 02) [-1 2]	-0 05 (-0 06) [-0 9]	-0 01 (-0 04) [-0 3]	-	0 13 -0 05 [2 7]	0 14 -0 05 [2 4]	0 08 -0 05 [1 7]
Δ SPAIN	-0 08 (-0 05) [-1 52]	-0 03 (-0 07) [-0 5]	-0 01 (-0 05) [-0 3]	-0 06 (-0 04) [-0 13]	-0 13 (-0 1) [-1 2]	0 05 (-0 07) [0 7]	0 09 (-0 04) [1 96]	0 03 (-0 09) [0 3]	-0 01 (-0 05) [-0 3]	0 13 (-0 04) [2 6]	0 01 (-0 05) [0 19]	0 03 (-0 02) [1 51]	-0 14 (-0 07) [-1 9]	-0 04 (-0 05) [-0 9]	-0 07 (-0 05) [-1 42]	-	0 13 -0 07 [1 8]	-0 06 -0 06 [-1 1]
Δ SWEDEN	0 14 (-0 06) [2 3]	-0 06 (-0 08) [-0 7]	0 12 (-0 05) [2 2]	0 06 (-0 05) [1 2]	-0 04 (-0 1) [-0 3]	-0 23 (-0 08) [-2 8]	0 09 (-0 05) [1 86]	-0 26 (-0 1) [-2 5]	-0 22 (-0 06) [-1 5]	0 01 (-0 05) [0 1]	0 06 (-0 06) [1 04]	0 07 (-0 03) [2 4]	-0 14 (-0 08) [-1 7]	0 04 (-0 05) [0 68]	0 01 (-0 06) [0 11]	0 05 -0 07 [0 69]	-	0 09 -0 07 [1 4]
Δ SWITZERLAND	0 03 (-0 06) [0 4]	0 001 (-0 07) [-0 1]	0 17 (-0 05) [3 1]	-0 11 (-0 05) [-2 3]	0 08 (-0 1) [0 6]	-0 08 (-0 08) [-1 3]	0 10 (-0 05) [2 4]	0 09 (-0 1) [0 9]	0 08 (-0 06) [1 3]	0 00 (-0 05) [0 04]	0 02 (-0 06) [0 36]	0 03 (-0 03) [1 2]	-0 06 (-0 08) [-0 82]	-0 07 (-0 05) [-1 2]	0 11 (-0 06) [1 95]	0 02 -0 07 [0 34]	0 19 -0 08 [2 4]	-

Note [ ] presents t-Statistics and ( ) Standard Error.

Table: 4.35; Johansen Maximum Likelihood Test for the Stock Markets of Countries of Western Europe Region

Null Hypothesis	Alternative Hypothesis	λ Trace Value	Critical Values	
			5%	1%
r = 0**	r > 0	390 31	291 4	307 64
r ≤ 1**	r > 1	273 72	244 15	257.68
r ≤ 2*	r > 2	207 004	202 92	215.74
r ≤ 3	r > 3	159 72	165 58	177 2
r ≤ 4	r > 4	116.12	131 7	143 09
r ≤ 5	r > 5	89 15	102 14	111 01
r ≤ 6	r > 6	65.18	76 07	84 45
r ≤ 7	r > 7	· 42 59	53 12	60 16
r ≤ 8	r > 8	22 39	34 91	41 07
r ≤ 9	r > 9	10 6	19 96	24 6
r ≤ 10	r > 10	2 68	9 24	12 97
Null Hypothesis	**Alternative Hypothesis**	**λ Max Value**	**Critical Values**	
			5%	**1%**
r = 0**	r = 1	116 58	69 74	76 63
r = 1*	r = 2	66 71	63 57	69 94
r = 2	r = 3	47 28	57 42	63.71
r = 3	r = 4	43.59	52	57 95
r = 4	r = 5	26 97	46 45	51 91
r = 5	r = 6	23 97	40 3	46 82
r = 6	r = 7	22 59	34 4	39 79
r = 7	r = 8	20 19	28 14	33 24
r = 8	r = 9	11 79	22	26 81
r = 9	r = 10	7.91	15 67	20 2
r = 10	r = 11	2 68	9 24	12 97

*, (**) denotes rejection of the hypothesis at the 5%, (1%) level respectively
r = No of Cointegrating Vectors.

Pair Wise Granger Causality Test for the Stock Markets Countries of South and Central America Region

Null Hypothesis:	F-Statistic	Probability
BRAZIL does not Granger Cause ARGENTINA	0 013	0.987
CHILE does not Granger Cause ARGENTINA	0.460	0.632
ARGENTINA does not Granger Cause COLOMBIA	1 358	0.258
COSTARICA does not Granger Cause	0.552	0 576
ARGENTINA does not Granger Cause	1.246	0.288
MSCI does not Granger Cause ARGENTINA	1 259	0 285
ARGENTINA does not Granger Cause MSCI	0 037	0.964
PERU does not Granger Cause ARGENTINA	1.231	0.293
VENEZUELA does not Granger Cause	0 596	0.552
CHILE does not Granger Cause BRAZIL	1.401	0.247
BRAZIL does not Granger Cause COLOMBIA	1 605	0.202
COSTARICA does not Granger Cause BRAZIL	1 087	0.338
BRAZIL does not Granger Cause COSTARICA	1.836	0.160
BRAZIL does not Granger Cause MSCI	0.955	0.385
VENEZUELA does not Granger Cause BRAZIL	0.407	0 665
BRAZIL does not Granger Cause VENEZUELA	2.229	0 109
COLOMBIA does not Granger Cause CHILE	0 685	0.504
CHILE does not Granger Cause COLOMBIA	0.665	0.514
COSTARICA does not Granger Cause CHILE	0 346	0.707
CHILE does not Granger Cause COSTARICA	0.368	0.692
CHILE does not Granger Cause MSCI	0 365	0 694
VENEZUELA does not Granger Cause CHILE	2.186	0 113
CHILE does not Granger Cause VENEZUELA	1.033	0 356
COSTARICA does not Granger Cause COLOMBIA	0 091	0 912
COLOMBIA does not Granger Cause COSTARICA	1 047	0 351
PERU does not Granger Cause COLOMBIA	2 378	0.094
VENEZUELA does not Granger Cause COLOMBIA	1 163	0.313
COLOMBIA does not Granger Cause VENEZUELA	1.899	0 151
MSCI does not Granger Cause COSTARICA	0 242	0.784
COSTARICA does not Granger Cause MSCI	0.155	0 856
PERU does not Granger Cause COSTARICA	0 884	0.413
COSTARICA does not Granger Cause PERU	1 040	0.354
VENEZUELA does not Granger Cause	1.269	0 282
COSTARICA does not Granger Cause	1.619	0.199
PERU does not Granger Cause MSCI	2 639	0.072
VENEZUELA does not Granger Cause MSCI	0.169	0.844
VENEZUELA does not Granger Cause PERU	1 679	0.187

Pair Wise Granger Causality for the Stock Markets of Countries of Asia Pacific Region

Null Hypothesis:	F-Statistic	Probability
CHINA does not Granger Cause AUSTRALIA	0.676	0.509
AUSTRALIA does not Granger Cause CHINA	1.752	0.174
HONG KONG does not Granger Cause AUSTRALIA	0.617	0 540
AUSTRALIA does not Granger Cause HONG KONG	0.842	0.431
INDONESIA does not Granger Cause AUSTRALIA	0.114	0.892
JAPAN does not Granger Cause AUSTRALIA	0 048	0.953
AUSTRALIA does not Granger Cause JAPAN	0.660	0.517
KOREA REPUBLIC does not Granger Cause	0.275	0.760
MALAYSIA does not Granger Cause AUSTRALIA	0.952	0 386
AUSTRALIA does not Granger Cause MALAYSIA	1.125	0.325
MSCI does not Granger Cause AUSTRALIA	0 011	0.989
AUSTRALIA does not Granger Cause NEW ZEALAND	2.464	0.086
PHILIPPINES does not Granger Cause AUSTRALIA	0 652	0.522
AUSTRALIA does not Granger Cause PHILIPPINES	1.526	0.218
AUSTRALIA does not Granger Cause SINGAPORE	1 964	0.141
TAIWAN does not Granger Cause AUSTRALIA	2.098	0.124
AUSTRALIA does not Granger Cause TAIWAN	1 794	0.167
THAILAND does not Granger Cause AUSTRALIA	0.383	0.682
AUSTRALIA does not Granger Cause THAILAND	1 092	0.336
HONG KONG does not Granger Cause CHINA	0.204	0 816
CHINA does not Granger Cause HONG KONG	0.197	0.821
INDONESIA does not Granger Cause CHINA	1 240	0 290
CHINA does not Granger Cause INDONESIA	2.523	0 081
JAPAN does not Granger Cause CHINA	1 704	0.183
CHINA does not Granger Cause JAPAN	0.354	0.702
KOREA REPUBLIC does not Granger Cause CHINA	1 590	0 205
CHINA does not Granger Cause KOREA REPUBLIC	2.648	0 072
MALAYSIA does not Granger Cause CHINA	1 143	0 320
CHINA does not Granger Cause MALAYSIA	0.851	0.428
CHINA does not Granger Cause NEW ZEALAND	0 328	0 720
PHILIPPINES does not Granger Cause CHINA	0.269	0 764
CHINA does not Granger Cause PHILIPPINES	0.665	0:515
CHINA does not Granger Cause SINGAPORE	1 096	0.335
TAIWAN does not Granger Cause CHINA	0.861	0 423
CHINA does not Granger Cause TAIWAN	1.230	0.293
THAILAND does not Granger Cause CHINA	1.133	0 323
CHINA does not Granger Cause THAILAND	0.393	0.675
INDONESIA does not Granger Cause HONG KONG	2.012	0.135
JAPAN does not Granger Cause HONG KONG	0 741	0 477
HONG KONG does not Granger Cause JAPAN	0.160	0.852

Pair Wise Granger Causality for the Stock Markets of Countries of Asia Pacific Region

Null Hypothesis:	F-Statistic	Probability
KOREA REPUBLIC does not Grangei Cause HONG	0.063	0.939
HONG KONG does not Grangei Cause KOREA	1 508	0.222
HONG KONG does not Granger Cause MALAYSIA	0 112	0.894
MSCI does not Granger Cause HONG KONG	1.085	0.338
PHILIPPINES does not Granger Cause HONG KONG	2.443	0.088
TAIWAN does not Granger Cause HONG KONG01	0.925	0.397
THAILAND does not Grangei Cause HONG KONG	1.252	0.287
HONG KONG01 does not Granger Cause THAILAND	0.228	0.796
JAPAN does not Granger Cause INDONESIA	0.001	0.999
MSCI does not Granger Cause CHINA	0.430	0.651
INDONESIA does not Granger Cause JAPAN	0 792	0.454
INDONESIA does not Granger Cause DKOREA	1.929	0.146
MALAYSIA does not Granger Cause INDONESIA	1.284	0.278
INDONESIA does not Granger Cause MALAYSIA	2 698	0.068
INDONESIA does not Granger Cause MSCI	0.809	0.446
NEW ZEALAND does not Gianger Cause INDONESIA	1 154	0.316
INDONESIA does not Granger Cause NEW ZEALAND	2.629	0.073
INDONESIA does not Granger Cause PHILIPPINES	1 335	0.264
INDONESIA does not Grangei Cause SINGAPORE	0 521	0 594
INDONESIA does not Granger Cause TAIWAN	0 753	0.471
INDONESIA does not Granger Cause THAILAND	1.064	0.346
KOREA REPUBLIC does not Gianger Cause JAPAN	1 091	0 337
JAPAN does not Grangei Cause MALAYSIA	2 226	0.109
MSCI does not Granger Cause JAPAN	2.777	0.063
JAPAN does not Giangei Cause MSCI	0.341	0 711
NEW ZEALAND does not Granger Cause JAPAN	0 059	0.943
PHILIPPINES does not Granger Cause JAPAN	1 597	0 203
JAPAN does not Granger Cause PHILIPPINES	0.755	0 471
SINGAPORE does not Grangei Cause JAPAN	2 033	0.132
JAPAN does not Granger Cause SINGAPORE	0 003	0 997
TAIWAN does not Grangei Cause JAPAN	1 179	0 308
JAPAN does not Granger Cause TAIWAN	1.287	0.277
THAILAND does not Granger Cause JAPAN	0 167	0 846
JAPAN does not Granger Cause THAILAND	0.700	0 497
MASCI does not Gianger Cause KOREA REPUBLIC	2 270	0 104
PHILIPPINES does not Granger Cause KOREA	0 882	0.414

Cont.....

Pair Wise Granger Causality for the Stock Markets of Countries of Asia Pacific Region

Null Hypothesis:	F-Statistic	Probability
TAIWAN does not Granger Cause KOREA REPUBLIC	0.827	0.438
KOREA REPUBLIC does not Granger Cause TAIWAN	1.108	0.331
KOREA REPUBLIC does not Granger Cause THAILAND	1.368	0.255
MASCI does not Granger Cause MALAYSIA	0.986	0.374
MALAYSIA does not Granger Cause MASCI	1 072	0.343
PHILIPPINES does not Granger Cause MALAYSIA	0.705	0.495
MALAYSIA does not Granger Cause PHILIPPINES	1.758	0.173
SINGAPORE does not Granger Cause MALAYSIA	1.918	0.148
MALAYSIA does not Granger Cause SINGAPORE	0.725	0 485
TAIWAN does not Granger Cause MALAYSIA	0.262	0.769
MALAYSIA does not Granger Cause TAIWAN	0.820	0.441
MALAYSIA does not Granger Cause THAILAND	2.642	0.072
MSCI does not Granger Cause NEW ZEALAND	0.640	0 528
MSCI does not Granger Cause SINGAPORE	1 206	0.300
MSCI does not Granger Cause TAIWAN	1 309	0.271
MSCI does not Granger Cause THAILAND	0.777	0.460
SINGAPORE does not Granger Cause NEW ZEALAND	1.868	0 155
PHILIPPINES does not Granger Cause TAIWAN	1.856	0.157
PHILIPPINES does not Granger Cause THAILAND	0 236	0.790
TAIWAN does not Granger Cause SINGAPORE	0.461	0 631
TAIWAN does not Granger Cause THAILAND	1.632	0.196

Pair Wise Granger Causality Test for the Stock Markets of Countries of Africa and Middle East Region

Null Hypothesis:	F-Statistic	Probability
EGYPT does not Granger Cause BOTSWANA	0.067	0.935
BOTSWANA does not Granger Cause EGYPT	0.024	0 976
GHANA does not Granger Cause BOTSWANA	2.429	0.089
ISRAEL does not Granger Cause BOTSWANA	0.218	0.804
BOTSWANA does not Granger Cause ISRAEL	0.379	0 685
JORDAN does not Granger Cause BOTSWANA	2.321	0.099
BOTSWANA does not Granger Cause JORDAN	2.449	0 087
KUWAIT does not Granger Cause BOTSWANA	0 825	0.439
BOTSWANA does not Granger Cause KUWAIT	0.035	0 965
MAURITIOUS does not Granger Cause BOTSWANA	0.605	0.546
BOTSWANA does not Granger Cause MAURITIOUS	0.275	0.759
MSCI does not Granger Cause BOTSWANA	0.138	0 871

Cont.....

Pair Wise Granger Causality Test for the Stock Markets of Countries of Africa and Middle East Region

Null Hypothesis:	F-Statistic	Probability
KUWAIT does not Granger Cause EGYPT	1.013	0.364
BOTSWANA does not Granger Cause MSCI	1 408	0.246
NIGERIA does not Granger Cause BOTSWANA	0.572	0.565
BOTSWANA does not Granger Cause NIGERIA	0 146	0.864
OMAN does not Granger Cause BOTSWANA	2.068	0.127
SAUDI ARABIA does not Granger Cause BOTSWANA	0.199	0.820
BOTSWANA does not Grangei Cause SAUDI ARABIA	0 763	0 467
SOUTH AFRICA does not Grangei Cause BOTSWANA	0 174	0.840
BOTSWANA does not Granger Cause SOUTH AFRICA	1.014	0 364
TUNISIA does not Granger Cause BOTSWANA	0 561	0.571
BOTSWANA does not Granger Cause TUNISIA	0.519	0.595
GHANA does not Granger Cause EGYPT	1 060	0.347
EGYPT does not Grangei Cause GHANA	0 319	0.727
EGYPT does not Granger Cause ISRAEL	0 513	0.599
EGYPT does not Granger Cause KUWAIT	1.915	0 148
EGYPT does not Granger Cause MAURITIOUS	2.031	0.132
EGYPT does not Granger Cause MSCI	0 763	0 467
NIGERIA does not Granger Cause EGYPT	0.096	0.909
EGYPT does not Granger Cause NIGERIA	0 445	0 641
EGYPT does not Gıanger Cause OMAN	0 682	0.506
EGYPT does not Gıanger Cause SAUDI ARABIA	0.610	0.543
EGYPT does not Granger Cause SOUTH AFRICA	0 341	0 711
TUNISIA does not Grangei Cause EGYPT	0 582	0.559
EGYPT does not Granger Cause TUNISIA	0.025	0.975
ISRAEL does not Granger Cause GHANA	0 901	0.407
GHANA does not Granger Cause ISRAEL	1.148	0.318
KUWAIT does not Grangei Cause GHANA	0.610	0.544
MAURITIOUS does not Granger Cause GHANA	1 203	0.301
GHANA does not Gıanger Cause MAURITIOUS	1.072	0.343
MSCI does not Grangei Cause GHANA	1.169	0.311
GHANA does not Gıanger Cause MSCI	0.566	0.568
NIGERIA does not Grangei Cause GHANA	0 644	0.525
GHANA does not Granger Cause NIGERIA	1.406	0.246
OMAN does not Granger Cause GHANA	0 203	0 816
GHANA does not Granger Cause OMAN	0.698	0 498
SAUDI ARABIA does not Gıanger Cause GHANA	0 813	0.444
GHANA does not Granger Cause SAUDI ARABIA	0.878	0.416

Cont.....

Pair Wise Granger Causality Test for the Stock Markets of Countries of Africa and Middle East Region

Null Hypothesis:	F-Statistic	Probability
SOUTH AFRICA does not Granger Cause GHANA	0 539	0 584
GHANA does not Granger Cause SOUTH AFRICA	0.569	0.566
TUNISIA does not Granger Cause GHANA	0 456	0.634
GHANA does not Granger Cause TUNISIA	0.060	0.942
ISRAEL does not Granger Cause JORDAN	0 600	0.549
KUWAIT does not Granger Cause ISRAEL	0.110	0.896
ISRAEL does not Granger Cause KUWAIT	0.297	0.743
MAURITIOUS does not Granger Cause ISRAEL	1.381	0.252
NIGERIA does not Granger Cause ISRAEL	0.335	0.716
ISRAEL does not Granger Cause NIGERIA	0.379	0.685
OMAN does not Granger Cause ISRAEL	0.402	0.669
ISRAEL does not Granger Cause OMAN	0 191	0.827
SAUDI ARABIA does not Granger Cause ISRAEL	1.273	0.281
ISRAEL does not Granger Cause SAUDI ARABIA	1.792	0.168
ISRAEL does not Granger Cause SOUTH AFRICA	1.600	0 203
TUNISIA does not Granger Cause ISRAEL	2.247	0.107
ISRAEL does not Granger Cause TUNISIA	1 577	0.208
KUWAIT does not Granger Cause JORDAN	0.423	0.655
JORDAN does not Granger Cause KUWAIT	0 618	0.539
MAURITIOUS does not Granger Cause JORDAN	0 831	0.436
JORDAN does not Granger Cause MAURITIOUS	2.644	0 072
NIGERIA does not Granger Cause JORDAN	0.131	0.877
JORDAN does not Granger Cause NIGERIA	0.184	0.832
OMAN does not Granger Cause JORDAN	2.205	0 111
JORDAN does not Granger Cause OMAN	0 430	0.651
SAUDI ARABIA does not Granger Cause JORDAN	0.895	0.409
JORDAN does not Granger Cause SAUDI ARABIA	0.671	0 512
SOUTH AFRICA does not Granger Cause JORDAN	1 177	0 309
JORDAN does not Granger Cause SOUTH AFRICA	1 655	0.192
TUNISIA does not Granger Cause JORDAN	1 475	0.230
JORDAN does not Granger Cause TUNISIA	0 609	0.544
MAURITIOUS does not Granger Cause KUWAIT	1.701	0.183
KUWAIT does not Granger Cause MAURITIOUS	0.560	0 572
MSCI does not Granger Cause KUWAIT	0 885	0.413
KUWAIT does not Granger Cause MSCI	2.515	0.082
NIGERIA does not Granger Cause KUWAIT	0.015	0.985

Cont.....

Pair Wise Granger Causality Test for the Stock Markets of Countries of Africa and Middle East Region

Null Hypothesis:	F-Statistic	Probability
KUWAIT does not Granger Cause NIGERIA	1.086	0 338
KUWAIT does not Granger Cause OMAN	0 235	0.791
KUWAIT does not Granger Cause SAUDI ARABIA	0.915	0.401
SOUTH AFRICA does not Granger Cause KUWAIT	1.078	0.341
KUWAIT does not Granger Cause SOUTH AFRICA	1.445	0.237
TUNISIA does not Granger Cause KUWAIT	0.020	0 980
KUWAIT does not Granger Cause TUNISIA	0 106	0.900
MSCI does not Granger Cause MAURITIOUS	1 957	0.142
MAURITIOUS does not Granger Cause MSCI	0.214	0.807
NIGERIA does not Granger Cause MAURITIOUS	1.641	0 195
MAURITIOUS does not Granger Cause NIGERIA	0 294	0.745
OMAN does not Granger Cause MAURITIOUS	0.429	0.651
MAURITIOUS does not Granger Cause OMAN	0.121	0 886
SAUDI ARABIA does not Granger Cause MAURITIOUS	1.001	0.368
MAURITIOUS does not Granger Cause SAUDI ARABIA	1 464	0.232
SOUTH AFRICA does not Granger Cause MAURITIOUS	1 464	0.232
MAURITIOUS does not Granger Cause SOUTH AFRICA	0.177	0.838
TUNISIA does not Granger Cause MAURITIOUS	0.131	0.877
MAURITIOUS does not Granger Cause TUNISIA	0.388	0.679
NIGERIA does not Granger Cause MSCI	1 692	0.185
MSCI does not Granger Cause NIGERIA	0 055	0.947
OMAN does not Granger Cause MSCI	2.476	0.085
MSCI does not Granger Cause OMAN	0.787	0.456
SAUDI ARABIA does not Granger Cause MSCI	1 342	0.262
MSCI does not Granger Cause SAUDI ARABIA	0 006	0.994
SOUTH AFRICA does not Granger Cause MSCI	1 909	0.149
MSCI does not Granger Cause SOUTH AFRICA	1.402	0.247
TUNISIA does not Granger Cause MSCI	0.088	0 916
MSCI does not Granger Cause TUNISIA	1.480	0.228
OMAN does not Granger Cause NIGERIA	1 013	0 364
NIGERIA does not Granger Cause OMAN	0 845	0.430
SAUDI ARABIA does not Granger Cause NIGERIA	0.332	0 717
NIGERIA does not Granger Cause SAUDI ARABIA	2.075	0.126
SOUTH AFRICA does not Granger Cause NIGERIA	0.105	0.900
NIGERIA does not Granger Cause SOUTH AFRICA	1 791	0 168
NIGERIA does not Granger Cause TUNISIA	1 360	0.258
SAUDI ARABIA does not Granger Cause OMAN	1.531	0.217

Cont.....

Pair Wise Granger Causality Test for the Stock Markets of Countries of Africa and Middle East Region

Null Hypothesis:	F-Statistic	Probability
OMAN does not Granger Cause SAUDI ARABIA	1.303	0.273
SOUTH AFRICA does not Granger Cause OMAN	0.511	0.600
OMAN does not Granger Cause SOUTH AFRICA	0 805	0 448
TUNISIA does not Granger Cause OMAN	0.832	0.436
OMAN does not Granger Cause TUNISIA	1.650	0.193
SOUTH AFRICA does not Granger Cause SAUDI ARABIA	0.272	0.762
SAUDI ARABIA does not Granger Cause SOUTH AFRICA	0 008	0 992
TUNISIA does not Granger Cause SAUDI ARABIA	1 518	0.220
SAUDI ARABIA does not Granger Cause TUNISIA	0.176	0.839
TUNISIA does not Granger Cause SOUTH AFRICA	0.176	0.839
SOUTH AFRICA does not Granger Cause TUNISIA	0.090	0 914

Pair Wise Granger Causality Test for the Stock Markets of Countries of Eastern Europe Region

Null Hypothesis:	F-Statistic	Probability
HUNGARY Does not Granger Cause CZECH REPUBLIC	0.54	0.58
CZECH REPUBLIC Does not Granger Cause HUNGARY	1 13	0.32
CZECH REPUBLIC Does not Granger Cause LITHUANIA	1.55	0.21
MSCI Does not Granger Cause CZECH REPUBLIC	0.82	0.44
POLAND Does not Granger Cause CZECH REPUBLIC	0.34	0.71
CZECH REPUBLIC Does not Granger Cause POLAND	2.42	0.09
ROMANIA Does not Granger Cause CZECH REPUBLIC	1.79	0.17
CZECH REPUBLIC Does not Granger Cause ROMANIA	0 21	0 81
CZECH REPUBLIC Does not Granger Cause RUSSIAN	0.67	0 51
SLOVAK REPUBLIC Does not Granger Cause CZECH	0.04	0.96
CZECH REPUBLIC Does not Granger Cause SLOVAK	4.34	0.36
SLOVENIA Does not Granger Cause CZECH REPUBLIC	2 60	0.08
CZECH REPUBLIC Does not Granger Cause SLOVENIA	0.05	0.95
CZECH REPUBLIC Does not Granger Cause TURKEY	0 69	0.50
LITHUANIA Does not Granger Cause HUNGARY	4 43	0.23
HUNGARY Does not Granger Cause LITHUANIA	0.50	0.61
MSCI Does not Granger Cause HUNGARY	1.08	0.34
POLAND Does not Granger Cause HUNGARY	0 54	0 58
HUNGARY Does not Granger Cause POLAND	0.74	0.48
HUNGARY Does not Granger Cause ROMANIA	1.04	0.35
HUNGARY Does not Granger Cause RUSSIAN Federation	4.42	0.24
SLOVAK REPUBLIC Does not Granger Cause HUNGARY	0 20	0.82

Cont.....

Pair Wise Granger Causality Test for the Stock Markets of Countries of Eastern Europe Region

Null Hypothesis:	F-Statistic	Probability
HUNGARY Does not Granger Cause SLOVAK REPUBLIC	2.05	0.13
SLOVENIA Does not Granger Cause HUNGARY	0.52	0.59
HUNGARY Does not Granger Cause SLOVENIA	1.69	0.19
TURKEY Does not Granger Cause HUNGARY	1.75	0.17
HUNGARY Does not Granger Cause TURKEY	4.33	0.36
MSCI Does not Granger Cause LITHUANIA	0.04	0.96
LITHUANIA Does not Granger Cause MSCI	4.47	0.86
POLAND Does not Granger Cause LITHUANIA	0.48	0.62
LITHUANIA Does not Granger Cause ROMANIA	0 40	0.67
RUSSIAN Federation Does not Granger Cause LITHUANIA	0.60	0.55
LITHUANIA Does not Granger Cause RUSSIAN Federation	2.58	0 08
SLOVAK REPUBLIC Does not Granger Cause LITHUANIA	0 51	0.60
LITHUANIA Does not Granger Cause SLOVAK REPUBLIC	2.22	0.11
SLOVENIA Does not Granger Cause LITHUANIA	0.12	0.89
LITHUANIA Does not Granger Cause SLOVENIA	0.04	0.96
TURKEY Does not Granger Cause LITHUANIA	1.06	0.35
LITHUANIA Does not Granger Cause TURKEY	0.10	0.91
ROMANIA Does not Granger Cause MSCI	0.72	0.49
MSCI Does not Granger Cause ROMANIA	0.17	0.84
MSCI Does not Granger Cause RUSSIAN Federation	1.09	0.34
SLOVAK REPUBLIC Does not Granger Cause MSCI	1 09	0.34
MSCI Does not Granger Cause SLOVAK REPUBLIC	0.74	0.48
SLOVENIA Does not Granger Cause MSCI	1.07	0 34
MSCI Does not Granger Cause TURKEY	4.06	0.77
POLAND Does not Granger Cause ROMANIA	0.31	0.99
POLAN Does not Granger Cause RUSSIAN Federation	2.26	0.11
SLOVAK REPUBLIC Does not Granger Cause POLAND	0.84	0.43
POLAND Does not Granger Cause SLOVAK REPUBLIC	1.11	0.33
SLOVENIA Does not Granger Cause POLAND	1 83	0 16
POLAND Does not Granger Cause SLOVENIA	1.51	0.22
POLAND Does not Granger Cause TURKEY	0.76	0.47
RUSSIAN Federation Does not Granger Cause ROMANIA	1.04	0.35
SLOVAK REPUBLIC Does not Granger Cause ROMANIA	1.11	0.33
ROMANIA Does not Granger Cause SLOVAK REPUBLIC	1.57	0.21
SLOVENIA Does not Granger Cause ROMANIA	0 12	0.88

Cont.....

Pair Wise Granger Causality Test for the Stock Markets of Countries of Eastern Europe Region

Null Hypothesis:	F-Statistic	Probability
TURKEY Does not Granger Cause ROMANIA	0.78	0.46
ROMANIA Does not Granger Cause TURKEY	1.26	0.29
SLOVAK REPUBLIC Does not Granger Cause RUSSIAN	1.52	0.22
SLOVENIA Does not Granger Cause RUSSIAN Federation	0.82	0 44
RUSSIAN Federation Does not Granger Cause SLOVENIA	0.27	0.76
TURKEY Does not Granger Cause RUSSIAN Federation	4.24	0.48
SLOVENIA Does not Granger Cause SLOVAK REPUBLIC	0 46	0.63
SLOVAK REPUBLIC Does not Granger Cause SLOVENIA	2.12	0.12
TURKEY Does not Granger Cause SLOVAK REPUBLIC	0.65	0.52
SLOVAK REPUBLIC Does not Granger Cause TURKEY	0.29	0.75
TURKEY Does not Granger Cause SLOVENIA	0.82	0.44
SLOVENIA Does not Granger Cause TURKEY	1.07	0 34

Pair Wise Granger Causality Test for the Stock Markets of Countries of Western Europe Region

Null Hypothesis:	F-Statistic	Probability
BELGIUM does not Granger Cause AUSTRIA	0 759	0.469
AUSTRIA does not Granger Cause BELGIUM	1.437	0.238
BRITAIN does not Granger Cause AUSTRIA	2.607	0.075
DENMARK does not Granger Cause AUSTRIA	0.341	0.711
FINLAND does not Granger Cause AUSTRIA	0.582	0.559
FRANCE does not Granger Cause AUSTRIA	0 218	0.804
AUSTRIA does not Granger Cause FRANCE	0.392	0.676
GERMANY does not Granger Cause AUSTRIA	0 897	0 408
AUSTRIA does not Granger Cause GERMANY	1.339	0.263
GREECE does not Granger Cause AUSTRIA	0.617	0.540
IRELAND does not Granger Cause AUSTRIA	1.880	0.154
ITALY does not Granger Cause AUSTRIA	0.781	0.459
AUSTRIA does not Granger Cause ITALY	1 407	0.246
LUXEMBOURG does not Granger Cause AUSTRIA	1 661	0 191
AUSTRIA does not Granger Cause LUXEMBOURG	0.664	0.515
MSCI does not Granger Cause AUSTRIA	1.202	0 301
NETHERLANDS does not Granger Cause AUSTRIA	0.759	0.469
AUSTRIA does not Granger Cause NETHERLANDS	1.183	0 307
AUSTRIA does not Granger Cause PORTUGAL	2.643	0 072
SWEDEN does not Granger Cause AUSTRIA	2 234	0.108
SWITZERLAND does not Granger Cause AUSTRIA	1 070	0.344
BRITAIN does not Granger Cause BELGIUM	1.665	0.190
BELGIUM does not Granger Cause BRITAIN	0.151	0.860

Cont....

Pair Wise Granger Causality Test for the Stock Markets of Countries of Western Europe Region

Null Hypothesis:	F-Statistic	Probability
DENMARK does not Granger Cause BELGIUM	0.401	0.670
BELGIUM does not Granger Cause DENMARK	1.556	0 212
FINLAND does not Granger Cause BELGIUM	0 784	0.457
BELGIUM does not Granger Cause FINLAND	1.220	0.296
FRANCE does not Granger Cause BELGIUM	0.305	0.737
BELGIUM does not Granger Cause FRANCE	0.082	0.922
GERMANY does not Granger Cause BELGIUM	0.619	0.539
BELGIUM does not Granger Cause GERMANY	0.062	0.940
GREECE does not Granger Cause BELGIUM	1 072	0.343
BELGIUM does not Granger Cause GREECE	1.171	0.311
IRELAND does not Granger Cause BELGIUM	1 370	0.255
BELGIUM does not Granger Cause IRELAND	0.442	0.643
ITALY does not Granger Cause BELGIUM	0.156	0.856
BELGIUM does not Granger Cause ITALY	0.138	0.871
LUXEMBOURG does not Granger Cause BELGIUM	1 274	0.281
BELGIUM does not Granger Cause LUXEMBOURG	0 024	0 976
MSCI does not Granger Cause BELGIUM	1 525	0.219
BELGIUM does not Granger Cause MSCI	0.429	0.652
NETHERLANDS does not Granger Cause BELGIUM	0 178	0 837
BELGIUM does not Granger Cause NETHERLANDS	0 104	0.901
NORWAY does not Granger Cause BELGIUM	0.256	0 774
BELGIUM does not Granger Cause NORWAY	0 967	0.381
PORTUGAL does not Granger Cause BELGIUM	2.116	0.121
BELGIUM does not Granger Cause PORTUGAL	0.299	0 741
BELGIUM does not Granger Cause SPAIN	0 145	0.865
SWEDEN does not Granger Cause BELGIUM	1.871	0.155
BELGIUM does not Granger Cause SWEDEN	0.857	0.425
SWITZERLAND does not Granger Cause BELGIUM	1.829	0.161
BELGIUM does not Granger Cause SWITZERLAND	0.318	0.728
DENMARK does not Granger Cause BRITAIN	0 436	0.647
FINLAND does not Granger Cause BRITAIN	0 779	0.459
BRITAIN does not Granger Cause FINLAND	0.619	0.539
FRANCE does not Granger Cause BRITAIN	2.116	0 121
GERMANY does not Granger Cause BRITAIN	0.048	0.953
BRITAIN does not Granger Cause GERMANY	0.555	0.574
GREECE does not Granger Cause BRITAIN	1.223	0.295
IRELAND does not Granger Cause BRITAIN	0.098	0 907
ITALY does not Granger Cause BRITAIN	0.478	0.620
BRITAIN does not Granger Cause ITALY	1.893	0.152

Cont.....

Pair Wise Granger Causality Test for the Stock Markets of Countries of Western Europe Region

Null Hypothesis:	F-Statistic	Probability
LUXEMBOURG does not Granger Cause BRITAIN	0.090	0 914
BRITAIN does not Grangei Cause LUXEMBOURG	0.061	0.941
MSCI does not Granger Cause BRITAIN	1 895	0.151
NETHERLANDS does not Granger Cause BRITAIN	0.227	0.797
BRITAIN does not Granger Cause NETHERLANDS	0.823	0.440
NORWAY does not Granger Cause BRITAIN	1.761	0.173
PORTUGAL does not Granger Cause BRITAIN	0.793	0.453
SPAIN does not Granger Cause BRITAIN	0 063	0.939
BRITAIN does not Granger Cause SPAIN	0.291	0.747
SWEDEN does not Granger Cause BRITAIN	0.392	0.676
SWITZERLAND does not Grangei Cause BRITAIN	0.658	0.518
BRITAIN does not Granger Cause SWITZERLAND	2.286	0 103
DENMARK does not Granger Cause FINLAND	0.100	0.905
DENMARK does not Granger Cause FRANCE	0 942	0.391
GERMANY does not Granger Cause DENMARK	0.907	0.404
DENMARK does not Granger Cause GERMANY	2.652	0.071
DENMARK does not Grangei Cause IRELAND	2.348	0.097
ITALY does not Gıanger Cause DENMARK	1.493	0.226
DENMARK does not Granger Cause ITALY	2.422	0.090
LUXEMBOURG does not Granger Cause DENMARK	0.004	0.996
DENMARK does not Granger Cause LUXEMBOURG	2.481	0.085
DENMARK does not Granger Cause MSCI	0.056	0.945
NETHERLANDS does not Granger Cause DENMARK	0.486	0.616
DENMARK does not Granger Cause NETHERLANDS	0.151	0.860
DENMARK does not Granger Cause NORWAY	1.478	0.229
PORTUGAL does not Granger Cause DENMARK	1.040	0.354
DENMARK does not Gıanger Cause SPAIN	0 664	0.515
DENMARK does not Granger Cause SWEDEN	0.018	0.982
DENMARK does not Granger Cause SWITZERLAND	0 954	0 386
GERMANY does not Granger Cause FINLAND	0.776	0 461
FINLAND does not Grangei Cause GERMANY	1.545	0.214
GREECE does not Gıanger Cause FINLAND	0.777	0.460
IRELAND does not Granger Cause FINLAND	0.302	0.739
FINLAND does not Granger Cause IRELAND	1 113	0 329
ITALY does not Gıanger Cause FINLAND	0.367	0 693
FINLAND does not Granger Cause LUXEMBOURG	1 910	0 149
MSCI does not Grangei Cause FINLAND	0.043	0 958
NETHERLANDS does not Granger Cause FINLAND	0 705	0 494
FINLAND does not Granger Cause NETHERLANDS	0.908	0.404
NORWAY does not Granger Cause FINLAND	0 198	0.820

Cont....

Pair Wise Granger Causality Test for the Stock Markets of Countries of Western Europe Region

Null Hypothesis:	F-Statistic	Probability
PORTUGAL does not Granger Cause FINLAND	0.428	0.652
SPAIN does not Granger Cause FINLAND	0.187	0.830
FINLAND does not Granger Cause SPAIN	1.058	0.348
SWEDEN does not Granger Cause FINLAND	0.659	0 518
FINLAND does not Granger Cause SWEDEN	1.588	0.205
SWITZERLAND does not Granger Cause FINLAND	0.622	0.537
FINLAND does not Granger Cause SWITZERLAND	0.575	0.563
GERMANY does not Granger Cause FRANCE	0 694	0.500
FRANCE does not Granger Cause GERMANY	0.478	0.620
FRANCE does not Granger Cause GREECE	1.052	0.350
FRANCE does not Granger Cause IRELAND	1.664	0.190
ITALY does not Granger Cause FRANCE	1 269	0.282
FRANCE does not Granger Cause ITALY	0.975	0.378
LUXEMBOURG does not Granger Cause FRANCE	0 227	0 797
FRANCE does not Granger Cause LUXEMBOURG	2.114	0.122
FRANCE does not Granger Cause MSCI	2.267	0.105
NETHERLANDS does not Granger Cause FRANCE	0 546	0.580
FRANCE does not Granger Cause NETHERLANDS	0 656	0.520
FRANCE does not Granger Cause NORWAY	1 804	0 165
FRANCE does not Granger Cause PORTUGAL	0.037	0.964
FRANCE does not Granger Cause SWITZERLAND	2.084	0.125
GREECE does not Granger Cause GERMANY	1.382	0.252
GERMANY does not Granger Cause GREECE	0.452	0 636
IRELAND does not Granger Cause GERMANY	0 840	0.432
GERMANY does not Granger Cause IRELAND	0.182	0.834
LUXEMBOURG does not Granger Cause GERMANY	0.518	0.596
MSCI does not Granger Cause GERMANY	0.723	0.486
GERMANY does not Granger Cause MSCI	0 054	0 947
NORWAY does not Granger Cause GERMANY	0.068	0.934
GERMANY does not Granger Cause NORWAY	0.468	0 626
GERMANY does not Granger Cause PORTUGAL	0 540	0 583
GERMANY does not Granger Cause SPAIN	0 077	0 926
SWEDEN does not Granger Cause GERMANY	0.292	0.747
GERMANY does not Granger Cause SWEDEN	0.568	0.567
SWITZERLAND does not Granger Cause GERMANY	1 743	0.176
GERMANY does not Granger Cause SWITZERLAND	1.029	0.358
ITALY does not Granger Cause GREECE	0.258	0 772
GREECE does not Granger Cause ITALY	1.479	0.229
LUXEMBOURG does not Granger Cause GREECE	0.133	0.875
GREECE does not Granger Cause LUXEMBOURG	0.610	0.544
MSCI does not Granger Cause GREECE	2.444	0.088

Pair Wise Granger Causality Test for the Stock Markets of Countries of Western Europe Region

Null Hypothesis:	F-Statistic	Probability
NETHERLANDS does not Granger Cause GREECE	0 332	0.718
GREECE does not Granger Cause NETHERLANDS	1.722	0.180
PORTUGAL does not Granger Cause GREECE	0.654	0.520
GREECE does not Granger Cause SPAIN	1.802	0.166
GREECE does not Granger Cause SWEDEN	1 046	0.352
GREECE does not Granger Cause SWITZERLAND	0 855	0.426
ITALY does not Granger Cause IRELAND	0.433	0.649
IRELAND does not Granger Cause ITALY	1 410	0 245
LUXEMBOURG does not Granger Cause IRELAND	0.102	0.903
IRELAND does not Granger Cause LUXEMBOURG	1 150	0.318
MSCI does not Granger Cause IRELAND	2.100	0.123
NETHERLANDS does not Granger Cause IRELAND	1 597	0.203
IRELAND does not Granger Cause NETHERLANDS	0 137	0.872
PORTUGAL does not Granger Cause IRELAND	0 522	0.594
IRELAND does not Granger Cause SPAIN	0.371	0 690
IRELAND does not Granger Cause SWEDEN	0 217	0.805
IRELAND does not Granger Cause SWITZERLAND	1 640	0.195
LUXEMBOURG does not Granger Cause ITALY	2.537	0 080
MSCI does not Granger Cause ITALY	0 293	0.746
ITALY does not Granger Cause MSCI	0.805	0.448
ITALY does not Granger Cause NETHERLANDS	1.104	0.332
NORWAY does not Granger Cause ITALY	0.625	0 536
ITALY does not Granger Cause NORWAY	2.763	0 064
SPAIN does not Granger Cause ITALY	2 417	0.090
ITALY does not Granger Cause SPAIN	0.090	0.914
SWEDEN does not Granger Cause ITALY	0 311	0 733
ITALY does not Granger Cause SWEDEN	0.899	0.408
SWITZERLAND does not Granger Cause ITALY	1.325	0.267
ITALY does not Granger Cause SWITZERLAND	0 330	0.719
MSCI does not Granger Cause LUXEMBOURG	0 124	0.883
LUXEMBOURG does not Granger Cause MSCI	0 210	0.811
LUXEMBOURG does not Granger Cause	0 522	0.594
NORWAY does not Granger Cause LUXEMBOURG	0.179	0.836
LUXEMBOURG does not Granger Cause NORWAY	0.392	0 676
LUXEMBOURG does not Granger Cause PORTUGAL	1 101	0 333
SPAIN does not Granger Cause LUXEMBOURG	0 087	0.916
LUXEMBOURG does not Granger Cause SPAIN	1.662	0.191
SWEDEN does not Granger Cause LUXEMBOURG	0.946	0 389
LUXEMBOURG does not Granger Cause SWEDEN	1 791	0.168
SWITZERLAND does not Granger Cause LUXEMBOURG	0 228	0.796
LUXEMBOURG does not Granger Cause SWITZERLAND	0.375	0.687

Pair Wise Granger Causality Test for the Stock Markets of Countries of Western Europe Region

Null Hypothesis:	F-Statistic	Probability
NETHERLANDS does not Granger Cause MSCI	0.125	0.883
MSCI does not Grangei Cause NETHERLANDS	0.115	0.892
NORWAY does not Granger Cause MSCI	0.097	0.908
PORTUGAL does not Grangei Cause MSCI	0.936	0.393
MSCI does not Granger Cause PORTUGAL	0.427	0.653
MSCI does not Granger Cause SPAIN	1 133	0.323
MSCI does not Granger Cause SWEDEN	0.653	0 521
MSCI does not Granger Cause SWITZERLAND	1.306	0.272
NORWAY does not Granger Cause NETHERLANDS	0.426	0.653
NETHERLANDS does not Granger Cause NORWAY	0.269	0 764
PORTUGAL does not Gıangei Cause NETHERLANDS	0 390	0.678
SPAIN does not Granger Cause NETHERLANDS ·	0.932	0.395
NETHERLANDS does not Granger Cause SPAIN	0.043	0.958
SWEDEN does not Granger Cause NETHERLANDS	0 135	0 874
NETHERLANDS does not Gıanger Cause SWEDEN	0 768	0.464
SWITZERLAND does not Grangei Cause	1.400	0.247
NETHERLANDS does not Grangei Cause	0.221	0.802
PORTUGAL does not Granger Cause NORWAY	0.446	0.640
NORWAY does not Granger Cause PORTUGAL	2.726	0.066
NORWAY does not Granger Cause SPAIN	1.559	0.211
NORWAY does not Granger Cause SWEDEN	1.633	0.196
NORWAY does not Granger Cause SWITZERLAND	1.236	0.291
SPAIN does not Granger Cause PORTUGAL	1 743	0 176
PORTUGAL does not Granger Cause SPAIN	1.582	0.206
SWEDEN does not Granger Cause PORTUGAL	1 019	0.362
PORTUGAL does not Granger Cause SWEDEN	0 570	0.566
PORTUGAL does not Granger Cause SWITZERLAND	0.121	0.886
SWEDEN does not Grangei Cause SPAIN	0 805	0 447
SWITZERLAND does not Gıangei Cause SPAIN	0 083	0 920
SPAIN does not Granger Cause SWITZERLAND	0.014	0 986
SWEDEN does not Grangei Cause SWITZERLAND	0.804	0.448

CHAPTER V

CHAPTER V

TESTING PERSISTENCE OF VOLATILITY IN THE STOCK MARKETS

5.1 Introduction

A special feature of stock volatility is that it is not directly observable. Hence the unobservability of volatility makes it difficult to evaluate the forecasting performance of Conditional Heteroscedastic models Although volatility is not directly observable, it has some characteristics that are commonly seen in asset returns. First, there exist volatility clusters i e , volatility may be high for certain time periods and low for other periods Secondly volatility evolves over time in a continuous manner Thirdly volatility does not .diverge infinitely that is volatility varies within some fixed range Statistically speaking, this means that volatility is often stationary Fourth, volatility seems to react differently to a big price increase or a big price drop These properties play an important role in the development of volatility models Some volatility models were proposed specifically to capture these characteristics For example, ARCH and GARCH models are used to capture volatility and its persistence over a period of time and EGARCH model was developed to capture the asymmetry in volatility induced by big "positive" and "negative" asset returns Dynamic interlinkages and short term lead-lag relationships between the stock markets is facilitating the scope for increasing transmission of information and volatility spill over in the asset return series As a result, the volatility and its persistence in the asset returns is a subject of increasing integrations among the financial markets. After studying the dynamic interlinkages between stock markets, the present study has taken an attempt to focus on the volatility structure of these stock markets. In this chapter, the ARCH and GARCH model has been used which allows the variance to vary across the time and hence explicitly account for conditional volatility in the time series data The present study examines whether the mean transmission in one country's financial market has impact on others in the presence of time-varying variance specification Specifically, the present study first examines the long memory characteristics of the stock markets and then uses a multivariate GARCH model to identify the persistence of volatility within a sample of equity markets.

5.2 Review of Earlier Studies:

Andrew Karolyi (1995) examines the short-run dynamics of returns and volatility for stocks traded on the New York and Toronto stock exchanges. The paper examines the dynamic relationship between the U S and Canadian daily stock market returns and return volatilities using a bivariate generalized autoregressive conditional Heteroscedasticity (GARCH) model The author not only analyzed how rapidly stock-return innovations originating in the U S. and Canadian markets transmit to the other market but also make out how rapidly the volatility of these innovations transmits to the other market by simulating the impulse responses of the estimated bivariate GARCH model. These results have important implications for the global pricing of securities, for hedging and other trading strategies, and for regulatory policies within these two financial markets If that short-run cross-market dependence in the security returns are accepted and volatilities are significant, then we need to assess the impact of this international spill over for our understanding of the degree of integration or segmentation in the pricing of Canadian and U S. securities within the global North American context

Kroner, K F and Victor K Ng (1998), introduced a set of robust conditional moment tests to detect misspecification in the covariance matrix, and introduce a general model which nests the four most popular multivariate GARCH models and their natural "asymmetric" extensions The sample period is from July 1962 to December 1988, for a total of 1371 weekly observations The model is applied to study the dynamic relation between large and small firm returns Existing multivariate models allowing the covariance matrix to be time varying generally impose strong restrictions on how past shocks can affect the covariance matrix The results suggest that bad news about large firms can cause volatility in both small and large firm returns, while news about small firms, whether good or bad, has minimal effect on the covariance matrix. The conditional covariance between large firm and small firm returns also tends to increase following bad news about large firms but not bad news about small firms

King, M , Sentana, E , and Sushil Wadhwani (1994), empirically tried to account for the time-variation in the covariance between stock markets, and to assess the extent of capital market integration They estimate the multivariate factor asset

pricing model on monthly data for returns on sixteen national stock markets from 1970:1 to 1988:10. The studied countries are Australia, Austria, Belgium, Canada, Den- mark, France, Germany, Italy, Japan, Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The authors analysed a factor model for a study of sixteen national stock market returns The result suggests world index as a market factor may be misleading. The authors conclude idiosyncratic risk is priced and the 'price of risk' is different across stock markets. Only a small proportion of their covariance can be accounted for by 'observable' economic variables Correlation changes are driven primarily by movements in 'unobservables '

Mervyn, A K. and Sushil Wadhwani (1990), investigates why, in October 1987, almost all stock markets fell together despite widely differing economic circumstances The estimate of the contagion model was based on hourly data for London, New York, and Tokyo over the period July 1987 to February 1988 The authors examine a rational expectations price equilibrium and model contagion between markets as the outcome of rational attempts to use imperfect information about the events relevant to equity values Because investors including market-makers have access to different sets of information they can infer valuable information from price changes in other markets. The empirical evidence suggests that an increase in volatility leads in turn to an increase in the size of the contagion effects The rise in the correlation between markets just after the crash is evidence of this

Kristin J F and Roberto Rigobon (2002), examines stock market co-movements. Stock market returns are calculated as rolling-average, two-day returns based on each country's aggregate stock market index They utilize average two-day returns to control for the fact that markets in different countries are not open during the same hours They calculate returns based on U S dollars as well as local currency, but focus on U S dollar returns since these were most frequently used in past work on contagion The authors utilize five lags in order to control for serial correlation and any within-week variation in trading patterns Interest rates have been used to control for any aggregate shocks and/or monetary policy coordination It begins with a discussion of several conceptual issues involved in measuring these movements and how to test for contagion The unadjusted correlation coefficient is conditional on market movements over the time period under consideration, so that during a period of turmoil when stock market volatility increases, standard estimates of cross-market

correlations will be biased upward. The paper applies these concepts to test for stock market contagion during the 1997 East Asian crises, the 1994 Mexican peso collapse, and the 1987 U.S. stock market crash In each of these cases, tests based on the unadjusted correlation coefficients find evidence of contagion in several countries, while tests based on the adjusted coefficients find virtually no contagion This suggests that high market co-movements were a continuation of strong cross-market linkages. In other words, during these three crises there was no contagion, only interdependence.

Hamao, Y , Masulis, R W. and Victor Ng (1990) consider the short-term relations among security prices across three major stock markets such as Tokyo, London, and New York for daily and intraday stock-price activity over the three-years i.e. April 1, 1985 to March 31, 1988 They set out to examine the extent to which security price changes in one market influence the opening prices in another market to trade and whether changes in price volatility in one market are positively related to changes in price volatility in another market The authors examine the transmission mechanisms of the conditional first and second moments in common stock prices across international stock markets and allow for changing conditional variances as well as conditional mean returns This study documents the existence of price change and price volatility effects from one international stock market to the next They find daily stock returns measured from close-to-open and open-to-close to be approximated by a GARCH-M (1, 1) model. For the conditional variance, they find spill over effects from the U S and the U K stock markets to the Japanese market. This effect shows an intriguing asymmetry while the volatility spill over effect on the Japanese market is significant, the spill over effects on the other two markets is much weaker. This result is not affected by whether returns are converted into a single currency. Unexpected changes in foreign market indices are associated with significant spill over effects on the conditional mean of the domestic market for both open-to-close and close-to-open returns. While the effect on the open-to-close returns suggests some informational inefficiency in these markets, further examination of this evidence indicates that overlapping trading between London and New York and the inclusion of stale quotes in the calculation of the Nikkei and S&P opening prices are more likely explanations For the close-to-open returns, this effect on the conditional

mean is consistent with international financial integration, while the magnitude of volatility spill over is much less.

Kurz, M. and Motolese, M. (1999), analysed Rational Expectations Equilibria (REE) and their implications to market volatility. The paper reviews four basic problems which have constituted puzzles or anomalies in relation to the assumptions of REE. (i) Why are asset prices much more volatile than their underlying fundamentals? (ii) The equity premium puzzle why under REE the predicted riskless rate is so high and the equity risk premium so low? (iii) Why do asset prices exhibit the "GARCH" behavior without exogenous fundamental variables to explain it? (iv) The "Forward Discount Bias" in foreign exchange why are interest rate differentials poor predictors of future changes in the exchange rates? The common economic explanation for these phenomena is the existence of heterogonous agents with diverse but correlated beliefs. Given such diversity, some agents are optimistic and some pessimistic The authors develop a simple model which allows agents to be in these two states of belief but the identity of the optimists and the pessimists fluctuates over time since at any date any agent may be in these two states of belief In this model there is a unique parameterization under which the model makes all the above predictions simultaneously. That is, although the parameter space of the RBE is large, all parameterizations outside a small neighborhood of the parameter space fail significantly to reproduce some subset of variables under consideration. Any parameter choice in this small neighborhood requires the optimists to be in the majority but the rationality of belief conditions of the RBE requires the pessimists to have a higher intensity level This higher intensity has a decisive effect on the market it increases the demand for risk less assets, decreases the equilibrium risk less rate and increases the equity premium In simple terms, the large equity premium and the lower equilibrium risk less rate are the result of the fact that at any moment of time there are agents who hold extreme pessimistic beliefs and they have a relatively stronger impact on the market The relative impact of these two groups of agents who are, at any moment of time, in the two states of belief is a direct consequence of the rationality of belief conditions and in that sense it is unique to an RBE As for the correlation among the beliefs of agents, the paper shows that the dynamics of asset prices are strongly affected by such correlation The pattern of correlation which was used in the model can be explained intuitively in terms of its effect on the dynamics of

prices. The model correlation causes periods of price rises (i e bull markets) to develop slower than periods of decline (i e. bear markets) hence the model dynamics does not permit prices to shoot directly from the bottom to the top but the opposite is possible and takes the form of market crashes

Longin, F. and Solnik, B. (2001) studied the conditional correlation structure of international equity returns and derive a formal statistical method, based on extreme value theory that provides asymptotic results, but it offers the benefit that its asymptotic results hold for a wide range of parametric distributions of returns, not only the multivariate normal. An attractive feature of the methodology is that the asymptotic tail distribution is characterized by very few parameters regardless of the actual distribution. Under the assumption of multivariate normality with constant correlation, the correlation of large returns should asymptotically go to zero as the threshold level increases This is not found to be the case for this estimation based on 38 years of monthly data for the five largest stock markets, at least for large negative returns. The correlation of large negative returns does not converge to zero, but tends to increase with the threshold level, and rejection of multivariate normality is highly significant statistically On the other hand, the correlation of large positive returns tends to decrease and to converge to zero and the assumption of multivariate normality cannot be rejected The results favour the explanation that correlation increases in bear markets, but not in bull markets

Koulakiotis, A , Papasyriopoulos, N and Molyneux, P (2006) studied the evidence on the relationship between stock price returns and volatility for industrialized countries taking into account two models, the GARCH-M and the E-GARCHM. The authors wanted to see the symmetric and asymmetric (bad and good news) impact of stock price volatility on the expected returns The data period in the study consist of time series of weekly stock-market indices at the closing of the markets, in terms of local currency between January 1980 to October 1997 for the countries of Australia, Canada, France, Italy, Japan, UK, USA, and Germany The authors found that the GARCH-M model has modelling limitations and gives inconclusive results in comparison to the EGARCH-M model that provides more accurate results with respect to the relationship between stock price returns and volatility In general, authors found through the use of two models that the

relationship between stock price returns and volatility is weak for the specific stock markets of industrialized countries.

Bollerslev, T. and Mikkelsen, H. O (1996) in the paper titled "Modelling and pricing long memory in stock market volatility" focused on long-memory features in the conditional variance of aggregate U.S stock market volatility. Daily Standard and Poor's 500 composite stock price index has been considered over the period of 1953 to 1990. A new class of more flexible fractionally integrated EGARCH models for characterizing the long-run dependencies in U S stock market volatility was proposed by the authors Strong evidence was uncovered that the conditional variance for the Standard and Poor's 500 composite index is best modelled as a mean-reverting fractionally integrated process The practical importance of this finding was illustrated via the simulation of hypothetical prices for long-term options on the index. These findings of long-memory components in the volatility processes of asset returns have proved important implications for many paradigms in modern financial economics In addition to the pricing of long-term options, the optimal portfolio allocations may become extremely sensitive to the investment horizon if the volatility of the returns is long-range dependent

Cathy W.S. Chen et al (2003) tries to examine the hypothesis that both stock returns and volatility are asymmetrical functions of past information from the US market By employing a double-threshold GARCH model to investigate six major index-return series, the authors found strong evidence supporting the asymmetrical hypothesis of stock returns Specifically, negative news from the US market will cause a larger decline in a national stock return than an equal magnitude of good news. This holds true for the volatility series The variance appears to be more volatile when bad news impacts the market than when good news does The data consist of daily closing values for seven stock indices from January 1, 1985, through November 14, 2001. The daily stock-return series are generated by taking the logarithmic difference of the daily stock-index times 100

Deniel B. N (1991) studied Conditional Heteroscedasticity in Asset Returns through a class of ARCH models that do not suffer from some of the drawbacks of GARCH models. The author's model has made a contribution to this end that the goal is far from accomplished It remains to develop a multivariate version of exponential

ARCH and a satisfactory asymptotic theory for the maximum likelihood parameter estimates. The method is used to estimate a model of the risk premium on the CRSP Value-Weighted Market Index from 1962 to 1987

From the above review of the earlier studies, the present research has got enough insights about the volatility structure of the equity markets It is found that if the short-run cross-market dependence in the security returns are accepted and volatilities are significant, then one can measure the impact of international spill over for enhancing the understanding of the degree of financial integration. This also suggests that high market comovements may be a continuation of strong cross-market linkages In some cases, the effect on the conditional mean is also found to be consistent with international financial integration. The information shock to the market in the form of good and bad news is also quite prominent. The bad news about large firms can cause volatility in both small and large firm returns, while news about small firms, whether good or bad, has minimal effect on large firm return series The empirical evidence suggests that an increase in volatility leads to an increase in the size of the contagion effects also

5.3 Methodology:

Conditional Heteroscedastic Models of Volatility:

The prime motivation behind the development of conditional volatility models is twofold First, the linear time series models were inappropriate in the sense that they provide poor forecast intervals, and it was contended that like conditional mean, variance (volatility) could as well evolve over time, and hence it was important to model them both simultaneously Secondly, an assumption of Classical Linear Regression Model (CLRM) is that the variance of the error term is constant If the errors are heteroscedastic, but assumed to be homoscedastic, an important implication would be that standard error estimates could be wrong It is unlikely in the context of financial time series that the variance are constant over time and it makes sense to consider a model that does not assume that variance is constant An attempt in this regard was made by Engel (1982) who proposed the Auto Regressive Conditional Heteroscedastic (ARCH) model Another important feature of many series of financial asset returns which provides a motivation for the ARCH class of models is known as "volatility clustering" or "volatility pooling" This volatility clustering

describes the tendency of large changes in asset prices (of either sign) to follow large changes, and small changes (of either sign) to follow small changes. Hence the current level of volatility tends to be positively correlated with its level during the immediate preceding periods.

5.3.1 The ARCH Model

The first model that provides a systematic framework for volatility modelling is the ARCH model of Engle (1982) The model shows that it is possible to simultaneously model the mean and variance of a series As a preliminary step to understand Engle's methodology, let's estimate a stationary ARMA model $y_t = \alpha_0 + \alpha_1 y_{t-1} + \varepsilon_t$ where $E[\varepsilon_t] = 0$, $\text{var}[\varepsilon_t] = \sigma^2$ for all t and forecast y_{t+1} A forecast of y_{t+1} is conditional expectation of y_{t+1} in period t, given the value of y_t as follows

$$E_t[y_{t+1}] = \alpha_0 + \alpha_1 y_t \qquad (5\ 1)$$

If we use this conditional mean to forecast y_{t+1}, the forecast error variance is

$E_t\left[(y_{t+1} - \alpha_0 - \alpha_1 y_t)^2\right] = E_t\left[\varepsilon_{t+1}^2\right] = \sigma^2$ Instead, if unconditional forecasts are used, the unconditional forecast is always the long run mean of the $\{y_t\}$sequence that is equal to $\alpha_0/(1-\alpha_1)$ The unconditional forecast error variance is

$$E\left\{\left[y_{t+1} - \alpha_0/(1-\alpha_1)\right]^2\right\} = E\left[\left(\varepsilon_{t+1} + \alpha_1\varepsilon_t + \alpha_1^2\varepsilon_{t-1} + \alpha_1^3\varepsilon_{t-2} + \qquad\right)^2\right] = \sigma^2/(1-\alpha_1^2) \qquad (5.2)$$

Since $1/(1-\alpha_1^2) > 1$, the unconditional forecast has a greater variance than the conditional forecast Thus, conditional forecasts are preferable Similarly, if the variance of $\{\varepsilon_t\}$ is not constant, we can estimate any tendency for sustained movements in the variance using an ARMA model Let's $\left\{\hat{\varepsilon}_t\right\}$ will be the estimated residuals from the model $y_t = \alpha_0 + \alpha_1 y_{t-1} + \varepsilon_t$, so that the conditional variance of y_{t+1} will be

$$Var(y_{t+1}|y_t) = E_t\left[(y_{t+1} - \alpha_0 - \alpha_1 y_t)^2\right] = E_t\left[\varepsilon_{t+1}^2\right] \qquad (5\ 3)$$

Thus far, we have set $E_t\varepsilon_{t+1}^2$ equal to σ^2. Now suppose that the conditional variance is not constant. One simple strategy is to model the conditional variance as an AR (q) process using the square of the estimated residuals.

$$\hat{\varepsilon}_t^2 = \alpha_0 + \alpha_1 \hat{\varepsilon}_{t-1}^2 + \alpha_2 \hat{\varepsilon}_{t-2}^2 + \qquad + \alpha_q \hat{\varepsilon}_{t-q}^2 + v_t \qquad (5\ 4)$$

Where v_t is a white noise process. If the values of $\alpha_1, \alpha_2, \ldots \alpha_q$ all equal to zero, the estimated variance is simply the constant α_0 Otherwise the conditional variance of y_t evolves according to the autoregressive process given by (5.4) As such we can use (5.4) to forecast the conditional variance at t+1 as

$$E_t \hat{\varepsilon}_{t+1}^2 = \alpha_0 + \alpha_1 \hat{\varepsilon}_t^2 + \alpha_2 \hat{\varepsilon}_{t-1}^2 + \ldots \qquad + \alpha_q \hat{\varepsilon}_{t+1-q}^2 \quad .$$

For this reason, an equation like (5 4) is called an autoregressive conditional heteroscedastic (ARCH) model

Though the ARCH model offers some advantages described above, it has some weakness too

- The model assumes that positive and negative shocks have the same effect in volatility because it depends on the square of previous shocks In practice it is well known that price of the financial asset responds differently to positive and negative shocks.
- The ARCH model is rather restrictive For instance, α_1^2 of an ARCH (1) model must be in the interval [0, 1/3] if the series is to have a finite fourth moment The constraints become complicated for higher order ARCH model
- The ARCH model does not provide insights for understanding the source of variations of a financial time series It only provides a mechanical way to describe the behaviour of the conditional variance It gives no indication about what causes such behaviour to occur
- ARCH models are likely to over predict the volatility because they respond slowly to large isolated shocks to the return series

Building an ARCH Model:

A way to build an ARCH model consists of three steps Step (1) builds an econometric model for example an ARMA model for the return series to remove any linear dependence in the data and use the residual series of the model to test for ARCH effects. Step (2) specifies the ARCH order and performs estimation. Step (3) involves checking the fitted ARCH model carefully and refining it if necessary

5.3.2 The GARCH Model

GARCH models explain variance by two distributed lags, one on past squared residuals to capture high frequency effects or news about volatility from the previous period measured as the lag of the squared residual from mean equation, and second on lagged values of variance itself to capture long term influences. In the GARCH (1, 1) model, the variance expected at any given data is a combination of long run variance and the variance expected for the last period, adjusted to take into account the size of the last periods observed shock In the GARCH model estimates for financial asset returns data, the sum of coefficients on the lagged squared error and lagged conditional variance is very close to unity This implies that shocks to the conditional variance will be highly persistence and the presence of quite long memory but being less than unit, it is still mean reverting

Bollerslev (1986) proposes a useful extension of ARCH model known as the Generalized ARCH (i.e. GARCH) model Bollerslev extended Engle's original work by developing a technique that allows the conditional variance to be an ARMA process. Let the error process be such that $\varepsilon_t = v_t\sqrt{h_t}$

where $\sigma_v^2 = 1$ and $h_t = \alpha_0 + \alpha_1\varepsilon_{t-1}^2$

$$h_t = \alpha_0 + \sum_{i=1}^{q}\alpha_i\varepsilon_{t-i}^2 + \sum_{i=1}^{p}\beta_i h_{t-i} \qquad (5\ 5)$$

Since $\{v_t\}$ is a white noise process that is independent of past realization of ε_{t-i}, the conditional and unconditional means of ε_t are equal to zero By taking the expected values of ε_t, it is easy to verify that $E\varepsilon_t = Ev_t\sqrt{h_t} = 0$ The important point is that the conditional variance of ε_t is given by $E_{t-1}\varepsilon_t^2 = h_t$ Thus, the conditional variance of ε_t is given by h_t in equation (5.5).

The generalised ARCH (p, q) model of equation (5.5) is called as GARCH (p, q) that allows for both autoregressive and moving average components in the heteroskedastic variance If we set $p = 0$ and $q = 1$, it is clear that the first order ARCH model is simply a GARCH (0, 1) model If all the β_i equal to zero, the GARCH (p, q) model is equivalent to an ARCH (q) model The benefit of GARCH model should be clear as a higher order ARCH model may have a more parsimonious GARCH representation which is much easier to identify and estimate. This is particularly true since all coefficients in (5 5) must be positive

5.4 Nature and Data Sources

The country benchmark index is used as the representative of stock market of the respective countries We have taken weekly index series and the data period is spanning from 2nd week of August 1995 to 4th week of December 2006, around 594 observations. Log transformation of the indices is taken into consideration to make the series smooth. The indices are collected from subscribed sources of Bloomberg. The descriptions about the country benchmark indices are presented in Appendix I.

5.5 Results and Analysis

The persistence of volatility in the stock markets of different countries is studied by ARCH and GARCH models. Since all the benchmark indices representing the stock markets of the respective countries having unit root problem, the indices are taken in log difference. The unit root results are presented in chapter IV In order to model the volatility of the error terms of the return series, first the present has estimated the best autoregressive and moving average model Then error terms are modelled with Autoregressive Conditional Heteroscedasticity (ARCH) model to trace out the existence of ARCH effect This ARCH effect again has been confirmed by Generalised Autoregressive Conditional Heteroscedastic (GARCH) model The best ARMA models for the respective stock markets are presented in Appendix V (I) and the descriptive statistics and the distribution of the log return series of all the indices are presented in Appendix V (II) in end of chapter V It has been observed that the assumption of normality i.e the Null Hypothesis of normality (H_0 = normally distributed) is rejected at zero probability level by Jarque-Bera statistics for almost all the indices. Hence satisfying the properties of ARCH mode we have taken all the return series with GED distribution The residuals of best ARIMA model is used for

ARCH-LM test at first level to test the existence of ARCH effect. If the ARCH- LM test suggests the existence of ARCH effects, then it is reconfirmed by GARCH models. Most of the earlier studies found GARCH (1, 1) as the optimum order and for some cases a higher order GARCH model is require capturing the ARCH effects of the residual series Then at the final stage the GARCH errors has been tested with ARCH-LM to reconfirm the existence of ARCH effects.

ARCH component reflects the influence of random deviations in previous period error terms on σ_t which is a function of random error terms and realised variance of previous periods Similarly, GARCH coefficient measures the part of the realised variances in the previous period that is carried over in to the current period. The sum of ARCH coefficient and GARCH coefficient ($\alpha + \beta$) determines the short run dynamics of the resulting volatility time series. More specifically, a large ARCH error coefficient (α) means that volatility reacts intensely to market movements and a large GARCH error coefficient (β) indicates that shocks to conditional variance take a long time to die out. So volatility is persistence Hence current volatility can be explained by past volatility that tends to persist overtime If α is relatively high and β is relatively low, then volatility tends to be spikier

Table 5 1 to 5.7 contains the ARCH-LM test of the mean equations and variance equations of the studied stock markets The residuals of the estimated best ARMA model are used for ARCH-LM test and the estimated F-statistics, its probability value and observed R-Square with its probability value are presented under columns of mean equation The ARCH-LM tests of the mean equation suggest that the stock markets of Bermuda, Canada and USA of North America Region have ARCH effect confirmed to a very low probability value which is closer to zero for both F-statistics and observed R-square In order to reinsure the estimates with ARCH effects, the present study moves one step ahead estimating GARCH (1, 1) model The GARCH (1, 1) estimated coefficients of the stock markets of North America Region are presented in Table 5 8 The coefficients of the GED parameters are also presented in last column of the table which are also found to be significant The ARCH coefficient (α) in GARCH (1, 1) model is found to be comparatively higher for Bermuda stock market This shows that volatility of Bermuda stock market reacts immediately to the market movements of the random movements of the previous

periods' error terms. USA stock market also seems to be carrying some influence on market movements. But persistence of volatility is found to be higher in both Canada and USA stock market keeping $(\alpha+\beta)$ very high, 0.9473 and 0.9407 respectively. This shows that the part of the realised variances in the previous period that is carried over to the current period volatility of Canada and USA stock market that tend to persist over time and will take long time to die out. At the same time there is no ARCH effect found in Mexico stock market. This shows that the influence of random deviations of the past error terms is carrying an insignificant influence on creating volatility and some other factors are associated to contribute the volatility of Mexican stock market The ARCH-LM test of the variance equation of GARCH (1, 1) model for the stock markets of Bermuda, Canada and USA are presented in Table 5 1 that suggests existence of no ARCH effect as GARCH (1, 1) model has already captured Hence the null hypothesis of H_0: $\alpha_i = 0$ could not be rejected for the variance equations. The GED parameters of the log return indices also stands to be significant for the stock markets of North America Region.

The ARCH-LM test results for the stock markets of South and Central America Region are presented in Table 5 2. It has been observed that out of seven stock markets of the region, stock market of Argentina does not have ARCH effect The F-statistics and the observed R square for the error distribution of the mean equation is not significant This means the past random error distributions are insignificant in creating a volatile return series and Argentina stock market never react strongly with immediate market movements But the stock markets like Brazil, Chile, Colombia, Costa Rica, Peru and Venezuela have ARCH effects in their error distributions of log return indices The F-statistics and the observed R-square support a significant presence of ARCH effect in the return series To reconfirm the ARCH effect, GARCH (1, 1) model has been estimated and the results are presented in Table 5.9. Stock market of Brazil and Chile is having very small ARCH coefficients (0 091 and 0 079 respectively) implies that these stock markets hardly react to immediate market movements But large GARCH coefficient indicates that shocks to conditional variance take a long time to die out Hence the persistence of volatility in Brazil and Chile stock market is very high and persists over time The sum of ARCH and GARCH coefficients $(\alpha+\beta)$ of Colombia stock market is 1 048 implies an Integrated GARCH model i.e. the GARCH error distributions are non stationary and

follows random walk Similar is the case for Costa Rica stock market which is also having an integrated GARCH model. The ARCH coefficient (α) of Costa Rica stock exchange is larger than its' GARCH coefficient (β), implies Costa Rica stock market reacts strongly with market movements and the volatility tends to be more spiky. The ARCH coefficients (α) of Peru and Venezuela stock market are 0 1812 and 0.2846 respectively Venezuela stock market seems to be comparatively more sensitive to the market movements than Peru The ARCH-LM test of GARCH (1, 1) series is presented in the variance column of Table 5 2 which is found with large probability values. This shows no ARCH effects in the variance equations as GARCH (1, 1) model has already absorbed it

The ARCH-LM test statistics (presented in Table 5.3) of the mean equations for the stock markets of four countries of South Asia region supports the presence of ARCH effect in all the stock markets of the region The probability level for F-Statistics and Observed R-Square confirms the existence of non zero (α_i) in the series of error distributions. The existence of ARCH effect has been further justified by GARCH (1, 1) model presented in Table 5 10 Bangladesh stock market follow an Integrated GARCH (IGARCH) model as the sum of ARCH and GARCH coefficients $(\alpha+\beta)$ is greater than one and practically $(\alpha+\beta)$ for Bangladesh stock market is 2 627 ARCH coefficient is placed at very high i e 2 304 which shows high sensitivity of Bangladesh stock market with the random deviations of previous period error terms. In other words, the random volatility of the past error terms influences the market more than its conditional variances Stock markets of Pakistan and Sri Lanka also have some sensitivity towards the market movements carrying the ARCH coefficient of 0.149 and 0.166 respectively The GARCH coefficient (β) is also placed high at 0 77 for both of the countries' stock market But ARCH coefficient (α) is very small (i.e 0.042) for India stock market implies less sensitivity of Indian stock market with the random deviations of previous period error terms The high GARCH coefficient (β) shows a strong persistence of Volatility and the shocks to conditional variances persist over the period of time and take a long time to die out The sum of the coefficients $(\alpha+\beta)$ for all the stock markets of the region except Bangladesh is very high (0 963, 0.923 and 0 945 for India, Pakistan and Sri Lanka

Respectively) showing the existence of high persistence of volatility. The ARCH-LM test of the variance equation of GARCH (1, 1) model presented in Table 5 3 suggest no ARCH effects for the respective stock markets as GARCH (1, 1) model has already captured those and hence the null hypothesis of H_0 $\alpha_i = 0$ could not be rejected for the variance equations The GED parameters are also highly significant for all the four stock markets of the region.

The results for the stock markets of Asia Pacific Region are captured in Table 5 4 that presents the ARCH-LM test of the mean equation and variance equation for the respective stock markets of the region. In the mean equation, the F-statistics and probability value of ARCH coefficient is significant expect Japan and Taiwan stock market The corresponding statistics of observed R-square and its probability value also suggest no ARCH effect for Japan and Taiwan stock market Stock market of Australia, China, Hong Kong, Indonesia, Malaysia, New Zealand, Philippines, Singapore, Korea Republic and Thailand has ARCH effects This has been further justified by GARCH (1, 1) model presented in Table 5 11 The ARCH coefficient (α) is very small for all the stock markets of Asia Pacific Region This shows that these stock markets are very less sensitive to the immediate market fluctuations. The influence of random error deviations of previous period on (σ_i) is nominal But the GARCH coefficients are bigger in number shows the high persistence of Volatility in these stock markets Current volatility on the stock markets of Asia Pacific regions are explained by past volatility that tends to persist over time The sum of $(\alpha+\beta)$ for stock markets of Australia, China, Hong Kong, Indonesia, Malaysia, New Zealand, Philippines, Singapore, Korea Republic and Thailand are 0 892, 0 969, 0 917, 0 889, 0.899, 0 919, 0 962, 0 894, 0 904 and 0 987 respectively All the log return index series are taken under GED distribution due to rejection of the null hypothesis of normality. The ARCH-LM test of the variance equation of GARCH (1, 1) model presented in Table 5(A) 4 suggest no ARCH effect for the respective stock markets as GARCH (1,1) model has already captured those Hence the null hypothesis of H_0 $\alpha_i = 0$ could not be rejected for the variance equations The GED parameters are significant for all the stock markets under out consideration in Asia Pacific region which can be found in the last column of Table 5 4

The ARCH-LM test for the stock markets of Africa and Middle East region are presented in Table 5 5. Out of twelve stock markets of the region Botswana, Jordan, and Nigeria stock market does not have any ARCH effect. The F statistics of the residual terms of estimated mean equations are found to be insignificant. For rest of the stock markets of the region, the F statistics and the observed R square values are stationary at 1% and less probability level proving the existence of ARCH effect in the estimated error distributions of the mean equations It has been further justified with GARCH (1, 1) models presented in Table 5.12. The sum of ARCH coefficient and GARCH coefficient $(\alpha+\beta)$ is greater than one for the stock markets of Egypt, Ghana, Oman and Tunisia. Sum of $(\alpha+\beta)$ implies the GARCH model to be Integrated GARCH (IGARCH) mode Hence the error distribution is random and there exist unit root problems The ARCH coefficient of Ghana stock market is quite high (0 495) means Ghana stock market reacts intensely to market movements and past squared error distribution has comparatively less influence The sum of ARCH and GARCH coefficient of Israel is 0 522. This shows Israel stock market is bit sensitive with market movements and the persistence of volatility is also very low The current volatility is very less explained by past volatility Stock markets of Kuwait, Mauritius and Saudi Arabia are more volatile and react strongly with market movements. These markets are highly volatile with random deviations in the previous period error terms ARCH coefficient of Tunisia stock market is comparatively smaller than ARCH coefficients of Kuwait, Mauritius and Saudi Arabia But the GARCH coefficient is stronger for Kuwait, Saudi Arabia and Tunisia showing a high persistence of volatility in these stock markets The volatility in the return series of these stock markets are explained by its past volatility which may take a long time to die out Similarly South Africa stock market also experiences a high persistence of volatility But it is very less sensitive to the immediate market fluctuations proved by lower ARCH coefficient The ARCH-LM test of the variance equation of GARCH (1, 1) model presented in Table 5 5 suggest no ARCH effect for the stock markets of Egypt, Oman, Israel, Kuwait, Mauritius, Oman, Saudi Arabia, South Africa and Tunisia as GARCH (1, 1) model has already captured, and hence the null hypothesis of H_0 $\alpha_i = 0$ could not be rejected for the variance equations All the return series are taken into GED distribution where the GED parameters are found to be significant for all the log difference series for the region.

The ARCH-LM test statistics of mean equation and variance equation for the stock markets of Eastern Europe region are presented in Table 5.6. Out of nine stock markets of Eastern Europe region, Czech Republic and Hungary does not have ARCH effect at all. The F-Statistics and the probability of observed R-Square could not be able to reject the null hypothesis of H_0 $\alpha_i = 0$. Stock markets of Lithuania, Poland, Romania, Russia Federation, Slovak Republic, Slovenia and Turkey have ARCH effects Rejection of null hypothesis i e. H_0: $\alpha_i = 0$ implies that there exists some non zero α_i in the series of error distribution to model volatility The GARCH (1, 1) model presented in Table 5.13 shows both ARCH and GARCH coefficients that confirm the existence of ARCH effects at higher order The sum of the coefficients $(\alpha + \beta)$ is greater than one for Lithuania and Romania stock market implying an Integrated GARCH (IGARCH) model Hence the GARCH error distribution is non stationary and follows random walk The ARCH coefficient (α_i) is bit high for the stock market of Slovak Republic implying high sensitivity of the stock market with market movements. The ARCH coefficient (α_i) is also can be considered bit high for stock markets of Russian Federation and Slovenia Looking at GARCH coefficients (i e β), the figures are looking high The sum of the coefficients $(\alpha + \beta)$ is also above 0 9 for all the stock market of Eastern Europe region This shows a high persistence of volatility. Current volatility in these stock markets is explained by their past volatility of a higher time lag Hence the conditional variance will take some more time to die out in these stock markets The ARCH-LM test of the variance equation of GARCH (1, 1) model presented in Table 5 6 suggest no ARCH effects for the respective stock markets as GARCH (1,1) model has already captured those and hence the null hypothesis, H_0 $\alpha_i = 0$ could not be rejected for the variance equations The GED parameters are quite significant for the log return indices of Eastern Europe Region.

Table 5 7 presents the ARCH-LM test statistics for the stock markets of Western Europe region. It has been observed that only Greece stock market does not have any ARCH effect. The null hypothesis of H_0 $\alpha_i = 0$ could not be rejected by F statistics and the observed R Square statistics But for rest of the stock markets of the region such as Austria, Belgium, Britain, France, Germany, Italy, Netherlands,

Norway, Sweden, Portugal, Luxembourg, Denmark, Ireland, Finland, Switzerland and Spain, the null hypothesis of H_0. $\alpha_i = 0$ has been rejected proving the existence of some non zero coefficients (α_i) in the error distribution of the return series A higher order of ARCH model known as GARCH model has been estimated to reconfirm the existence of ARCH effects in the studied stock markets. The GARCH model has been optimised at order (1, 1) and the estimated statistics are presented in Table 5 14. The table has been divided into two parts because the size of the table could not be fitted with a single page The ARCH coefficient of Austria, Belgium, Britain, France, Germany, Italy, Netherlands, Norway, Sweden, Portugal, Luxembourg and Switzerland can be considered as large coefficients implying the sensitivity of these stock markets with immediate market movements The impact of random deviations of previous period error terms on σ_t is very high as a result volatility in these stock markets reacts intensely to immediate market movements. Luxembourg stock market carries a strong effect of ARCH coefficient and proved to react strongly with market movements Most of these stock markets have large GARCH coefficients showing a strong persistence of volatility. The sum of the coefficients $(\alpha + \beta)$ is greater than one for Germany, Netherlands and Luxembourg implying an IGARCH model The ARCH-LM test of the variance equation of the estimated GARCH (1, 1) for the respective stock markets are presented in Table 5 7 shows no ARCH effect as GARCH (1, 1) model has already captured those The null hypothesis of H_0 $\alpha_i = 0$ could not be rejected for the variance equations But the ARCH-LM test of the variance equation of Ireland still suggests the existence of ARCH effect which indicates that GARCH (1, 1) model could not be able to capture it Hence it keeps an opportunity to go for a higher order GARCH model Table 5 15 presents a higher order GARCH model for Ireland stock market It has been observed that a GARCH (2, 2) model is able to capture the ARCH effects of Ireland (Table 5 16) But the ambiguity lies with the sigh of the ARCH and GARCH coefficients estimated by a higher order GARCH (2, 2) model The second order ARCH and GARCH coefficient is negative which is not supposed to happen This makes it clear that simple GARCH model is not sufficient for capturing the volatility of Ireland stock market Probably an EGARCH or MGARCH model may be suitable to capture the volatile of Ireland stock market.

5.6 Conclusion:

The present study has used ARCH and GARCH models to capture the persistence of volatility in the stock markets of the selected countries. Out of 65 countries' stock market covered under 7 regional blocks, the stock markets of countries like Mexico, Argentina, Botswana, Jordan, Nigeria, Japan, Taiwan, Czech Republic, Hungary and Greece does not have ARCH effect. The F-Statistics and the probability of observed R-Square could not be able to reject the null hypothesis i e. H_0: $\alpha_i = 0$ The rest of the stock markets such as Bermuda, Canada, USA, Brazil, Chile, Colombia, Costa Rica, Peru, Venezuela, Egypt, Ghana, Israel, Kuwait, Mauritius, Oman, Saudi Arabia, South Africa, Tunisia, Australia, China, Hong Kong, Indonesia, Malaysia, New Zealand, Philippines, Singapore, Korea Republic, Thailand, Bangladesh, India, Pakistan, Sri Lanka, Lithuania, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Turkey, Austria, Belgium, Britain, France, Germany, Italy, Netherlands, Norway, Sweden, Portugal, Luxembourg, Denmark, Ireland, Finland, Switzerland and Spain have ARCH effect in mean equation suggested by ARCH-LM test These stock markets are again analysed under GARCH models. In most of the cases GARCH (1, 1) model is found to be best fitting to capture the ARCH effects effectively Reviewing the results of the GARCH model, the present study found that stock markets of Bermuda, Colombia, Costa Rica, Peru, Venezuela, Ghana, Kuwait Mauritius, Saudi Arabia, Tunisia, Bangladesh, Romania, Slovak Republic, Belgium, Germany, Italy, Netherlands, Norway, Luxembourg and Switzerland have high ARCH coefficients. This implies that these stock markets are highly sensitive with immediate market fluctuations The influence of random deviations in the previous period error terms is quite prominent in creating a volatile return series. As a result the stock market reacts strongly with immediate market movements In such cases the volatility series tends to be spikier

The GARCH coefficients for the stock markets of countries like Canada, USA, Brazil, Chile, Colombia, Peru, Egypt, Oman, Saudi Arabia, South Africa, Tunisia, Australia, China, Hong Kong, Indonesia, Malaysia, New Zealand, Philippines, Singapore, Korea Republic, Thailand, India, Lithuania, Poland, Russian Federation, Slovenia, Turkey, Austria, Britain, France, Germany, Netherlands, Sweden, Denmark, Ireland, Finland and Spain are very high i e close to one. A higher GARCH coefficient implies existence of high persistence of volatility as a

result the shocks to conditional variance take a long time to die out. The GARCH coefficient of Bermuda, Venezuela, Ghana, Kuwait, Pakistan, Sri Lanka, Romania, Slovak Republic Belgium, Italy, Norway, Luxembourg, and Switzerland stock markets are also bit higher. Hence volatility in these stock markets persists for some time. But the stock markets of Bangladesh, Costa Rica, Mauritius and Israel have very small GARCH coefficients showing low persistence of Volatilities in these stock markets. A relatively higher ARCH coefficient and relatively low GARCH coefficient implies volatility tends to be spikier.

The ARCH-LM test of the variance equations of GARCH (1, 1) model suggests no ARCH effects for the GARCH residuals. Hence the null hypothesis of H_0 $\alpha_i = 0$ could not be rejected for the variance equations The sum of ARCH and GARCH coefficients $(\alpha + \beta)$ for stock markets of Colombia, Costa Rica, Egypt, Ghana, Oman, Tunisia, Bangladesh, Lithuania, Romania, Germany, Netherlands and Luxembourg are greater than one indicating Integrated GARCH (IGARCH) models In such cases, the GARCH error distributions are non stationary and hence follow random walk. But the ARCH-LM test of the variance equation of stock market of Ireland suggests the existence of ARCH effect in the GARCH (1, 1) error series Hence it keeps an opportunity to go for a higher order GARCH model It has been found that a GARCH (2, 2) model is able to capture the ARCH effects of Ireland stock market But the ambiguity lies with the sign of the ARCH and GARCH coefficients estimated by a GARCH (2, 2) model. The second order ARCH and GARCH coefficient is negative which is not supposed to happen This makes it clear that simple GARCH model is not sufficient for capturing the volatility of Ireland stock market Probably an EGARCH or MGARCH model may be suitable to capture the volatile of Ireland stock market

TABLES

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APPENDIX-V

TABLES PRESENTING ARCH-LM TEST STATISTICS FOR THE STUDIED STOCK MARKETS

Table 5.1: ARCH-LM Test for the Stock Markets of Countries of North America Region

	Mean Equation				Variance Equation			
	F-stat	Prob.	Obs. R-squared	Prob.	F-stat	Prob.	Obs. R-squared	Prob.
Bermuda	23.533	0.000	22 704	0.000	0.011	0.915	0.011	0.915
Canada	4.843	0 028	4.820	0.028	0.054	0.816	0.055	0.815
Mexico	1.735	0 188	1 736	0.188	***	***	***	***
USA	27 207	0 000	26 092	0.000	0.315	0.575	0.316	0.574

Table 5.2: ARCH-LM Test for the Stock Markets of Countries of South and Central America Region

	Mean Equation				Variance Equation			
	F-stat	Prob	Obs. R-squared	Prob.	F-stat	Prob.	Obs. R-squared	Prob.
Argentina	0 119	0.731	0.119	0.730	***	***	***	***
Brazil	4.817	0 029	4 793	0.029	0 001	0 971	0.001	0 971
Chile	13.045	0.000	12 806	0.000	0.123	0.726	0.123	0.726
Colombia	20 751	0 000	20.110	0 000	0 004	0.948	0.004	0 947
Costa Rica	24.288	0.000	26.155	0 000	0.206	0.650	0.207	0.649
Peru	52.438	0.000	48.302	0 000	0.256	0.613	0.257	0.612
Venezuela	4 449	0.035	4.430	0.035	0.056	0.813	0.056	0.812

Table 5.3: ARCH-LM Test for the Stock Markets of Countries of South Asia Region

	Mean Equation				Variance Equation			
	F-stat	Prob.	Obs. R-squared	Prob.	F-stat	Prob.	Obs. R-squared	Prob.
Bangladesh	9.949	0.002	9.816	0.002	0 007	0.934	0.007	0 934
India	4.707	0.030	4.686	0.030	1.087	0 298	1.088	0.297
Pakistan	21 336	0.000	20.658	0.000	0.153	0.696	0.154	0.695
Sri Lanka	5.836	0.016	5.798	0.016	0.018	0.894	0.018	0.894

Table 5.4: ARCH-LM Test for the Stock Markets of Countries of Asia Pacific Region

	Mean Equation				Variance Equation			
	F-stat	Prob.	Obs R-squared	Prob.	F-stat	Prob.	Obs. R-squared	Prob.
Australia	10.820	0.001	10.660	0.001	0.012	0.914	0.012	0.914
China	15 168	0.000	14.835	0.000	2.022	0.156	2.022	0.155
Hong Kong	5.827	0.016	5.789	0.016	0.144	0.704	0.145	0.704
Indonesia	39.481	0.000	37.115	0.000	0.070	0.792	0 070	0.791
Japan	0.703	0.402	0.705	0.401	***	***	***	***
Malaysia	4.289	0.039	4.272	0 039	1 495	0 222	1.496	0.221
New Zealand	40.166	0.000	37.718	0.000	0 533	0.466	0.534	0.465
Philippines	7.350	0.007	7 284	0.007	0.025	0 875	0.025	0.875
Singapore	9.225	0.002	9.113	0.003	1.633	0.202	1.634	0.201
Korea Republic	18.677	0.000	18.164	0.000	0.329	0.567	0.330	0.566
Taiwan	1 462	0.227	1.464	0.226	***	***	***	***
Thailand	27 195	0.000	26.079	0.000	0.005	0.942	0.005	0.942

Table 5.5: ARCH-LM Test for the Stock Markets of Countries of Africa and Middle East Region

	Mean Equation				Variance Equation			
	F-stat	Prob.	Obs. R-squared	Prob.	F-stat	Prob.	Obs. R-squared	Prob
Botswana	1.638	0.201	1.639	0 200	***	***	***	***
Egypt	48.243	0.000	44.736	0.000	0.190	0.663	0.191	0 662
Ghana	5.591	0.018	5.557	0.018	0 050	0.824	0.050	0.823
Israel	6.076	0.014	6 034	0 014	0.003	0 953	0.003	0.953
Jordan	2.441	0.119	2.439	0.118	***	***	***	***
Kuwait	40.624	0.000	38.128	0.000	0.108	0.743	0.108	0.742
Mauritius	76.161	0.000	67.657	0.000	0.001	0 969	0.001	0.969
Nigeria	0 001	0.980	0 001	0.979	***	***	***	***
Oman	18.751	0.000	18 233	0 000	0.092	0.762	0.092	0.762
Saudi Arabia	58.083	0.000	53.041	0.000	0.084	0.772	0.084	0.772
South Africa	3.197	0.074	3.191	0.074	0.009	0.926	0.009	0.926
Tunisia	6.120	0.014	6.077	0.014	0.050	0.823	0.050	0.822

Table 5.6: ARCH-LM Test for the Stock Markets of Countries of Eastern Europe Region

	Mean Equation				Variance Equation			
	F-stat	Prob.	Obs. R-squared	Prob.	F-stat	Prob.	Obs. R-squared	Prob.
Czech Republic	2.084	0.149	2.083	0.149	***	***	***	***
Hungary	2.903	0.097	2.898	0.095	***	***	***	***
Lithuania	6.149	0.013	6.106	0.013	0.027	0.869	0.027	0.869
Poland	4.036	0.045	4.022	0.045	2.227	0.136	2.226	0.136
Romania	18.592	0.000	18.084	0.000	0.153	0.696	0.154	0.695
Russian Federation	23.423	0.000	22.601	0.000	0.002	0.962	0.002	0.962
Slovak Republic.	7.465	0.006	7.396	0.007	0.189	0.664	0.190	0.663
Slovenia	18 841	0.000	18.318	0 000	0 050	0.823	0 050	0.823
Turkey	28.168	0.000	25 960	0.000	0 018	0 895	0.018	0.894

Table 5.7: ARCH-LM Test for the Stock Markets of Countries of Western Europe Region

	Mean Equation				Variance Equation			
	F-stat	Prob	Obs. R-squaied	Prob.	F-stat	Prob.	Obs. R-squared	Prob.
Austria	5.937	0.015	5.898	0.015	0 327	0.568	0.328	0.567
Belgium	3 654	0 056	3.644	0.056	0.100	0.752	0.100	0 752
Britain	29 585	0.000	28.261	0.000	0.003	0.956	0.003	0.956
France	22.682	0.000	21.914	0 000	0.791	0 374	0.793	0.373
Germany	26.784	0.000	25.704	0.000	0.327	0.568	0.328	0.567
Italy	52 877	0 000	48 673	0 000	0.063	0 801	0.064	0.801
Netherlands	28.467	0.000	27 243	0.000	0 684	0 408	0.686	0.408
Norway	67 148	0.000	60 471	0.000	3.075	0.094	3 069	0.090
Sweden	7.991	0.005	7 910	0 005	0.957	0 328	0.959	0.327
Portugal	55.868	0.000	51 194	0.000	0.177	0 674	0.178	0.673
Luxembourg	81 088	0.000	71.503	0.000	0 002	0.966	0.002	0.966
Denmark	8.945	0.003	8.840	0.003	0 786	0 376	0.788	0.375
Ireland	42 552	0.000	39.811	0.000	10.224	0.001	10.083	0 001
Finland	13.532	0.000	13 272	0.000	0.322	0.571	0.323	0.570
Greece	2.339	0.127	2.338	0.126	***	***	***	***
Switzerland	40.815	0.000	38.292	0.000	1.001	0.317	1.003	0.317
Spain	6.638	0.010	6.586	0.010	0.097	0.756	0.097	0.756

TABLES PRESENTING GARCH (1, 1) TEST STATISTICS FOR THE STUDIED STOCK MARKETS

Table 5.8: GARCH (1, 1) Model for the Stock Markets of Countries of North America Region

	α	β	α + β	GED Parameter
Bermuda	0.24071 [3.077] (0.0021)	0.63762 [7.673] (0.00)	0.8783	0.9484 [15.55] (0.00)
Canada	0.0859 [3.028] (0.0025)	0.8614 [21 95] (0.00)	0.9473	1.276 [12.16] (0 00)
Mexico	* **	* **	**	* **
USA	0.1487 [3.77] (0.002)	0.792 [13 84] (0 000)	0.9407	1.512 [14.79] (0 00)

Note: [ ] presents z-Statistics and ( ) presents probability values.

Table 5.9: GARCH (1, 1) Model for the Stock Markets of Countries of South & Central America Region

	α	β	α + β	GED Parameter
Argentina	* *	* **	* *	**
Brazil	0.09166 [2 361] (0.018)	0.851 [13.863] (0.000)	0 9430	1 379 [15.447] (0.000)
Chile	0.0795 [3 343] (0 008)	0.8914 [30.65] (0.00)	0.9710	1 604 [13.84] (0.000)
Colombia	0.1827 [2.789] (0.005)	0 8655 [20.836] (0.000)	1.0483	0.9145 [22.04] (0.00)
Costa Rica	0.897 [2.606] (0 0091)	0.3056 [2.552] (0.0107)	1.2026	0.5280 [16.057] (0.000)
Peru	0.1812 [3.461] (0.0005)	0.6924 [8 376] (0.000)	0.8737	1.3442 [14.406] (0.000)
Venezuela	0.2846 [3.521] (0.004)	0.6421 [7.271] (0.000)	0.9267	0.8722 [7.271] (0.000)

Note: [ ] presents z-Statistics and ( ) presents probability values.

Table 5.10: GARCH (1, 1) Model for the Stock Markets of Countries of South Asia Region

	α	β	α + β	GED Parameter
Bangladesh	2.304 [6.312] (0.000)	0.3236 [7.148] (0.000)	2.627	0.4524 [24.971] (0.000)
India	0.0422 [2.133] (0.038)	0.9215 [31.174] (0.000)	0.963	1 512 [13.053] (0.000)
Pakistan	0.149 [3.334] (0.0009)	0.7742 [12.334] (0.000)	0 923	1.2557 [12.632] (0.000)
Sri Lanka	0.1665 [2.805] (0.005)	0.778 [13.676] (0.000)	0.945	1.287 [17.353] (0.000)

Note: [ ] presents z-Statistics and ( ) presents probability values.

Table 5.11: GARCH (1, 1) Model for the Stock Markets of Countries of Asia Pacific Region

	α	β	α + β	GED Parameter
Australia	0.0712 [2.264] (0.0236)	0.8215 [10.262] (0.000)	0.892	1.5866 [10.710] (0.000)
China	0.05291 [2.583] (0.0098)	0.9164 [45.936] (0.000)	0.9693	1.1013 [14.426] (0.000)
Hong Kong	0.0701 [3 568] (0.0004)	0.8474 [45.053] (0 000)	0 9175	1.7948 [14.178] (0.000)
Indonesia	0.0963 [3.836] (0.0001)	0.7928 [28.013] (0 000)	0.8891	1.1943 [13.194] (0.000)
Japan	***	***	***	***
Malaysia	0.0646 [3.961] (0.0001)	0 8347 [26 754] (0.000)	0 8994	1.3001 [13.353] (0.000)
New Zealand	0 09365 [2.922] (0.0035)	0 8258 [16.937] (0.000)	0.919	1.532 [11.884] (0 000)
Philippines	0.0639 [2.428] (0.0151)	0.898 [23.592] (0.000)	0.962	1.356 [15.938] (0.000)
Singapore	0.0822 [3.956] (0.0001)	0.8124 [36.225] (0.000)	0.894	1.206 [18.162] (0.000)
Korea Republic	0 0753 [3 912] (0.000)	0 8195 [47.642] (0.000)	0.904	1.7185 [11.485] (0.000)
Taiwan	***	***	***	***
Thailand	0.0555 [3 439] (0.0006)	0.9226 [41.051] (0.000)	0.978	1.5448 [16.862] (0.000)

Note: [ ] presents z-Statistics and ( ) presents probability values.

Table 5.12: GARCH (1, 1) Model for the Stock Markets of Countries of Africa & Middle East Region

	α	β	α + β	GED Parameter
Botswana	***	***	***	***
Egypt	0.15331 [3.108] (0.0019)	0.8467 [19.58] (0.000)	1.009	1.0911 [19.945] (0.000)
Ghana	0.4955 [3 388] (0.0007)	0.6456 [11.285] (0.00)	1.141	0.6295 [18.941] (0.000)
Israel	0.1356 [2.187] (0.0287)	0.3869 [1.5036] (0.1327)	0.5225	1.574 [17.1668] (0.000)
Jordan	***	***	***	***
Kuwait	0.2697 [3.671] (0.0002)	0.6353 [7.345] (0.000)	0.905	1.257 [12.669] (0.000)
Mauritius	0.2991 [2.941] (0.003)	0.521 [4.237] (0.000)	0.8209	1.049 [15.297] (0.000)
Nigeria	***	***	***	***
Oman	0.1522 [3.748] (0.0002)	0 8553 [26.542] (0.000)	1 007	1.241 [17.30] (0.000)
Saudi Arabia	0.2435 [3.872] (0.001)	0.7206 [14.851] (0 000)	0.9642	1.1683 [14.546] (0.000)
South Africa	0.0551 [2.969] (0.003)	0.9157 [59.229] (0 000)	0 9711	1 297 [14 094] (0.000)
Tunisia	0.1962 [3 693] (0.0002)	0.8627 [27 626] (0 000)	1.058	0 9618 [25 782] (0.000)

Note: [ ] presents z-Statistics and ( ) presents probability values.

Table 5.13: GARCH (1, 1) Model for the Stock Markets of Countries of Eastern Europe Region

	α	β	α + β	GED Parameter
Czech Republic	***	***	***	***
Hungary	***	***	***	***
Lithuania	0.0789 [3.283] (0.001)	0.9299 [46.431] (0.000)	1 008	1.219 [20 035] (0.000)
Poland	0.0811 [3.105] (0.0019)	0.8955 [26.294] (0.000)	0 9766	1 485 [11.977] (0.000)
Romania	0.3432 [8.828] (0.000)	0.759 [43.638] (0 000)	1.102	1.017 [40.771] (0.000)
Russian Federation	0.145 [3.958] (0.0001)	0 8311 [22.747] (0.000)	0.976	1 329 [12.372] (0.000)
Slovak Republic	0.1905 [2.957] (0.003)	0 757 [11 05] (0 000)	0.947	1.116 [16.951] (0.000)
Slovenia	0.122 [3.808] (0.000)	0.824 [30.025] (0 000)	0 964	1.251 [16.359] (0 000)
Turkey	0 055 [3.308] (0.0009)	0 938 [25.43] (0 000)	0 973	1.303 [14.127] (0.000)

Note. [ ] presents z-Statistics and ( ) presents probability values

Appendix V (I)

THE BEST ARMA MODELS FITTED FOR THE RETURN SERIES OF THE STOCK MARKETS OF THE STUDIED COUNTRIES

Best ARMA Fitted to the Stock Markets of Countries of North America

Bermuda				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0.0011	0.0004	2.7383	0.0064
AR(1)	-0.5672	0.2351	-2.4120	0.0162
MA(1)	0.6559	0 2156	3.0421	0.0025
Canada				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.000	1.964	0.050
AR(1)	-0 638	0.295	-2.163	0.031
MA(1)	0.570	0 315	1.812	0.071
Mexico				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002	0 001	2.695	0.007
AR(1)	-0.813	0.145	-5.613	0.000
AR(3)	-0.051	0.035	-1.427	0.154
MA(1)	0 830	0 141	5.868	0.000
USA				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.000	1.846	0.066
AR(1)	-0.796	0.183	-4 348	0 000
MA(1)	0.741	0.203	3 649	0 000

Best ARMA Fitted to the Stock Markets of Countries of South and Central America

Argentina				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.763	0.042	-18 151	0 000
AR(2)	-1.014	0.044	-23.186	0.000
MA(1)	0 663	0.258	2 571	0.010
MA(2)	0.947	0.185	5.130	0.000
MA(3)	-0.046	0.252	-0.183	0.855
Brazil				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002	0.001	1.812	0.071
AR(1)	0.437	0 359	1.217	0.224
MA(1)	-0.473	0.358	-1.323	0.186
MA(2)	0.095	0.041	2.299	0.022
Chile				
Variable	Coefficient	Std Error	t-Statistic	Prob.
AR(1)	0 261	0.040	6.567	0.000
Colombia				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003	0 001	4.171	0.000
AR(1)	0.075	0.041	1 846	0.065
AR(2)	0.086	0.041	2.120	0.034
AR(3)	0.175	0.041	4.284	0.000
Costa Rica				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0 002	0.001	2 873	0 004
AR(1)	0 486	0.119	4.095	0 000
AR(2)	0.044	0.049	0 909	0.364
AR(3)	0.214	0.042	5.056	0.000
MA(1)	-0.678	0.118	-5.753	0.000
Peru				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002	0.001	2.394	0.017
AR(1)	0.139	0 041	3.383	0.001
AR(2)	0.106	0.041	2.571	0.010
Venezuela				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003	0.001	2.538	0.011
AR(1)	0.153	0.041	3.710	0.000
AR(2)	0.084	0.041	2.039	0.042

Best ARMA Fitted to the Stock Markets of Countries of South Asia

Bangladesh				
Variable	Coefficient	Std Error	t-Statistic	Prob.
AR(1)	-0.056	0.154	-0.361	0.718
AR(2)	0 602	0.154	3.909	0.000
MA(1)	0.093	0.173	0.536	0.592
MA(2)	-0.443	0.172	-2.574	0.010
India				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.683	0.043	-15.968	0.000
AR(2)	-0.918	0.039	-23.468	0.000
MA(1)	0.776	0.058	13.469	0.000
MA(2)	1.025	0 039	26.158	0.000
MA(3)	0.125	0.043	2.908	0.004
Pakistan				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0 001	0.001	1.593	0.112
AR(1)	1.208	0.008	53.348	0.000
AR(2)	-0.980	0.008	-24.062	0.000
MA(1)	-1 050	0.042	-25.284	0.000
MA(2)	0.807	0.050	16 229	0.000
MA(3)	0.151	0 041	3.672	0.000
Sri Lanka				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.567	0 150	3 767	0.000
MA(1)	-0 409	0.167	-2 446	0.015

Best ARMA Fitted to the Stock Markets of Countries of Asia Pacific

Australia				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0.001	0.000	2.534	0.012
AR(1)	-1.192	0.198	-6.032	0.000
AR(2)	-0.895	0.246	-3.643	0.000
AR(3)	0.067	0.195	0.342	0.733
MA(1)	1.222	0.196	6.238	0.000
MA(2)	0.960	0.243	3.945	0.000
MA(3)	-0.027	0 200	-0.135	0.893
China				
Variable	Coefficient	Std Error	t-Statistic	Prob.
AR(1)	0 469	0 082	5.742	0.000
AR(2)	-0.885	0 081	-10.960	0.000
AR(3)	0.134	0.044	3.064	0.002
MA(1)	-0.373	0.072	-5.171	0.000
MA(2)	0.892	0.068	13.085	0.000
Hong Kong				
Variable	Coefficient	Std Error	t-Statistic	Prob.
AR(1)	0 976	0.303	3.219	0.001
AR(2)	-0.635	0.230	-2.757	0.006
MA(1)	-0 954	0 287	-3.321	0.001
MA(2)	0.676	0.210	3.218	0.001
Indonesia				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.178	0.041	-4 352	0.000
AR(2)	0.172	0.041	4.187	0.000
AR(3)	0.121	0.041	2.961	0.003
Japan				
Variable	Coefficient	Std Error	t-Statistic	Prob.
AR(1)	-1.470	0.111	-13 262	0.000
AR(2)	-0.617	0 134	-4.595	0.000
MA(1)	1.418	0.121	11.689	0.000
MA(2)	0.575	0.147	3.918	0 000

Cont.....

Best ARMA Fitted to the Stock Markets of Countries of Asia Pacific

Malaysia				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.948	0.113	-8.409	0.000
AR(2)	0.490	0.175	2.792	0.005
AR(3)	0.770	0.096	8.044	0.000
MA(1)	0.991	0.127	7.829	0.000
MA(2)	-0.336	0.202	-1 660	0.098
MA(3)	-0.685	0.117	-5.845	0.000
New Zealand				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.234	0.147	-1.597	0.111
AR(2)	-0.219	0.104	-2.100	0.036
AR(3)	-0.812	0.122	-6.663	0.000
MA(1)	0.175	0.155	1.131	0.259
MA(2)	0.274	0.115	2.371	0.018
MA(3)	0.875	0.146	6.011	0.000
Philippines				
Variable	Coefficient	Std Error	t-Statistic	Prob.
AR(1)	0.036	0.041	0.892	0.373
AR(2)	0.153	0.041	3.762	0.000
Singapore				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.667	0 132	-5.061	0.000
MA(1)	0.779	0 111	7.014	0.000
Korea Republic				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.740	0.148	5.016	0.000
MA(1)	-0 838	0.149	-5.633	0.000
MA(2)	0.157	0 041	3.828	0.000
Taiwan				
Variable	Coefficient	Std. Error	t-Statistic	Prob
AR(1)	0 791	0.251	3.148	0 002
AR(2)	-0.444	0.241	-1.844	0.066
MA(1)	-0.843	0.235	-3.592	0.000
MA(2)	0.550	0.225	2.442	0.015

Cont....

Best ARMA Fitted to the Stock Markets of Countries of Asia Pacific

Thailand				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.538	0.205	-2.616	0.009
AR(2)	-0.502	0.150	-3.339	0.001
MA(1)	0.576	0.207	2.788	0.006
MA(2)	0.668	0.136	4.924	0.000
MA(3)	0 133	0.058	2.285	0.023

Best ARMA Fitted to the Stock Markets of Countries of Africa and Middle East

Botswana				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0.002	0 000	8 149	0.000
AR(1)	-0.384	0.049	-7.893	0.000
AR(2)	-0 751	0.024	-31.610	0.000
AR(3)	-0.593	0.038	-15.473	0.000
MA(1)	-0.389	0.051	-7 691	0.000
MA(2)	0 598	0 047	12.802	0.000
Egypt				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0 976	0 020	47 894	0.000
MA(1)	-0.939	0.032	-29.293	0.000
Ghana				
Variable	Coefficient	Std Error	t-Statistic	Prob
C	0 002	0.001	2 483	0 013
AR(1)	0.311	0 041	7 551	0.000
AR(2)	0 214	0 042	5 066	0.000
AR(3)	0.098	0 041	2.390	0.017
Israel				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0 001	0.000	2.286	0.023
AR(1)	-0 625	0 245	-2.551	0.011
MA(1)	0.549	0 262	2.090	0.037
Jordan				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.001	1.684	0.108
AR(1)	0.080	0.041	1.969	0.052

Cont....

Best ARMA Fitted to the Stock Markets of Countries of Africa and Middle East

Kuwait				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.001	1.813	0.072
AR(1)	0.954	0.040	23.631	0.000
MA(1)	-0.915	0.054	-16.931	0.000
Mauritius				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0 001	0.000	2.549	0.011
AR(1)	0.806	0 174	4.625	0 000
MA(1)	-0.625	0.181	-3.455	0.001
MA(2)	-0 106	0 059	-1.783	0 075
Nigeria				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002	0.015	-0.157	0.875
AR(1)	0 999	0 041	24.148	0 000
AR(2)	-0.004	0 044	-0 097	0.923
MA(1)	-1.016	0 008	-34 144	0.000
Oman				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.001	1.616	0.107
AR(1)	0 136	0.041	3 316	0.001
AR(2)	0.134	0.041	3 270	0.001
Saudi Arabia				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.980	0.020	49 426	0.000
MA(1)	-0 946	0.031	-30.815	0.000
South Africa				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0.001	0.001	2.178	0 030
AR(1)	0.073	0.041	1 780	0.076
Tunisia				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0.001	0 000	2.419	0.016
AR(1)	0.117	0.041	2.838	0.005
AR(2)	0.102	0 041	2.465	0.014
AR(3)	0.093	0.041	2.267	0.024

Cont.....

Best ARMA Fitted to the Stock Markets of Countries of Eastern Europe

Czech Republic				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0.001	0 001	1.712	0.087
AR(1)	0.109	0.041	2.669	0.008
Hungary				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002	0.001	2.379	0.018
AR(1)	-0.010	0.041	-0.250	0.803
AR(2)	0.147	0.041	3.612	0.000
Lithuania				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.001	2.293	0.022
AR(1)	-0.651	0.107	-6.096	0.000
AR(2)	0.190	0 050	3.773	0.000
AR(3)	0.193	0 050	3.834	0.000
AR(4)	0.168	0.051	3.322	0.001
AR(5)	0.173	0 042	4.086	0.000
MA(1)	0.778	0 103	7 538	0.000
Poland				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-1.133	0 140	-8.101	0.000
AR(2)	-0.484	0.182	-2.664	0 008
AR(3)	0.101	0 042	2.394	0.017
MA(1)	1.171	0.137	8.549	0.000
MA(2)	0.590	0.171	3.443	0.001
Romania				
Variable	Coefficient	Std. Error	t-Statistic	Prob
C	0.002	0.001	2.579	0.010
AR(1)	-0.788	0 116	-6.784	0.000
MA(1)	0.859	0.097	8 883	0.000
Russian Federation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.087	0.041	2.122	0.034
AR(2)	0.130	0.041	3.170	0.002

Cont...

Best ARMA Fitted to the Stock Markets of Countries of Eastern Europe

Slovak Republic				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.039	0.041	0.945	0.345
AR(2)	0.105	0.041	2.555	0.011
Slovenia				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.001	2.100	0.036
AR(1)	0.870	0.204	4.261	0.000
MA(1)	-0.741	0.208	-3.570	0.000
MA(2)	-0.119	0.047	-2.558	0.011
Turkey				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003	0.001	2 518	0.012
AR(1)	-0.015	0 041	-0.372	0.710
AR(2)	0.106	0.041	2.591	0.010

Best ARMA Fitted to the Stock Markets of Countries of Western Europe

Austria				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0 001	2.173	0.030
AR(1)	0.804	0.141	5.704	0.000
MA(1)	-0.748	0.158	-4.733	0.000
Belgium				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0.001	0.000	1 980	0.048
AR(1)	-1.233	0.192	-6.432	0.000
AR(2)	-0 689	0.181	-3 803	0.000
AR(3)	-0.110	0.044	-2 482	0 013
MA(1)	1.230	0 191	6.437	0.000
MA(2)	0.609	0 187	3 261	0 001
Britain				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	1.123	0.429	2.616	0.009
AR(2)	-0.439	0.408	-1 076	0.283
MA(1)	-1.138	0.433	-2.628	0 009
MA(2)	0.421	0.412	1.024	0.306

Cont....

Best ARMA Fitted to the Stock Markets of Countries of Western Europe

France				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0.001	0.000	1.930	0.062
AR(1)	-0.029	0.041	-0.710	0.478
Germany				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.828	0.141	-5.884	0.000
MA(1)	0.876	0.144	6.068	0.000
MA(2)	0.094	0.043	2.202	0.028
Italy				
Variable	Coefficient	Std Error	t-Statistic	Prob.
AR(1)	-0.741	0.123	-6 006	0.000
AR(2)	0.127	0.041	3.098	0.002
MA(1)	0.844	0.119	7.114	0.000
Netherlands				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.745	0.220	-3.388	0.001
AR(2)	0.062	0.045	1.387	0.166
MA(1)	0 762	0 218	3.502	0.001
Norway				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0 001	0 001	1.487	0.138
AR(1)	0.740	0.240	3.081	0.002
MA(1)	-0.684	0.261	-2.622	0 009
Sweden				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.436	0 073	-5 949	0.000
AR(2)	0.436	0 074	5 892	0 000
AR(3)	0 867	0.071	12.214	0 000
MA(1)	0.442	0.090	4 898	0.000
MA(2)	-0.428	0.092	-4.629	0 000
MA(3)	-0.792	0 088	-8 998	0 000
Portugal				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.674	0.149	4.527	0.000
MA(1)	-0.545	0.169	-3.225	0.001

Cont....

Best ARMA Fitted to the Stock Markets of Countries of Western Europe

Luxembourg				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.839	0 097	8.623	0.000
MA(1)	-0 754	0.117	-6.422	0.000
Greece				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.502	0.276	-1.817	0.070
MA(1)	0.593	0.258	2.302	0.022
Denmark				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.000	1.947	0.052
AR(1)	-1.300	0 065	-20.073	0.000
AR(2)	-0.912	0.063	-14.379	0.000
MA(1)	1.309	0.076	17.205	0.000
MA(2)	0.927	0.084	11.046	0.000
MA(3)	0.053	0 044	1 204	0.229
Ireland				
Variable	Coefficient	Std Error	t-Statistic	Prob.
C	0.001	0.000	2.349	0 019
AR(1)	-1.804	0 067	-26 787	0.000
AR(2)	-0.891	0 060	-14.861	0 000
MA(1)	1 896	0 076	24 880	0.000
MA(2)	1.080	0.098	11.060	0.000
MA(3)	0.091	0.044	2.054	0.040
Finland				
Variable	Coefficient	Std Error	t-Statistic	Prob.
AR(1)	-0.050	0.012	-4.095	0.000
AR(2)	-0.963	0.010	-97.444	0.000
MA(1)	0.033	0 009	3 732	0.000
MA(2)	0 995	0.002	53 370	0.000

Cont.....

Best ARMA Fitted to the Stock Markets of Countries of Western Europe

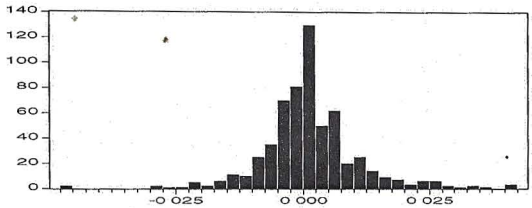
Switzerland				
Variable	Coefficient	Std Error	t-Statistic	Prob.
AR(1)	-0 053	0 007	-7 744	0 000
AR(2)	-0 982	0 007	-150 110	0.000
MA(1)	0 072	0 004	16 851	0 000
MA(2)	0.995	0 004	271 117	0 000
Spain				
Variable	Coefficient	Std Error	t-Statistic	Prob
C	0 001	0 001	1 871	0 062
AR(1)	-0 468	0 103	-4 529	0 000
AR(2)	-0 810	0 109	-7 449	0 000
AR(3)	0 099	0 043	2 305	0 022
MA(1)	0 536	0 096	5 560	0 000
MA(2)	0 882	0 098	9 030	0 000

Appendix V (II)

ERROR DISTRIBUTIONS AND DESCRIPTIVE STATISTICS OF THE STOCK MARKET BENCHMARK INDICES

Error Distribution of Benchmark Index Return Series of Stock Markets of North America Region

Bermuda



Series SER01	
Sample 1 592	
Observations 592	
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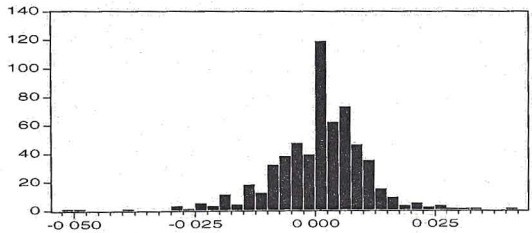
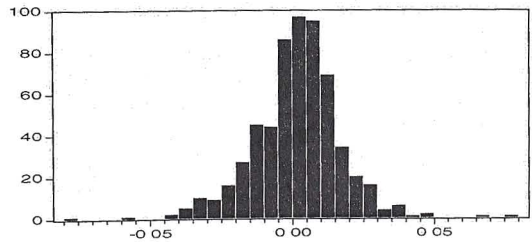
Median	0 000000
Maximum	0 040000
Minimum	-0 047000
Std Dev	0 009494
Skewness	0 293234
Kurtosis	7 272538
Jarque-Bera	458 7635
Probability	0 000000

Canada



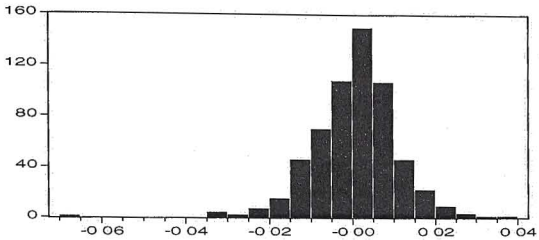
Series SER02	
Sample 1 592	
Observations 592	
Mean	0 000743
Median	0 001000
Maximum	0 040000
Minimum	-0 051000
Std Dev	0 009663
Skewness	0 654357
Kurtosis	6 451910
Jarque-Bera	336 1675
Probability	0 000000

Mexico



Series MEXICO	
Sample 1 592	
Observations 592	
Mean	0 001706
Median	0 002599
Maximum	0 076015
Minimum	-0 076941
Std Dev	0 015468
Skewness	-0 171266
Kurtosis	5 741293
Jarque-Bera	188 2564
Probability	0 000000

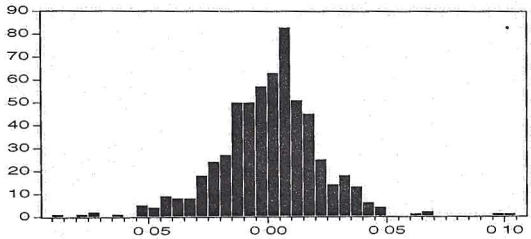
USA



Series USA	
Sample 1 592	
Observations 592	
Mean	0 000728
Median	0 001426
Maximum	0 035133
Minimum	-0 066829
Std Dev	0 009938
Skewness	-0 709180
Kurtosis	7 093635
Jarque-Bera	462 9833
Probability	0 000000

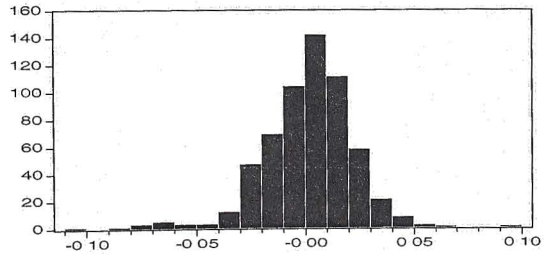
Error Distribution of Benchmark Index Return Series of Stock Markets of South and Central America Region

Argentina



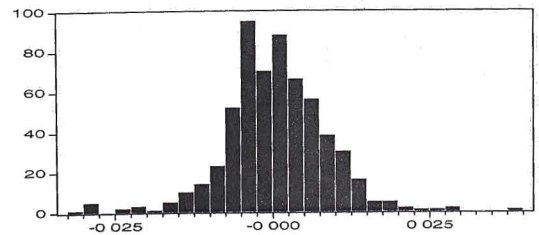
Series ARGENTINA	
Sample 1 592	
Observations 592	
Mean	0 001079
Median	0 002703
Maximum	0 103220
Minimum	-0 085068
Std Dev	0 021362
Skewness	-0 055560
Kurtosis	5 345721
Jarque-Bera	136 0306
Probability	0 000000

Brazil



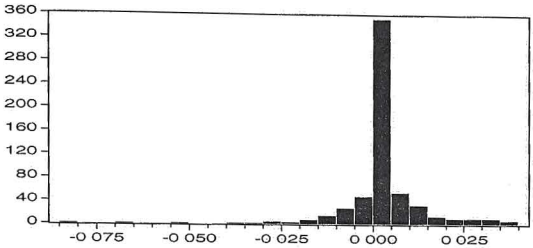
Series BRAZIL	
Sample 1 592	
Observations 592	
Mean	0 001718
Median	0 003242
Maximum	0 094490
Minimum	-0 108828
Std Dev	0 020550
Skewness	-0 620914
Kurtosis	6 183443
Jarque-Bera	288 0189
Probability	0 000000

Chile



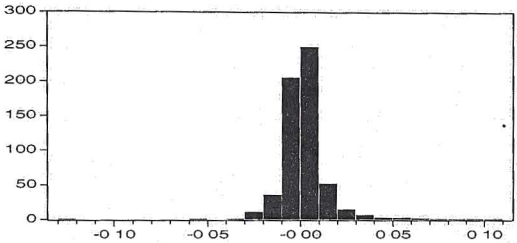
Series CHILE	
Sample 1 592	
Observations 592	
Mean	0 000532
Median	0 000391
Maximum	0 039567
Minimum	-0 030626
Std Dev	0 008086
Skewness	-0 094711
Kurtosis	5 515382
Jarque-Bera	156 9546
Probability	0 000000

Colombia



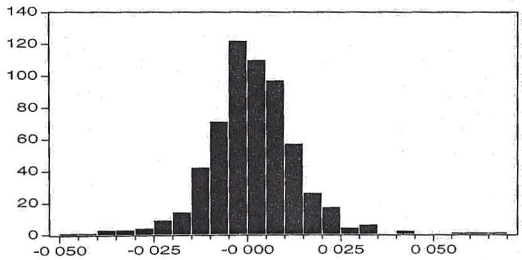
Series COLOMBIA	
Sample 1 592	
Observations 592	
Mean	0 002649
Median	0 001699
Maximum	0 037522
Minimum	-0 082809
Std Dev	0 010455
Skewness	-1 122891
Kurtosis	16 58531
Jarque-Bera	4676 903
Probability	0 000000

Costa Rica



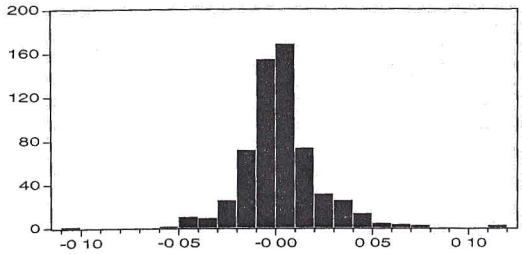
Series COSTA_RICA	
Sample 1 592	
Observations 592	
Mean	0 001982
Median	0 000199
Maximum	0 105724
Minimum	-0 128469
Std Dev	0 014275
Skewness	0 893791
Kurtosis	26 18207
Jarque-Bera	13334 89
Probability	0 000000

Peru



Series PERU	
Sample 1 592	
Observations 592	
Mean	0 001577
Median	0 001271
Maximum	0 067809
Minimum	-0 048666
Std Dev	0 012307
Skewness	0 400601
Kurtosis	6 888403
Jarque-Bera	388 7862
Probability	0 000000

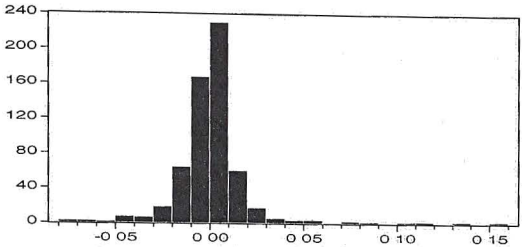
Venezuela



Series VENEZUELA	
Sample 1 592	
Observations 592	
Mean	0 002645
Median	0 001106
Maximum	0 115515
Minimum	-0 107587
Std Dev	0 019792
Skewness	0 642829
Kurtosis	8 346261
Jarque-Bera	745 8071
Probability	0 000000

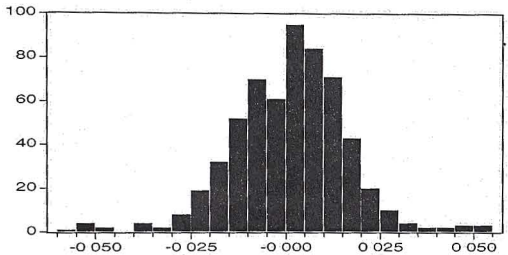
Error Distribution of Benchmark Index Return Series of Stock Markets of South Asia Region

Bangladesh



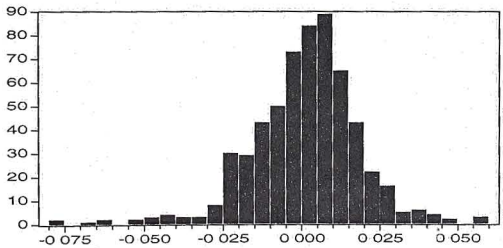
Series BANGLADESH	
Sample 1 592	
Observations 592	
Mean	0 000498
Median	8 98e-06
Maximum	0 159533
Minimum	-0 076941
Std Dev	0 018631
Skewness	2 256999
Kurtosis	22 10452
Jarque-Bera	9505 523
Probability	0 000000

India



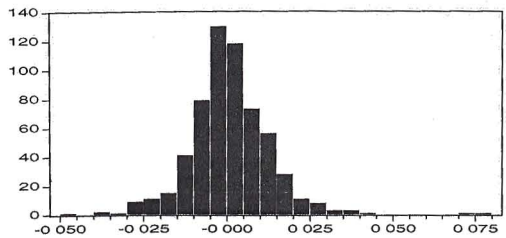
Series INDIA	
Sample 1 592	
Observations 592	
Mean	0 001033
Median	0 001831
Maximum	0 052460
Minimum	-0 057992
Std Dev	0 015072
Skewness	-0 235397
Kurtosis	4 682798
Jarque-Bera	75 31855
Probability	0 000000

Pakistan



Series PAKISTHAN	
Sample 1 592	
Observations 592	
Mean	0 001262
Median	0 002666
Maximum	0 056602
Minimum	-0 076514
Std Dev	0 017364
Skewness	-0 605120
Kurtosis	5 448704
Jarque-Bera	184 0339
Probability	0 000000

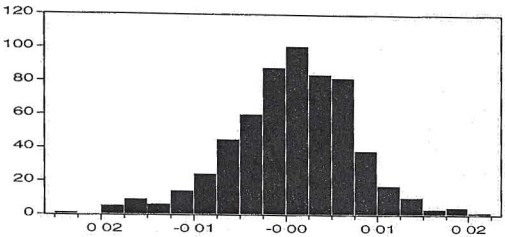
Sri Lanka



Series SRI_LANKA	
Sample 1 592	
Observations 592	
Mean	0 000951
Median	0 000206
Maximum	0 077970
Minimum	-0 045301
Std Dev	0 012176
Skewness	0 725140
Kurtosis	8 349783
Jarque-Bera	757 8461
Probability	0 000000

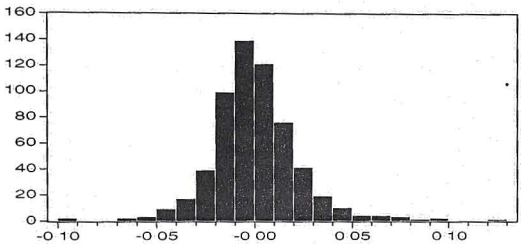
Error Distribution of Benchmark Index Return Series of the Stock Markets of Asia Pacific Region

Australia



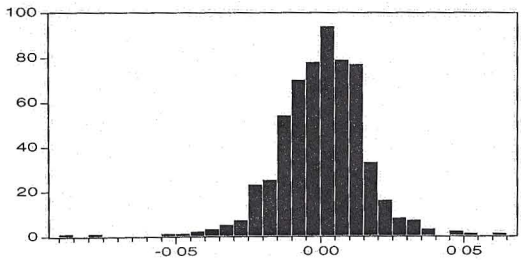
Series AUSTRALIA	
Sample 1 592	
Observations 592	
Mean	0 000719
Median	0 001311
Maximum	0 021615
Minimum	-0 022923
Std Dev	0 006623
Skewness	-0 355209
Kurtosis	3 676961
Jarque-Bera	23 75330
Probability	0 000007

China



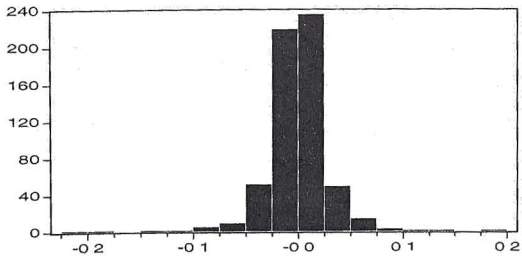
Series CHINA	
Sample 1 592	
Observations 592	
Mean	0 000531
Median	-0 000593
Maximum	0 122844
Minimum	-0 097779
Std Dev	0 022346
Skewness	0 605691
Kurtosis	7 009014
Jarque-Bera	432 6444
Probability	0 000000

Hong Kong



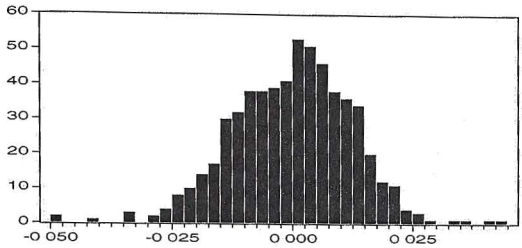
Series HONG_KONG	
Sample 1 592	
Observations 592	
Mean	0 000578
Median	0 001151
Maximum	0 060440
Minimum	-0 086518
Std Dev	0 014963
Skewness	-0 555727
Kurtosis	6 810557
Jarque-Bera	388 6400
Probability	0 000000

Indonesia



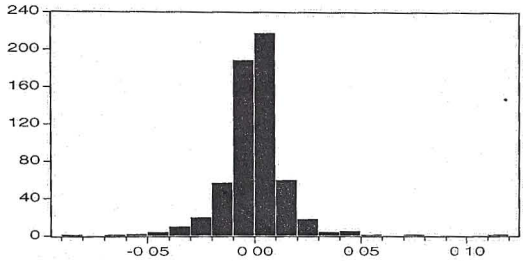
Series INDONESIA	
Sample 1 592	
Observations 592	
Mean	-6 26e-05
Median	0 000503
Maximum	0 187635
Minimum	-0 221097
Std Dev	0 029834
Skewness	-0 600369
Kurtosis	14 92036
Jarque-Bera	3540 575
Probability	0 000000

Japan



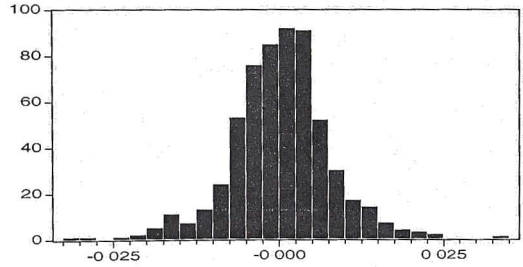
Series JAPAN	
Sample 1 592	
Observations 592	
Mean	-5 54e-05
Median	0 000464
Maximum	0 044800
Minimum	-0 049041
Std Dev	0 012292
Skewness	-0 213514
Kurtosis	3 793992
Jarque-Bera	20 04846
Probability	0 000044

Malaysia



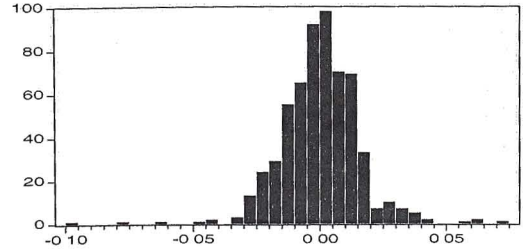
Series MALAYSIA	
Sample 1 592	
Observations 592	
Mean	5 71e-05
Median	0 000216
Maximum	0 115167
Minimum	-0 082632
Std Dev	0 014921
Skewness	0 409900
Kurtosis	13 25104
Jarque-Bera	2608 646
Probability	0 000000

New Zealand



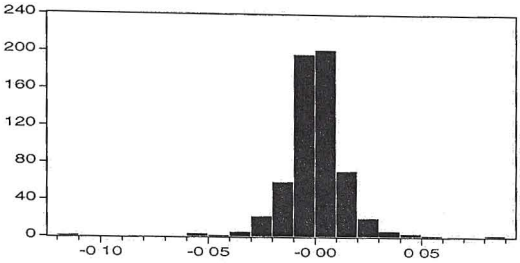
Series NEW_ZEALAND	
Sample 1 592	
Observations 592	
Mean	0 000340
Median	0 000485
Maximum	0 033539
Minimum	-0 032233
Std Dev	0 007552
Skewness	-0 077122
Kurtosis	4 856346
Jarque-Bera	85 58872
Probability	0 000000

Philippines



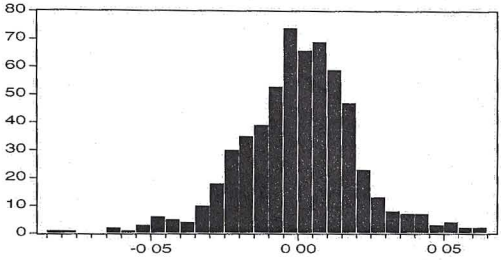
Series PHILIPPINES	
Sample 1 592	
Observations 592	
Mean	5 23e-05
Median	0 000546
Maximum	0 070289
Minimum	-0 095482
Std Dev	0 015410
Skewness	-0 271937
Kurtosis	8 093463
Jarque-Bera	647 2328
Probability	0 000000

Singapore



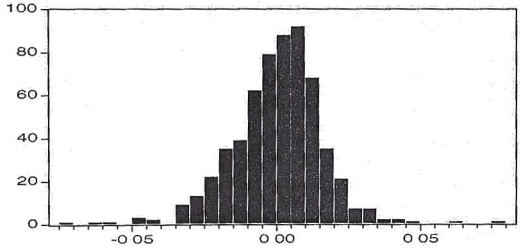
Series SINGAPORE	
Sample 1 592	
Observations 592	
Mean	0 000257
Median	0 000383
Maximum	0 086310
Minimum	-0 110774
Std Dev	0 013737
Skewness	-0 491304
Kurtosis	13 91013
Jarque-Bera	2959 910
Probability	0 000000

Korea Republic



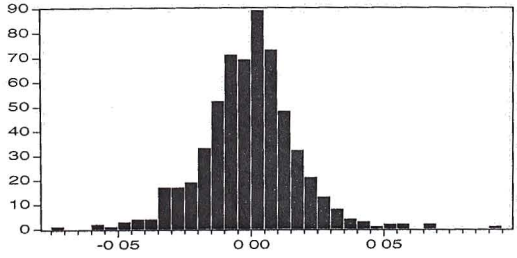
Series KOREA_REPUBLIC	
Sample 1 592	
Observations 592	
Mean	0 000324
Median	0 001131
Maximum	0 063867
Minimum	-0 083132
Std Dev	0 019753
Skewness	-0 224098
Kurtosis	4 429844
Jarque-Bera	55 38491
Probability	0 000000

Taiwan



Series TAIWAN	
Sample 1 592	
Observations 592	
Mean	0 000382
Median	0 001341
Maximum	0 079555
Minimum	-0 071260
Std Dev	0 015497
Skewness	-0 195422
Kurtosis	5 811486
Jarque-Bera	198 7445
Probability	0 000000

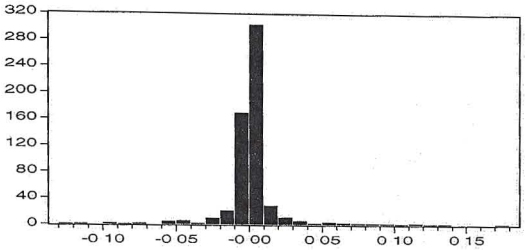
Thailand



Series THAILAND	
Sample 1 592	
Observations 592	
Mean	-0 000503
Median	0 000241
Maximum	0 094843
Minimum	-0 074889
Std Dev	0 017961
Skewness	0 227965
Kurtosis	5 555720
Jarque-Bera	166 2429
Probability	0 000000

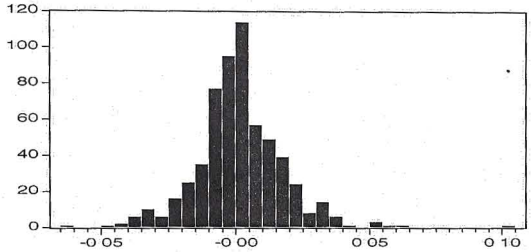
Error Distribution of Benchmark Index Return Series of the Stock Markets of Africa and Middle East Region

Botswana



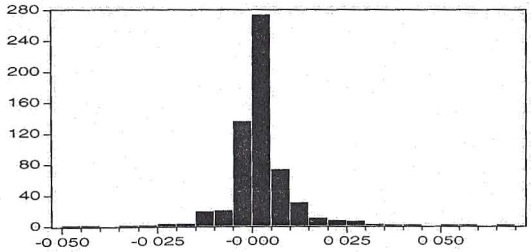
Series BOTSWANA	
Sample 1 592	
Observations 592	
Mean	0 002260
Median	0 001027
Maximum	0 176063
Minimum	-0 121868
Std Dev	0 022559
Skewness	1 461808
Kurtosis	20 09333
Jarque-Bera	7417 993
Probability	0 000000

Egypt



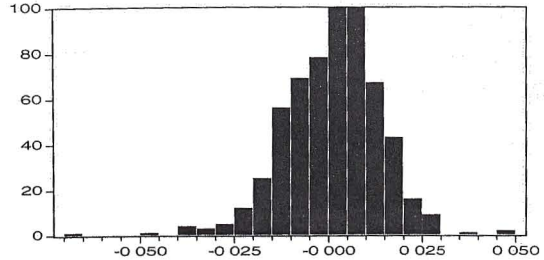
Series EGYPT	
Sample 1 592	
Observations 592	
Mean	0 001495
Median	0 000704
Maximum	0 101746
Minimum	-0 063833
Std Dev	0 016021
Skewness	0 475634
Kurtosis	6 702625
Jarque-Bera	360 4871
Probability	0 000000

Ghana



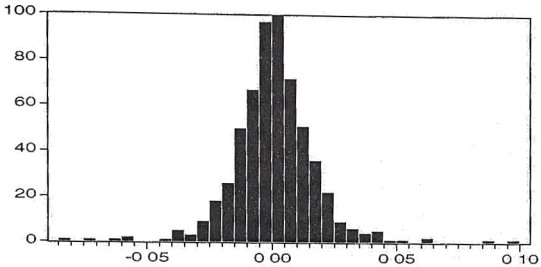
Series GHANA	
Sample 1 592	
Observations 592	
Mean	0 002034
Median	0 000775
Maximum	0 065503
Minimum	-0 047562
Std Dev	0 008810
Skewness	1 262054
Kurtosis	16 27175
Jarque-Bera	4501 926
Probability	0 000000

Israel



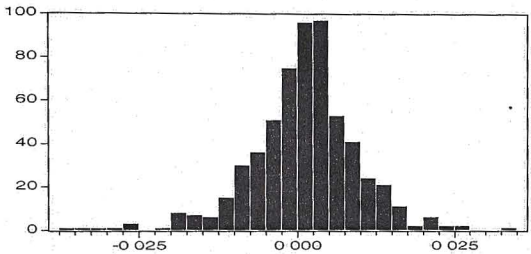
Series ISRAEL	
Sample 1 592	
Observations 592	
Mean	0 001126
Median	0 002070
Maximum	0 049418
Minimum	-0 066976
Std Dev	0 012559
Skewness	-0 413968
Kurtosis	5 023864
Jarque-Bera	117 9437
Probability	0 000000

Jordan



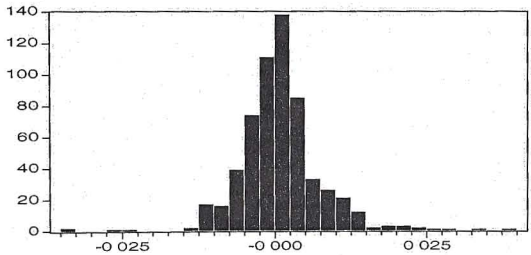
Series JORDAN	
Sample 1 592	
Observations 592	
Mean	0 001116
Median	0 000851
Maximum	0 096502
Minimum	-0 084872
Std Dev	0 016566
Skewness	0 211706
Kurtosis	8 266093
Jarque-Bera	688 4716
Probability	0 000000

Kuwait



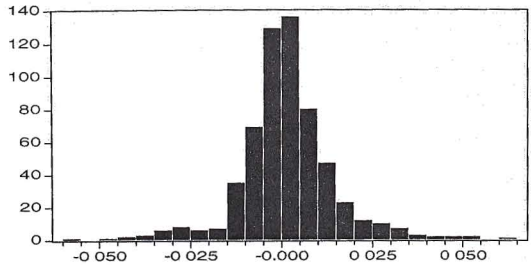
Series KUWAIT	
Sample 1 592	
Observations 592	
Mean	0 001182
Median	0 001682
Maximum	0 032827
Minimum	-0 036846
Std Dev	0 008415
Skewness	-0 425388
Kurtosis	5 230491
Jarque-Bera	140 5732
Probability	0 000000

Mauritius



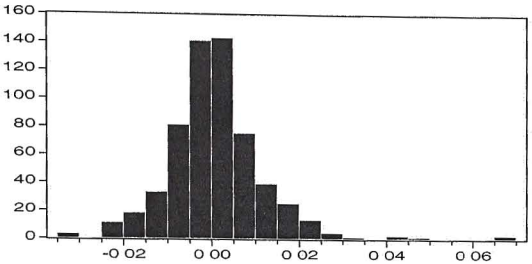
Series MAURITIOUS	
Sample 1 592	
Observations 592	
Mean	0 000911
Median	0 000611
Maximum	0 037855
Minimum	-0 034703
Std Dev	0 006776
Skewness	0 417972
Kurtosis	8 777628
Jarque-Bera	840 6348
Probability	0 000000

Nigeria



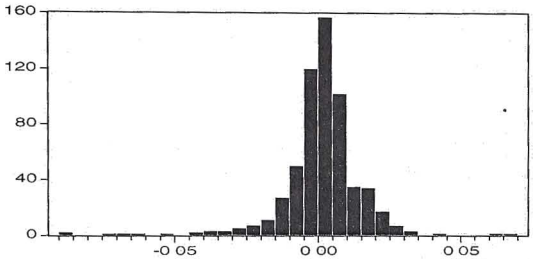
Series NIGERIA	
Sample 1 592	
Observations 592	
Mean	0 001471
Median	0 000801
Maximum	0 062673
Minimum	-0 057457
Std Dev	0 013010
Skewness	0 165275
Kurtosis	6 474828
Jarque-Bera	300 5310
Probability	0 000000

Oman



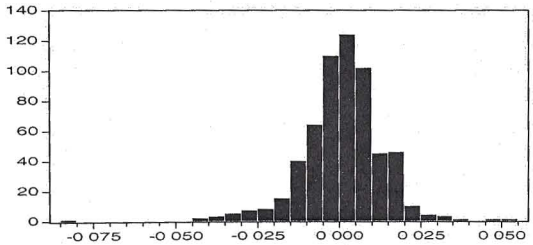
Series OMAN	
Sample 1 592	
Observations 592	
Mean	0 000944
Median	0 000331
Maximum	0 067301
Minimum	-0 033373
Std Dev	0 010650
Skewness	1 072644
Kurtosis	8 918338
Jarque-Bera	977 5149
Probability	0 000000

Saudi Arabia



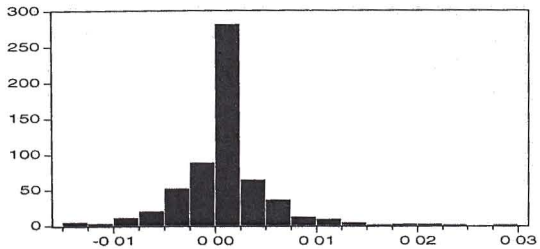
Series SAUDI_ARABIA	
Sample 1 592	
Observations 592	
Mean	0 001313
Median	0 001733
Maximum	0 067473
Minimum	-0 088038
Std Dev	0 013557
Skewness	-1 590783
Kurtosis	14 07263
Jarque-Bera	3273 896
Probability	0 000000

South Africa



Series SOUTH_AFRICA	
Sample 1 592	
Observations 592	
Mean	0 001161
Median	0 001421
Maximum	0 051674
Minimum	-0 080430
Std Dev	0 012105
Skewness	-0 727985
Kurtosis	7 738633
Jarque-Bera	606 1707
Probability	0 000000

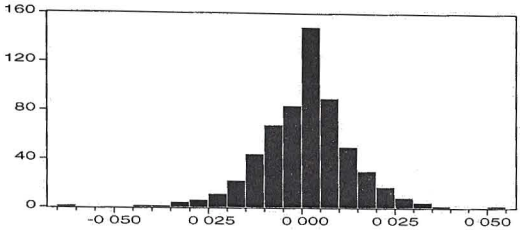
Tunisia



Series TUNISIA	
Sample 1 592	
Observations 592	
Mean	0 000639
Median	0 000227
Maximum	0 029523
Minimum	-0 013903
Std Dev	0 004485
Skewness	1 123988
Kurtosis	9 466364
Jarque-Bera	1156 059
Probability	0 000000

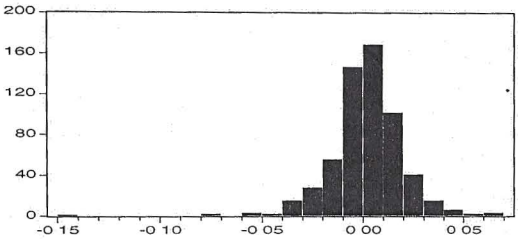
Error Distribution of Benchmark Index Return Series of the Stock Markets of Eastern Europe Region

Czech Republic



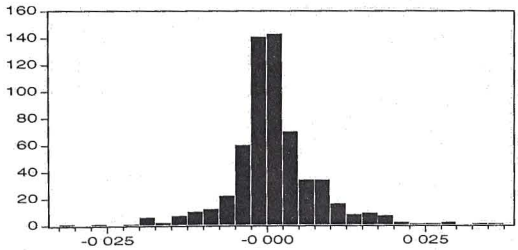
Series CZECH_REPUBLIC	
Sample 1 592	
Observations 592	
Mean	0 000934
Median	0 000447
Maximum	0 050286
Minimum	-0 060998
Std Dev	0 011827
Skewness	-0 295068
Kurtosis	5 117281
Jarque Bera	119 1681
Probability	0 000000

Hungary



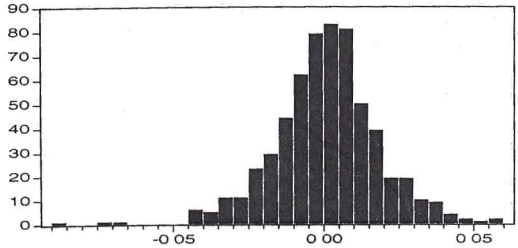
Series HUNGARY	
Sample 1 592	
Observations 592	
Mean	0 002048
Median	0 002407
Maximum	0 063996
Minimum	-0 143387
Std Dev	0 017983
Skewness	-1 066673
Kurtosis	11 59516
Jarque-Bera	1934 556
Probability	0 000000

Lithuania



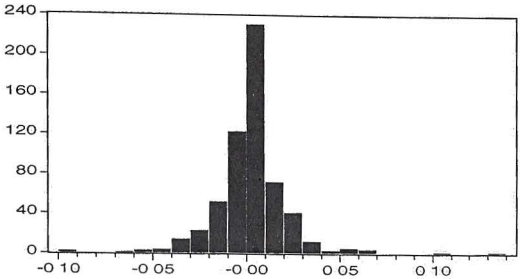
Series LITHUANIA	
Sample 1 592	
Observations 592	
Mean	0 001185
Median	0 000506
Maximum	0 036616
Minimum	-0 031965
Std Dev	0 007006
Skewness	0 452452
Kurtosis	7 421804
Jarque-Bera	502 4897
Probability	0 000000

Poland



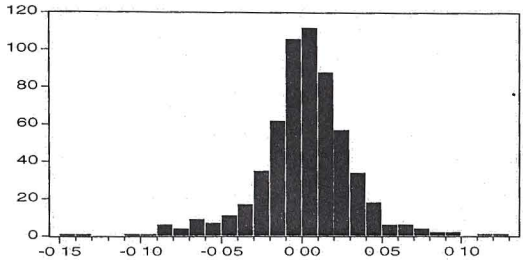
Series POLAND	
Sample 1 592	
Observations 592	
Mean	0 000999
Median	0 001185
Maximum	0 058150
Minimum	-0 088380
Std Dev	0 017369
Skewness	-0 306753
Kurtosis	5 060930
Jarque-Bera	114 0543
Probability	0 000000

Romania



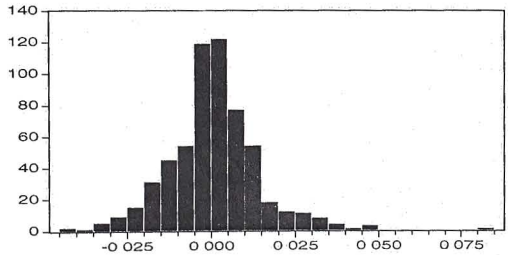
Series ROMANIA	
Sample 1 592	
Observations 592	
Mean	0 002045
Median	0 001378
Maximum	0 134077
Minimum	-0 094512
Std Dev	0 018572
Skewness	0 486987
Kurtosis	12 01781
Jarque-Bera	2029 314
Probability	0 000000

Russian Federation



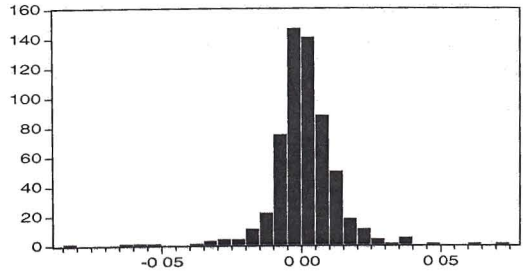
Series RUSSIAN_FED	
Sample 1 592	
Observations 592	
Mean	0 002168
Median	0 003469
Maximum	0 127921
Minimum	-0 148157
Std Dev	0 029890
Skewness	-0 492071
Kurtosis	6 308547
Jarque-Bera	293 9038
Probability	0 000000

Slovak Republic



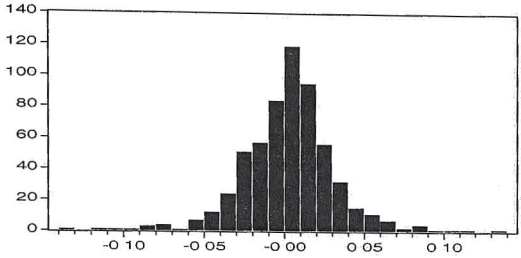
Series SLOVAKREPUBLIC	
Sample 1 592	
Observations 592	
Mean	0 000698
Median	0 000342
Maximum	0 081837
Minimum	-0 042216
Std Dev	0 013363
Skewness	0 552836
Kurtosis	6 168483
Jarque-Bera	277 7909
Probability	0 000000

Slovenia



Series SLOVENIA	
Sample 1 592	
Observations 592	
Mean	0 001260
Median	0 001025
Maximum	0 073118
Minimum	-0 081153
Std Dev	0 011889
Skewness	-0 301900
Kurtosis	13 32014
Jarque-Bera	2636 125
Probability	0 000000

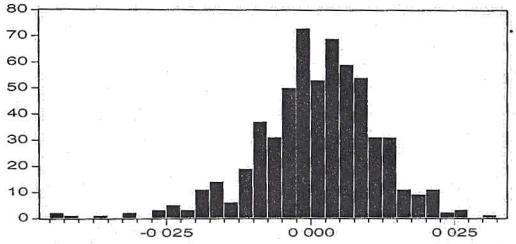
Turkey



Series TURKEY	
Sample 1 592	
Observations 592	
Mean	0 003267
Median	0 003612
Maximum	0 137810
Minimum	-0 131882
Std Dev	0 028688
Skewness	-0 059815
Kurtosis	6 052823
Jarque-Bera	230 2396
Probability	0 000000

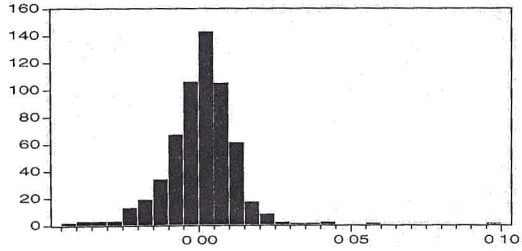
Error Distribution of Benchmark Index Return Series of the Stock Markets of Western Europe Region

Austria



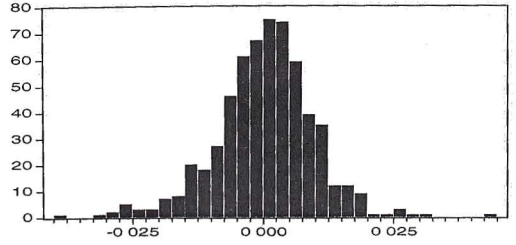
Series AUSTRIA	
Sample 1 592	
Observations 592	
Mean	0 001092
Median	0 001704
Maximum	0 030163
Minimum	-0 044978
Std Dev	0 010269
Skewness	-0 663557
Kurtosis	4 757106
Jarque-Bera	119 6001
Probability	0 000000

Belgium



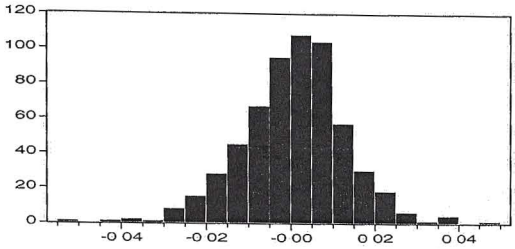
Series BELGIUM	
Sample 1 592	
Observations 592	
Mean	0 000875
Median	0 001527
Maximum	0 096279
Minimum	-0 044816
Std Dev	0 011605
Skewness	0 675613
Kurtosis	12 48338
Jarque-Bera	2263 419
Probability	0 000000

Britain



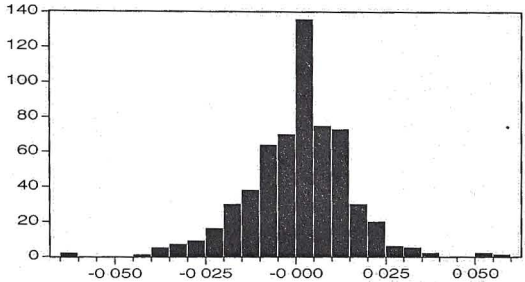
Series BRITAIN	
Sample 1 592	
Observations 592	
Mean	0 000417
Median	0 001117
Maximum	0 043731
Minimum	-0 038494
Std Dev	0 009308
Skewness	-0 200965
Kurtosis	4 749312
Jarque-Bera	79 46711
Probability	0 000000

France



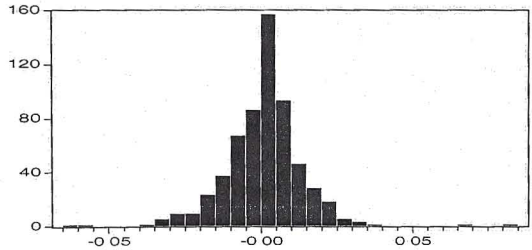
Series FRANCE	
Sample 1 592	
Observations 592	
Mean	0 000846
Median	0 000847
Maximum	0 047922
Minimum	-0 052664
Std Dev	0 012235
Skewness	-0 155920
Kurtosis	4 234603
Jarque-Bera	39 99672
Probability	0 000000

Germany



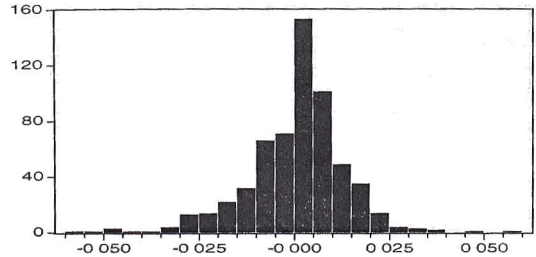
Series GERMANY	
Sample 1 592	
Observations 592	
Mean	0 000701
Median	0 000539
Maximum	0 055969
Minimum	-0 061146
Std Dev	0 013835
Skewness	-0 281575
Kurtosis	5 026085
Jarque-Bera	109 0799
Probability	0 000000

Italy



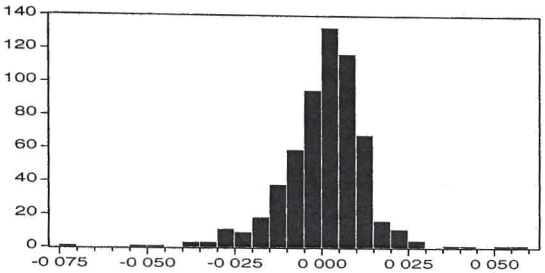
Series ITALY	
Sample 1 592	
Observations 592	
Mean	0 000769
Median	0 000447
Maximum	0 083804
Minimum	-0 060459
Std Dev	0 012439
Skewness	0 188561
Kurtosis	8 901468
Jarque-Bera	862 5822
Probability	0 000000

Netherlands



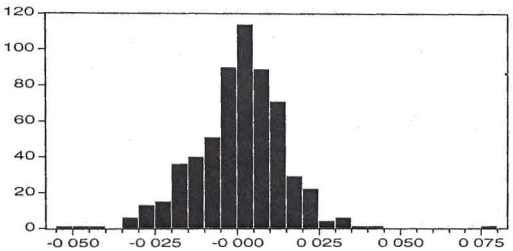
Series NETHERLANDS	
Sample 1 592	
Observations 592	
Mean	0 000558
Median	0 000990
Maximum	0 058984
Minimum	-0 056753
Std Dev	0 012936
Skewness	-0 491165
Kurtosis	5 666352
Jarque-Bera	199 1687
Probability	0 000000

Norway



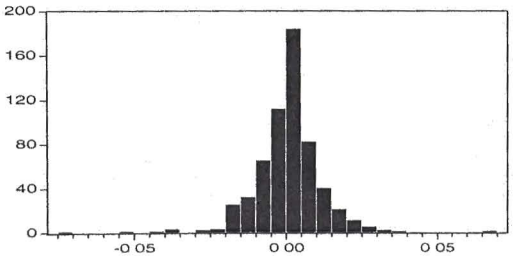
Series NORWAY	
Sample 1 592	
Observations 592	
Mean	0 000887
Median	0 001852
Maximum	0 057918
Minimum	-0 072920
Std Dev	0 011991
Skewness	-0 656626
Kurtosis	7 640579
Jarque-Bera	573 7368
Probability	0 000000

Sweden



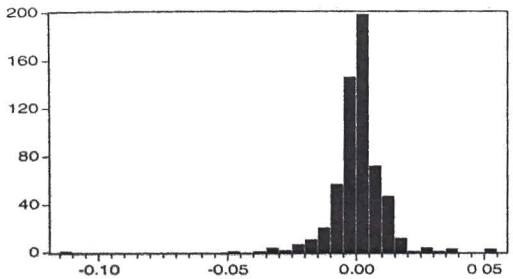
Series SWEDEN	
Sample 1 592	
Observations 592	
Mean	0 000882
Median	0 001951
Maximum	0 077815
Minimum	-0 052424
Std Dev	0 013433
Skewness	-0 060362
Kurtosis	5 190542
Jarque-Bera	118 7219
Probability	0 000000

Portugal



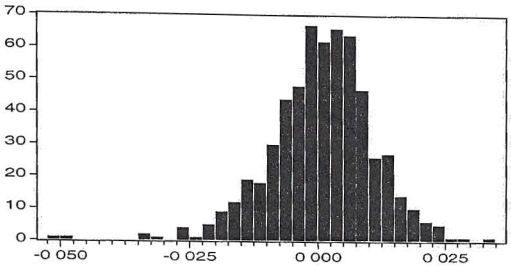
Series PORTUGAL	
Sample 1 592	
Observations 592	
Mean	0 000657
Median	5 63e-05
Maximum	0 067596
Minimum	-0 071938
Std Dev	0 010849
Skewness	-0 419853
Kurtosis	10 29567
Jarque-Bera	1330 322
Probability	0 000000

Luxembourg



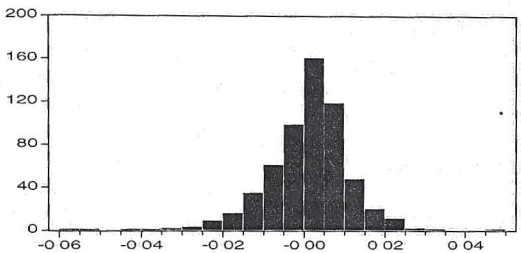
Series LUXEMBOURG	
Sample 1 592	
Observations 592	
Mean	0 000704
Median	0 000252
Maximum	0 054858
Minimum	-0 112896
Std Dev	0 010749
Skewness	-1 567853
Kurtosis	27 80542
Jarque-Bera	15420 16
Probability	0 000000

Denmark



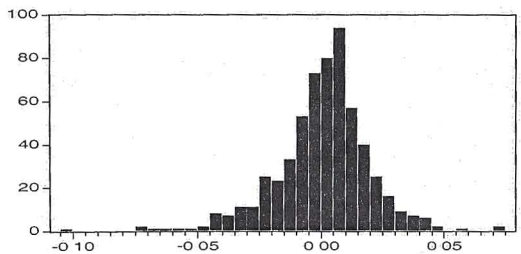
Series DENMARK	
Sample 1 592	
Observations 592	
Mean	0 000817
Median	0 001680
Maximum	0 033720
Minimum	-0 050327
Std Dev	0 010140
Skewness	-0 582421
Kurtosis	5 091135
Jarque-Bera	141 3326
Probability	0 000000

Ireland



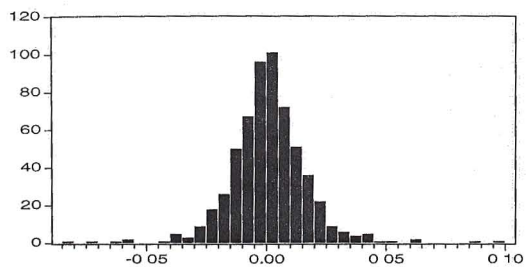
Series IRELAND	
Sample 1 592	
Observations 592	
Mean	0 001093
Median	0 001921
Maximum	0 045449
Minimum	-0 055959
Std Dev	0 010291
Skewness	-0 825561
Kurtosis	7 056515
Jarque-Bera	473 1441
Probability	0 000000

Finland



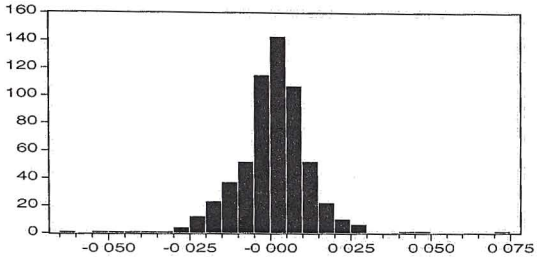
Series FINLAND	
Sample 1 592	
Observations 592	
Mean	0 001090
Median	0 002613
Maximum	0 073147
Minimum	-0 102132
Std Dev	0 018829
Skewness	-0 603860
Kurtosis	5 924888
Jarque-Bera	247 0012
Probability	0 000000

Greece



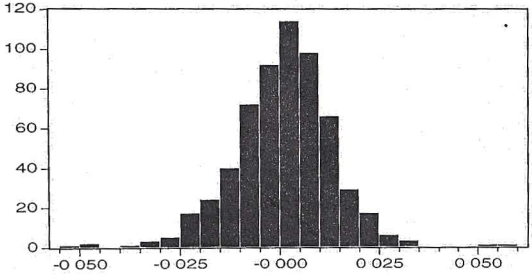
Series GREECE	
Sample 1 592	
Observations 592	
Mean	0 001129
Median	0 000943
Maximum	0 096502
Minimum	-0 084872
Std Dev	0 016565
Skewness	0 209468
Kurtosis	8 268790
Jarque-Bera	689 0794
Probability	0 000000

Switzerland



Series SWITZERLAND	
Sample 1 592	
Observations 592	
Mean	0 000815
Median	0 001731
Maximum	0 070740
Minimum	-0 063579
Std Dev	0 011370
Skewness	-0 273184
Kurtosis	8 751525
Jarque-Bera	823 3378
Probability	0 000000

Spain



Series SPAIN	
Sample 1 592	
Observations 592	
Mean	0 001021
Median	0 001936
Maximum	0 059002
Minimum	-0 050522
Std Dev	0 012144
Skewness	-0 171189
Kurtosis	5 156147
Jarque-Bera	117 5661
Probability	0 000000

CHAPTER VI

CHAPTER VI

SUMMARY AND CONCLUSIONS

6.1 Introduction

Since late twentieth century and early twenty first century, financial markets of the developing as well as developed countries have been experiencing explosive growth of capital flows in the form of financial transactions. Flexibility in capital movements and integration of financial services due to openness of the economy across the globe is considered as one of the major factor for achieving optimality in capital allocation. Increasing interdependence in financial markets facilitate market access to participants of various market segments. The market participants are like individual market investors, financial institutions as well as financial intermediaries. The process of globalization leads to the openness of the economy extends the path towards international integration of world's financial market with new challenges of monetary, financial, external and macroeconomic policies Stock markets are getting interlinked horizontally among various domestic financial segments and vertically with international stock markets As a result investors are not only keen to incorporate information of domestic markets but also the transmission of information around the globe in their decision making activities. It is useful to see whether pricing in one market is informationally reflected in pricing another equity market Integrated financial system also amplifies persistence of volatility and spillover effects The shocks in one market get easily transmitted to another market. The degree of integration of the domestic market with any of the stock markets of the world increases the sensitivity and transmission of shocks within stock markets. One market is being reflected in another market with its pros and cons. If the degree of integration and the speed of volatility transmission can be measured, then it will be relatively easy to predict the behavior of one market by studying the behavior of others

This is the major motivation for the present study which set out to analyse the dynamic interlinkages, long run equilibrium relationships and persistence of volatility in a sample of 65 countries' stock market around the world The analyses of the stock markets are done at regional level as the sample of 65 countries are clubbed in seven

regional blocks. Before analyzing the dynamic interdependences between the stock markets, the present study has made an attempt to analyse the development of stock markets with respect to their size and level liquidity in the sample of 65 countries. The stock markets of the selected countries are ranked on the basis of level of development with respect to size and liquidity. The study has also used Morgan Stanley Capital International (MSCI) index as proxy for world index in order to track the interdependence of individual country's stock market with world market.

For the analysis of development of stock markets with respect to size and liquidity, the present study has used six key stock market indicators: (1) Market capitalization of listed companies as percentage of GDP; (2) Domestic credit to private sector as percentage of GDP; (3) Total value of stocks traded as percentage of GDP; (4) Turnover ratio in percentage; (5) Total number of listed domestic companies; and (6) Market concentration. For further insight about the stock markets, two more indicators namely (7) Market capitalization of listed companies (in constant US $) and (8) GDP (in constant US $) are also used. The data period is spanning from 1988 to 2006 in annual frequency. The information about these indicators is collected from World Development Indicator (WDI) database of the World Bank.

6.2 Size and Liquidity

The present study has developed two indices: (a) development index and (b) liquidity index, to rank the stock markets of the countries with respect to their size and liquidity. The indices incorporate all the relevant information under the two broad heads of development and liquidity. Again countries are cross tabled in a 3×3 development and liquidity index. Briefly it is observed that most of the highly developed stock markets are highly liquid and less developed stock markets are less liquid. None of the highly developed stock markets are less liquid and none of the less developed stock markets are found to be highly liquid. Stock markets of United States, Hong Kong, Switzerland, Britain, Japan, Korea Republic, Malaysia, India, Netherlands, Singapore, Spain, Canada, Sweden, South Africa, France, Finland and Australia are highly developed and highly liquid stock markets. Luxembourg, Kuwait and Saudi Arabia stock markets are highly developed and moderately liquid stock markets. Similarly stock markets of Germany,

Thailand and China are found to be moderately developed and highly liquid stock markets. The moderately developed and moderately liquid stock markets are of countries of Jordan, Israel, Denmark, Ireland, Italy, Greece, Chile, Pakistan, Belgium, Turkey, Norway, Brazil, New Zealand and Portugal. In the similar context the study finds the less developed and less liquid stock markets of countries like Russian Federation, Mexico, Indonesia, Hungary, Argentina, Peru, Mauritius, Oman, Poland, Sri Lanka, Lithuania, Colombia, Slovenia, Nigeria, Botswana, Ghana, Venezuela, Costa Rica, Tunisia, Bangladesh, Bermuda and Taiwan. The stock markets of Romania, Philippines and Egypt are moderately developed but stand to be less liquid stock markets. Similarly, stock markets of Austria, Czech Republic and Slovak Republic are found to be less developed but moderately developed stock markets in the sample of 65 countries stock markets. It is noteworthy that the principal diagonal is heavily populated indicating a strong positive relation between size of stock market and its level of liquidity. These analyses are drawn on the basis of development and liquidity index. Above all these two indices are proved to be quite powerful in capturing the underline structure of the stock markets.

A detailed analysis at indicators level finds that the stock markets of United States, Hong Kong, Switzerland, Malaysia, Singapore, South Africa, Britain and Luxembourg are larger in size compared to the size their respective economies The larger of size of these stock markets are complemented by a large number of listed domestic companies. The stock markets of Jordan and Netherlands are 90% (approximately) of their economy. Similarly, Chile, Finland, Sweden, Japan & Canada have the stock markets whose size is 80% of their economy, followed by Austria & Kuwait with 75% approximately. Looking at small stock markets Venezuela, Slovak Republic, Romania & Bangladesh have the stock market whose size is less than 10% with the size of economy. Stock markets of Hungary, Pakistan, Botswana, Lithuania, Colombia, Austria, Slovenia, Ghana, Sri Lanka, Poland, Tunisia, Nigeria and Costa Rica have the stock markets whose size lies between 10% to 20% of the size of their economy, hence considered to be small size of stock markets

The sizes of these stock markets are complemented by number of listed domestic companies. Stock market of USA has highest number i.e. an average of 6929 listed domestic companies followed by India with an average of 4735. Stock market of

Romania of Eastern Europe region has an average of 3230 listed companies. Similarly stock market of Japan, Britain, Canada, Australia, Spain and Korea Republic has above one thousand numbers of listed domestic companies i.e. 2457, 2067, 1777, 1248, 1132 and 1090 respectively. Stock market of China, Egypt, France, Pakistan, Germany, Hong Kong, Malaysia, South Africa and Israel have average number of listed domestic companies in a range of 500 to 1000 (i.e. 810, 769, 673, 665, 655, 642, 636, 598, 528 respectively) which can also be considered as a good number to analyse the size of a stock market. The stock markets in which average number of listed companies range from 100 to 500 are stock market of Brazil, Czech republic, Slovak Republic, Thailand, Singapore, Chile, Italy, Indonesia, Sweden, Peru, Greece, Denmark, Switzerland, Turkey, Sri Lanka, Netherlands, Philippines, Bangladesh, Mexico, Nigeria, Russia Federation, Belgium, Norway, New Zealand, Poland, Lithuania, Argentina, Jordan, Portugal, Colombia and Finland. Stock markets with less than an average of 100 listed domestic companies are stock markets of Austria, Oman, Kuwait, Venezuela, Luxembourg, Ireland, Saudi Arabia, Costa Rica, Slovenia, Hungary, Tunisia, Mauritius, Ghana and Botswana. These stock markets are very small in size and very less liquid by nature.

Another salient feature of the stock market is total values of stocks traded as percentage of GDP and turnover ratio in percentage The present study has identified liquidity of a stock market on the basis of these two indicators along with domestic credit to private sector as percentage of GDP Looking at turnover ratio (%), it has been observed that stock markets of United States, Korea Republic, Pakistan, Spain, Chain, Germany, Turkey & Netherlands have turnover ratio above 100%. The turnover ratios (%) of Saudi Arabia, Switzerland and Italy, Sweden, Thailand, Norway, France, India & Britain lies between 80% to 100%. Stock markets like Kuwait, Finland, Japan, Canada, Australia, and Hong Kong & Singapore are having turnover ratio greater than 50%. In the similar manner stock markets of Botswana, Ghana, Mauritius, Nigeria, Colombia, Tunisia, Sri Lanka, Venezuela, Lithuania, Peru, Slovenia, Argentina, Oman etc have very low turnover ratio.

Looking at total values of stocks traded as percentage of GDP; stock markets of countries such as Switzerland, Hong Kong and United States have total values of stocks traded greater than hundred. Stock markets of Korea Republic, Britain, Netherlands,

Singapore, Malaysia, Spain & Sweden have total values of stock traded in the range of 60% to 90% of their GDP. Similarly, stock markets of Ghana, Nigeria, Botswana, Bangladesh, Costa Rica, Romania, Tunisia, Colombia, Venezuela, Mauritius, Sri Lanka, Lithuania, Luxembourg, Slovenia, Peru, Argentina, Slovak Republic etc, have very less total values of stocks traded with respect to their economy (GDP).

The present study also analyses market concentration on regional basis. Stock market of United States in North America region and stock market of India in South Asia region have market concentration above 90% captured by share of their market capitalization in the total market capitalization of their respective regions. Looking at other regions, Brazil in South & Central America, Japan in Asia pacific, South Africa in Africa & middle east region and Russian Federation in Eastern Europe region have highest market concentration with having market capitalization of 50% of the total market capitalization of their respective regions. Similarly in Western Europe, the highest market concentration is approximately 30% with Britain followed by France 15% and Germany 13%.

Another feature of financial market of interest is domestic credit to private sector. Taking it as a percentage of GDP, it has been observed that United States, Canada, China, Japan, Malaysia, New Zealand, Singapore, Thailand, South Africa, Britain, Germany, Luxembourg, Hong Kong, Netherlands, Sweden and Switzerland have domestic credit to private sector more than 100% of GDP. Brazil, Chile, Australia, Korea Republic, Israel, Jordan, Kuwait, Mauritius, Saudi Arabia, Tunisia, Czech Republic, Austria, Belgium, Denmark, Finland, France, Ireland, Italy, Norway, Portugal, and Spain have domestic credit support between 50 % to 100% of GDP. All the countries of Western Europe Region are providing domestic credit to private sector around 50% and more of their GDP. Peru, Venezuela, Argentina, Botswana, Ghana, Nigeria, Lithuania, Romania and Russian Federation have domestic credit support less than 20% of their respective GDP. Ghana has the least support i.e 9% of GDP.

6.3 Dynamic Interlinkages

The present study has tried to explore the dynamic interlinkages and long run equilibrium relationships between the stock markets of a sample of 65 countries The

analysis of the stock markets is done region wise as the 65 countries are clubbed in seven regional blocks. The weekly country benchmark indices are used as the representative of stock markets of their respective countries. The data period is spanning from 2nd week of August 1995 to 4th week of December 2006 i.e. around 594 observations (on weekly frequency). The indices are collected from Bloomberg. Various time series techniques are used to trace out the lead-lag relationships, dynamic interlinkages and long run equilibrium relationships between the stock markets. In order to identify the direction of causality and short term lead-lag relationships between the stock markets within the region, the present study has used pair wise Granger causality test. The study finds several uni-directional and bi-directional causality between the stock markets of the regions as well as with world market presented by MSCI index that shows the existence of short term lead-lag relationship between the stock markets. It is presented in the table below.

Lead-Lag Relationships

North America	Asia Pacific
Unidirectional Causality	*Unidirectional Causality*
Mexico → Bermuda	Australia → Indonesia
MSCI → Bermuda	Australia → Korea Republic
MSCI → Canada	Australia → MSCI
Canada → USA	New Zealand → Australia
Mexico → USA	Singapore → Australia
MSCI → USA	Singapore → China
Bidirectional Causality	Hong Kong → Indonesia
Canada ↔ Bermuda	Malaysia → Hong Kong
USA ↔ Bermuda	Hong Kong → MSCI
South and Central America	Hong Kong → Philippines
Unidirectional Causality	Singapore → Hong Kong
Argentina → Brazil	Hong Kong → Singapore
Argentina → Chile	Hong Kong → Taiwan
Colombia → Argentina	China → MSCI
Argentina → Peru	New Zealand → China
Argentina → Venezuela	Korea Republic → Indonesia
Brazil → Chile	MSCI → Indonesia
Colombia → Brazil	Philippines → Indonesia
MSCI → Brazil	Taiwan → Indonesia
MSCI → Chile	Thailand → Indonesia
Colombia → Peru	Japan → Korea Republic
MSCI → Peru	Malaysia → Japan
MSCI → Venezuela	Japan → New Zealand
Peru → Venezuela	Korea Republic → MSCI
Bi-directional Causality	Korea Republic → Philippines
Peru ↔ Brazil	Thailand → Korea Republic
Peru ↔ Chile	New Zealand → MSCI
MSCI ↔ Colombia	Singapore → MSCI
South Asia	Taiwan → MSCI
Unidirectional Causality	Thailand → MSCI
India → Pakistan	New Zealand → Singapore
India → Sri Lanka	Taiwan → New Zealand
MSCI → Sri Lanka	New Zealand → Taiwan
Bidirectional Causality	Taiwan → Philippines
MSCI ↔ India	Thailand → Philippines
Pakistan ↔ MSCI	Singapore → Taiwan
	Thailand → Taiwan

Cont....

Asia Pacific	Eastern Europe
Bidirectional Causality	*Unidirectional Causality*
New Zealand ↔ Hong Kong	Romania → Hungary
Malaysia ↔ Korea Republic	Russian Federation → Hungary
New Zealand ↔ Korea Republic	Lithuania → Poland
Singapore ↔ Korea Republic	Romania → Lithuania
New Zealand ↔ Malaysia	Russian Federation → MSCI
Philippines ↔ MSCI	MSCI → Slovenia
Philippines ↔ New Zealand	Turkey → MSCI
Thailand ↔ New Zealand	Romania → POLAND
Singapore ↔ Philippines	Russian Federation → Poland
Thailand ↔ Singapore	Turkey → Poland
Africa and Middle East	Romania → Russian Federation
Unidirectional Causality	Romania → Slovenia
Botswana → Ghana	Russian Federation → Slovak Republic
Botswana → Oman	Russian Federation → Turkey
Israel → Egypt	*Bidirectional Causality*
Mauritius → Egypt	Poland ↔ MSCI
MSCI → Egypt	**Western Europe**
Oman → Egypt	*Unidirectional Causality*
Saudi Arabia → Egypt	Austria → Britain
South Africa → Egypt	Austria → Denmark
Ghana → Kuwait	Austria → Finland
Jordan → Israel	Austria → Greece
Israel → Mauritius	Austria → Ireland
South Africa → Israel	Austria → MSCI
Oman → Kuwait	Austria → Norway
Saudi Arabia → Kuwait	Portugal → Austria
Tunisia → Nigeria	Austria → Sweden
Bidirectional Causality	Austria → Switzerland
Jordan ↔ Egypt	Spain → Belgium
Jordan ↔ Ghana	Britain → Denmark
MSCI ↔ Israel	Britain → France
MSCI ↔ Jordan	Britain → Greece
Eastern Europe	Britain → Ireland
Unidirectional Causality	Britain → MSCI
Lithuania → Czech Republic	Britain → Norway
Czech Republic → MSCI	Britain → Portugal
Russian Fed → Czech Republic	Britain → Sweden
Turkey → Czech Republic	Finland → Denmark
Hungary → MSCI	France → Denmark

Cont....

Western Europe	Ireland → MSCI
Unidirectional Causality	Ireland → Portugal
Ireland → Denmark	Spain → Ireland
MSCI → Denmark	Sweden → Ireland
Norway → Denmark	Switzerland → Ireland
Denmark → Portugal	Italy → Luxembourg
Spain → Denmark	Netherlands → Italy
Sweden → Denmark	Netherlands → Luxembourg
Switzerland → Denmark	Portugal → Luxembourg
Finland → France	MSCI → Norway
Finland → Greece	Spain → MSCI
Luxembourg → Finland	Sweden → MSCI
Finland → MSCI	Switzerland → MSCI
Finland → Norway	Netherlands → Portugal
Finland → Portugal	Spain → Norway
Greece → France	Sweden → Norway
Ireland → France	Switzerland → Norway
MSCI → France	Switzerland → Portugal
Norway → France	Spain → Sweden
Portugal → France	Switzerland → Sweden
Switzerland → France	*Bidirectional Causality*
Germany → Luxembourg	Spain ↔ Austria
Portugal → Germany	Greece ↔ Denmark
Spain → Germany	Spain ↔ France
Ireland → Greece	Sweden ↔ France
Greece → MSCI	Italy ↔ Germany
Greece → Portugal	Netherlands ↔ Germany
Spain → Greece	Norway ↔ Greece
Sweden → Greece	Norway ↔ Ireland
Switzerland → Greece	Portugal ↔ Italy

Short term Dynamic Interlinkages

Pair wise Granger causality reflecting a short term lead-lag relationships between the stock markets does not explore the dynamic interlinkages between these stock markets. In order to capture the dynamic interlinkages between the stock markets, the present study has used variance decomposition technique and vector error correction model. Analysing the estimated statistics of variance decomposition, it has been found that stock markets of Bermuda and Canada of North America region, Argentina, Colombia, Costa Rica and to some extent Venezuela of South and Central America

region; Bangladesh, India, Pakistan and Sri Lanka of South Asia region; China, Japan and to some extent stock market of Malaysia in Asia Pacific region; Botswana, Ghana, Israel, Mauritius, Nigeria, Oman, Saudi Arabia and Tunisia of Africa and Middle East region; Czech Republic, Lithuania, Romania, Slovak Republic and Slovenia at Eastern Europe region; and Austria, Belgium, France and Netherlands at Western Europe region are quite less dynamically interlinked with the stock markets at their respective regions. These stock markets explain almost 90% of its own forecast error variance and rest 10% of the forecast error variances are explained by other stock markets of the region. But in case of the stock market of Argentina of South and Central America and Czech Republic of Eastern Europe, although it is explaining most of its own forecast error variances, but explains quite substantial forecast error variances of other stock markets of their respective regions. Hence it can be said to be dynamically interlinked with the stock markets of the region. Stock markets like Mexico, USA, Argentina, Brazil, Chile, Peru, Australia, Hong Kong, Indonesia, Korea Republic, Philippines, Singapore, New Zealand, Taiwan, Thailand, Egypt, Czech Republic, Kuwait, South Africa, Hungary, Poland, Russia Federation, Turkey, Britain, Denmark, Finland, Germany, Portugal, Spain, Sweden and Switzerland are quite dynamically interlinked stock markets. These stock markets explain less of their own forecast error variances and leave most of their own forecast random error variances to be explained by other stock markets of their respective regions. World market presented by MSCI found to be dynamically interlinked with most of the countries stock markets of world. Most of these stock markets are also commonly found to be significant in explaining the Error correction terms of Vector Error Correction model (VECM) showing the short term dynamic interlinkages between the stock markets A significant error correction term implies that the short term disequilibrium in these countries' stock markets will be corrected significantly by the short term lagged differences of the stock markets of the region. It is found that the error correction terms (ECTs) are significant for the stock markets of Bermuda, Mexico and USA stock market of North America, Argentina, Brazil, Chile and Venezuela of South and Central America region, India in South Asia region, Australia, Hong Kong, Korea Republic, New Zealand, Singapore, Taiwan and Thailand of Asia Pacific region, Botswana, Israel, Mauritius and Nigeria of Africa and Middle East region, Russia

Federation, Slovak Republic and Turkey of Eastern Europe region and Austria, Britain, Denmark, Finland, Germany, Greece, Italy, Norway, Portugal, Spain, Sweden and Switzerland of Western Europe Region. MSCI index is found to be significant in North America, South and Central America, Eastern Europe and Western Europe region. These stock markets are found to be dynamically interlinked with the stock markets of their respective regions

Long run Equilibrium Relationships

These estimates never put light on the long run equilibrium relationships between the stock markets of the region Hence to identify the long run equilibrium relationships between the stock markets within their respective regions, the present study used Johansen Maximum likelihood estimates. The study identifies only one cointegrating vector suggested by λ-trace and λ-max eigen value at 5% level for the stock markets of North America region showing weak long run equilibrium relationships between these stock markets. In case of south and Central America region, λ-trace identifies 4 cointegrating vectors at 5% level and 3 cointegrating vectors at 1% level and λ-max suggests only 1 cointegrating vector at 5% level. Hence, the long run equilibrium relationships between the stock markets of South and Central America seem to be stronger. But there lies no long run equilibrium relationships between the stock markets of South Asia region. The stock markets of Asia Pacific region found to be having stronger long run equilibrium relationships within the region as λ-trace statistics suggests 4 and λ-max eigen value identifies 3 cointegrating equations within its regional level Similar is the case for the stock market of Africa and Middle East. Johansen maximum likelihood statistics identifies 4 and 3 cointegrating equations suggested by λ-trace and λ-max eigen values proving a strong long run equilibrium relationships between the stock markets. But the long run equilibrium relationships between the stock markets of Eastern Europe are moderate The λ-trace identifies only 2 cointegrating vectors within the region and λ-max eigen value identifies no cointegrating equations between the stock markets. A substantial long run equilibrium relationship exists between stock markets of Western European nations. The λ-trace identifies 2 and 3 cointegrating vectors at 1% and 5% level respectively and λ-max identifies one cointegrating equations at 1% and 2 at 5% level between the stock markets of the region.

6.4 Persistence of Volatility

In order to capture the persistence of volatility in the studied stock markets, the present study has used ARCH and GARCH models. Out of 65 countries' stock markets covered under 7 regional blocks, the stock markets of countries like Mexico, Argentina, Botswana, Jordan, Nigeria, Japan, Taiwan, Czech Republic, Hungary and Greece does not have ARCH effects. The F-statistics and the probability of observed R-square could not be able to reject the null hypothesis i.e. H_0: $\alpha_t = 0$. The rest of the stock markets like Bermuda, Canada, USA, Brazil, Chile, Colombia, Costa Rica, Peru, Venezuela, Egypt, Ghana, Israel, Kuwait, Mauritius, Oman, Saudi Arabia, South Africa, Tunisia, Australia, China, Hong Kong, Indonesia, Malaysia, New Zealand, Philippines, Singapore, Korea Republic, Thailand, Bangladesh, India, Pakistan, Sri Lanka, Lithuania, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Turkey, Austria, Belgium, Britain, France, Germany, Italy, Netherlands, Norway, Sweden, Portugal, Luxembourg, Denmark, Ireland, Finland, Switzerland and Spain that have ARCH effect in mean equation suggested by ARCH-LM test. These stock markets are again analysed under GARCH models. In most of the cases GARCH (1, 1) model found to be best fitting to capture the ARCH effects effectively. Reviewing the results of the GARCH model, the present study identified that stock markets of Bermuda, Colombia, Costa Rica, Peru, Venezuela, Ghana, Kuwait Mauritius, Saudi Arabia, Tunisia, Bangladesh, Romania, Slovak Republic, Belgium, Germany, Italy, Netherlands, Norway, Luxembourg and Switzerland have high ARCH coefficients. This implies that these stock markets are highly sensitive with immediate market fluctuations. The influence of random deviations in the previous period error terms is quite prominent in creating a volatile return series. As a result the stock market reacts strongly with immediate market movements. In such cases the volatility series tends to be spikier.

The GARCH coefficients for the stock markets of countries like Canada, USA, Brazil, Chile, Colombia, Peru, Egypt, Oman, Saudi Arabia, South Africa, Tunisia, Australia, China, Hong Kong, Indonesia, Malaysia, New Zealand, Philippines, Singapore, Korea Republic, Thailand, India, Lithuania, Poland, Russian Federation, Slovenia, Turkey, Austria, Britain, France, Germany, Netherlands, Sweden, Denmark, Ireland, Finland and Spain are very high i.e. closer to one. A higher GARCH coefficient implies

existence of high persistence of volatility as a result the shocks to conditional variance take a long time to die out. The GARCH coefficient of Bermuda, Venezuela, Ghana, Kuwait, Pakistan, Sri Lanka, Romania, Slovak Republic Belgium, Italy, Norway, Luxembourg, and Switzerland stock markets are also bit higher. Hence volatility in these stock markets persists for some time. But the stock markets of Bangladesh, Costa Rica, Mauritius and Israel have very small GARCH coefficients showing low persistence of Volatilities in these stock markets. A relatively higher ARCH coefficient and relatively low GARCH coefficient implies volatility tends to be spikier.

The ARCH-LM test of the variance equations of GARCH (1, 1) model for the stock markets suggests no ARCH effects in the GARCH residuals. Hence the null hypothesis of H_0. $\alpha_i = 0$ could not be rejected for the variance equations. The sum of ARCH and GARCH coefficients $(\alpha + \beta)$ for stock markets of Colombia, Costa Rica, Egypt, Ghana, Oman, Tunisia, Bangladesh, Lithuania, Romania, Germany, Netherlands and Luxembourg are greater than one indicating Integrated GARCH (IGARCH) models. In such cases, the GARCH error distributions are non stationary and hence follow random walk. But the ARCH-LM test of the variance equation of stock market of Ireland suggests the existence of ARCH effects in the GARCH (1, 1) error distribution. Hence it keeps an opportunity to go for a higher order GARCH models. It has been found that a GARCH (2, 2) model is able to capture the ARCH effects of Ireland stock market. But the ambiguity lies with the sign of the ARCH and GARCH coefficients estimated by a GARCH (2, 2) model. The second order ARCH and GARCH coefficient is negative which is not supposed to happen. This makes it clear that simple GARCH model is not sufficient for capturing the volatility of Ireland stock market. Probably an EGARCH or MGARCH model may be suitable to capture the volatile of Ireland stock market.

6.5 Concluding Remarks

The stock markets which are highly developed and highly liquid are stock markets of United States, Hong Kong, Switzerland, Britain, Japan, Korea Republic, Malaysia, India, Netherlands, Singapore, Spain, Canada, Sweden, South Africa, France, Finland and Australia. Except the stock market of Japan, Malaysia, India, Canada and France, the rest of the stock markets are found to be quite dynamically interlinked within their respective

regions. Stock markets of Jordan, Israel, Denmark, Ireland, Italy, Greece, Chile, Pakistan, Belgium, Turkey, Norway, Brazil, New Zealand and Portugal are moderately developed as well as moderately liquid stock markets. Out of these stock markets except Jordan, and Pakistan the rest of the stock markets are highly interlinked with the stock markets of their respective regions. Among the less developed and less liquid stock markets like Russian Federation, Mexico, Indonesia, Hungary, Argentina, Peru, Mauritius, Oman, Poland, Sri Lanka, Lithuania, Colombia, Slovenia, Nigeria, Botswana, Ghana, Venezuela, Costa Rica, Tunisia, Bangladesh, Bermuda, Taiwan, the stock markets of Russian Federation, Mexico, Indonesia, Argentina, Peru, Poland, Costa Rica and Taiwan are dynamically interlinked with the stock markets of their respective regions. Stock market of Germany and Thailand which are moderately developed but highly liquid stock markets stand to be quite dynamically interlinked within their respective region. China is found to be less interlinked with the stock market within Asia Pacific region. Austria and Czech Republic being less developed stock markets are found to be quite dynamically interlinked within the stock markets of Eastern and Western Europe region. Similarly, stock market of Philippines and Egypt are moderately developed and less liquid stock markets and are quite dynamically interlinked stock markets. Another group of stock markets of highly developed but moderately liquid are stock markets of Luxembourg, Kuwait and Saudi Arabia Out of these, Luxembourg, Kuwait stock markets are quite interlinked stock markets except Saudi Arabia.

On the view point of causality, the short term lead lag relationships exists between the pair of stock markets namely "Canada and Bermuda" and "United States and Bermuda" of North America Region, "Peru and Brazil", "Peru and Chile" and "MSCI and Colombia" of South and Central America region, "MSCI and India" and "Pakistan and MSCI" of South Asia Region, "New Zealand and Hong Kong", "Malaysia and Korea Republic", "New Zealand and Korea Republic", "Singapore and Korea Republic", "New Zealand and Malaysia", "Philippines and MSCI", "Philippines and New Zealand", "Thailand and New Zealand", "Singapore and Philippines" and "Thailand and Singapore" of Asia Pacific region, "Jordan and Egypt", "Jordan and Ghana", "MSCI and Israel", "MSCI and Jordan" of Africa and Middle East region, "Poland and MSCI" of Eastern Europe region, "Spain and Austria", "Greece and Denmark", "Spain and France",

"Sweden and France", "Italy and Germany", "Netherlands and Germany", "Norway and Greece", "Norway and Ireland" and "Portugal and Italy" of Western Europe region. These stock markets carry bidirectional causality. One way causality is also found in most of the stock markets of these regions.

The present study finds stronger long run equilibrium relationships between the stock markets of South and Central America, Asia pacific, Africa and Middle East and Western Europe region. Whereas weak long run equilibrium relationships are found between the stock markets of North America and Eastern Europe region. No long run equilibrium relationship exists among the stock markets of South Asia region.

Looking at the volatility structure of the stock market, the present study finds no ARCH effects in the mean equations of the index return series of stock markets of countries namely Mexico, Argentina, Botswana, Jordan, Nigeria, Japan, Taiwan, Czech Republic, Hungary and Greece. Stock markets of Bermuda, Canada, USA, Brazil, Chile, Colombia, Costa Rica, Peru, Venezuela, Egypt, Ghana, Israel, Kuwait, Mauritius, Oman, Saudi Arabia, South Africa, Tunisia, Australia, China, Hong Kong, Indonesia, Malaysia, New Zealand, Philippines, Singapore, Korea Republic, Thailand, Bangladesh, India, Pakistan, Sri Lanka, Lithuania, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Turkey, Austria, Belgium, Britain, France, Germany, Italy, Netherlands, Norway, Sweden, Portugal, Luxembourg, Denmark, Ireland, Finland, Switzerland and Spain have ARCH effects which implies that the volatility in the index return is impacted by linear combination of squared past errors. The stock markets of Bermuda, Colombia, Costa Rica, Peru, Venezuela, Ghana, Kuwait Mauritius, Saudi Arabia, Tunisia, Bangladesh, Romania, Slovak Republic, Belgium, Germany, Italy, Netherlands, Norway, Luxembourg and Switzerland have high ARCH coefficients. Hence these stock markets are highly sensitive with immediate market fluctuations. The influence of random deviations in the previous period error terms is quite prominent in creating a volatile return series. As a result these stock markets react strongly with immediate market movements. The present study also finds high persistence of volatility in the stock markets of countries namely Canada, USA, Brazil, Chile, Colombia, Peru, Egypt, Oman, Saudi Arabia, South Africa, Tunisia, Australia, China, Hong Kong, Indonesia, Malaysia, New Zealand, Philippines, Singapore, Korea Republic, Thailand, India, Lithuania,

Poland, Russian Federation, Slovenia, Turkey, Austria, Britain, France, Germany, Netherlands, Sweden, Denmark, Ireland, Finland and Spain. The persistence of volatility also exist to some extent in the stock markets of Bermuda, Venezuela, Ghana, Kuwait, Pakistan, Sri Lanka, Romania, Slovak Republic Belgium, Italy, Norway, Luxembourg, and Switzerland. In the similar fashion very low persistence of volatility exists in the stock markets of Bangladesh, Costa Rica, Mauritius and Israel. In these stock markets, volatility tends to be spikier.

6.6 Scope for Further Research:

The biggest drawback of our study is the regional boundaries Through clubbing the stock markets within the seven regions, we are neglecting their integration with the stock markets of rest of the world. It is expected that neighboring nations generally carry more interlinkages and spillovers, but financial openness has made the world small. There is no reason for a stock market to confine itself within a small geographical boundary. There is high probability that a well organized stock market of one region can be effectively interlinked with a developed stock market of another region. Knowing all those things the present study could not be able to solve some methodological drawbacks to club the world into one region. It is really very difficult to solve a huge matrix of 65 countries' benchmark indices as each index is unique with its time series properties. Again too many endogenous or exogenous presence of variables can cause loss of huge degrees of freedom. Hence there lays a scope to develop a robust time series methodology that can solve this huge matrix taking world as one unit without losing the time series properties of the individual countries stock markets

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APPENDIX-A

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APPENDIX A

List of Stock Market Indices and their Descriptions

Sl No	Countries	Index Ticker	Name of the Index	Description of Index
1	Argentina	MERVAL Index	Argentina Merval Index	The Argentina Mervel Index, a basket weighted index, is the market value of a stock portfolio, selected according to participation in the Buenos Aires Stock Exchange, number of transactions and trading value. The index has a base value of $0.01 as of June 30, 1986 The index is revised every 3 months, taking into account the trading volumes over the past 6 months.
2	Australia	AS30 Index	The Australian All Ordinaries Index	The Australian All Ordinaries Index is a capitalization weighted index The index is made up of the largest 500 companies as measured by market cap that are listed on the Australian Stock Exchange. The index was developed with a base value of 500 as of 1979 The groups of this index were discontinued on July 5th, 2002
3	Austria	ATX Index	The Austrian Traded Index	The Austrian Traded Index is a capitalization-weighted index of the most heavily traded stocks on the Vienna Stock Exchange The equities use free float adjusted shares in the index calculation The index has a base level of 1000 as of January 2, 1991
4	Bangladesh	Dhaka index	Dhaka Stock Index	Exchange carries prices of general index figure as of Dec 9, 2003. The index now has category A and B stock company stocks. Companies in category Z have been removed Weighted Average Share Price index has been calculated according to the SEC Directive given on 17th November 2001, excluding Z category shares and taking into consideration the day's traded number of shares of A & B categories by applying weighted average method with Base Index 817. 62 with effect from 24th Nov, 2001.
5	Bermuda	BSX	Bermuda Stock Exchange Index	The Bermuda Stock Exchange Index is a capitalization-weighted index designed to measure the performance of the Bermuda Stock Exchange.
6	Belgium	BEL20 Index	Belgium 20 Index	The BEL 20 Index is a modified capitalization-weighted index of the 20 most capitalized and liquid Belgian stocks that are traded on the Brussels Stock Exchange The equities use free float shares in the index calculation The index was developed with a base value of 1,000 as of January 1, 1991

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Sl. No	Countries	Index Ticker	Name of the Index	Description of the Index
7	Botswana	BGSMDC	Botswana Domestic Companies Index	The Botswana Domestic Companies Index consists of only those companies traded in Botswana. The method used to calculate the price of the index is the weighted arithmetic average of the current prices of the shares to the average of their starting price The weighting for each share is its market capitalization
8	Brazil	IBOV Index	Bovespa Index	The Bovespa Index is a total return index weighted by traded volume and is comprised of the most liquid stocks traded on the Sao Paulo Stock Exchange The Bovespa Index has been divided 10 times by a factor of 10 since January 1, 1985.
9	Britain	UKX Index	FTSE 100 Index	The FTSE 100 Index is a capitalization-weighted index of the 100 most highly capitalized companies traded on the London Stock Exchange. The equities use an invisibility weighting in the index calculation The index was developed with a base level of 1000 as of January 3, 1984.
10	Canada	SPTSX Index	S&P/Toronto Stock Exchange Composite Index	The S&P/Toronto Stock Exchange Composite Index is a capitalization-weighted index designed to measure market activity of stocks listed on the TSX. The index was developed with a base level of 1000 as of 1975. This index contains investment trusts effective 12/19/05
11	Chile	IPSA Index	Indice de Precios Selectivo de Acciones Index	The IPSA Index (Indice de Precios Selectivo de Acciones) is composed of the 40 stocks with the highest average annual trading volume in the Santiago Stock Exchange (Bolsa de Comercio de Santiago) On the last trading day of the year, the index is re-based back to 1000 The index has been calculated since 1977 and is revised on a quarterly basis.
12	China	SHBSHR Index	Shanghai B-Share Stock Price Index	The Shanghai B-Share Stock Price Index is a cap-weighted index The index tracks daily price performance of all B-shares listed on the Shanghai Stock Exchange that is available for investment by foreign investors The index was developed with a base value of 100 on February 21, 1992. The B-share market has been opened to investors since February 19, 2001

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Sl. No	Countries	Index Ticker	Name of the Index	Description of the Index
13	Colombia	IGBC Index	IGBC General Index	The IGBC Index from the Colombia Stock Exchange, also known as the General Index, is Price-weighted index of the liquid and highest capitalized stocks traded on the Colombia Stock Exchange (Bolsa de Valores de Colombia).
14	Costa Rica	crsmbct	BCT Corporate Costa Rica Stock Market Index	The BCT Corp Costa Rica Stock Market Index is a market capitalization weighted index. The members of the index are rebalanced every quarter by the BCT Corporation according to the most actively traded stocks of the previous quarter
15	Czech Republic	PX50 Index	Prague Stock Exchange-PX 50 Index	The PX-50 index is a capitalization-weighted index comprised of 50 companies listed on the Prague Stock Exchange Into which only issues from the Main and.Secondary market can be incorporated. As of March 17, 2006 the index will be discontinued
16	Denmark	KFMX Index	Kfmx Copenhagen Share Index	The KFMX Index is a capitalization-weighted index which consists of the stocks of the small and medium-sized companies traded on the Copenhagen Stock Exchange The KFMX index consists of the companies, which are not included into the KFX Index already. The index was developed with a base value of 1000 as of January 2001
17	Egypt	HERMES Index	Hermes Financial Index	The Hermes Financial Index (HFI) tracks the movement of the most active Egyptian stocks traded on the Cairo and Alexandria Stock Exchanges The HFI is capitalization weighted The index is calculated on a total return basis, taking into consideration the reinvestment of dividends.
18	Finland	HEX Index	Helsinki Stock Exchange General Index	The Helsinki Stock Exchange General Index (Economic Sector) is a capitalization weighted index consisting of all the stocks traded on the exchange The HEX Index is broken down using the GICS Classification as of July 1, 2005. The index was developed with a base level of 1,000 as of December 28, 1990
19	France	CAC Index	CAC 40 Index	The CAC-40 Index is a narrow-based, modified capitalization-weighted index of 40 companies listed on the Paris Bourse. The index was developed with a base level of 1,000 as of December 31, 1987 As of December 1, 2003 the index has become a free float weighted index
20	Germany	DAX Index	German Stock Index	The German Stock Index is a total return index of 30 selected German blue chip stocks traded on the Frankfurt Stock Exchange. The equities use free float shares in the index calculation. The DAX has a base value of 1,000 as of December 31, 1987

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Sl. No	Countries	Index Ticker	Name of the Index	Description of the Index
21	Ghana	GGSEGSE	GGSEGSE Index	The Stock Exchange was established in July 1989 as a private company limited. It was given recognition as an authorized Stock Exchange under the Stock Exchange Act of 1971 (Act 384) in October 1990 The Council of the Exchange was inaugurated on November 12, 1990 and trading commenced on its floor the same day. The Exchange changed its status to a public company limited by guarantee in April 1994
22	Greece	ASE Index	Athens Stock Exchange General Index	The Athens Stock Exchange General Index is a capitalization-weighted index of Greek stocks listed on the Athens Stock Exchange The index was developed with a base value of 100 as of December 31, 1980.
23	Hong Kong	HSI Index	Hang Seng Index	The Hang Seng Index is a free-float capitalization-weighted index of selection of companies from the Stock Exchange of Hong Kong. The components of the index are divided into four sub indexes. Commerce and Industry, Finance, Utilities, and Properties The index was developed with a base level of 100 as of July 31, 1964.
24	Hungary	BUX Index	Budapest Stock Exchange Index	The Budapest Stock Exchange Index is a capitalization-weighted index adjusted for free float The index tracks the daily price only performance of large, actively traded shares on the Budapest Stock Exchange The shares account for 58% of the domestic equity market capitalization. The index has a base value of 1000 points as of January 2, 1991
25	India	Sensex	Bombay Stock Exchange Sensitive Index	The Bombay Stock Exchange Sensitive Index (Sensex) is a cap-weighted index. The selection of the index members has been made on the basis of liquidity, depth, and floating-stock-adjustment depth and industry representation Sensex has a base date and value of 100 in 1978-1979 The index uses free float
26	Indonesia	JCI Index	Jakarta Stock Price Index	The Jakarta Stock Price Index is a modified capitalization-weighted index of all stocks listed on the regular board of the Indonesia Stock Exchange The index was developed with a base index value of 100 as of August 10, 1982.

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Sl. No	Countries	Index Ticker	Name of the Index	Description of the Index
27	Ireland	ISEQ Index	Irish Overall Index	The ISEQ Overall Index is a capitalization-weighted index of all Official list equities in the Irish Stock Exchange but excludes UK registered companies. The index has a base value of 1000 as of January 4, 1988.
28	Israel	TA-100 Index	Tel Aviv 100 Index	The Tel Aviv 100 Index is a capitalization-weighted index of 100 stocks traded on the Tel Aviv Stock Exchange (TASE). The Index was developed with a base value of 100 as of December 31, 1991. TA-100 is a total return index
29	Italy	MIB30 index	Milan MIB30 Index	The MIB 30 is a capitalization-weighted index of the 30 top Italian companies traded on the Milan Stock Exchange The index has a base value of 10,000 on December 31, 1992 This index is based on a current market capitalization-weighted methodology.
30	Japan	NKY Index	NIKKEI 225	The Nikkei-225 Stock Average is a price-weighted average of 225 top-rated Japanese companies listed in the First Section of the Tokyo Stock Exchange. The Nikkei Stock Average was first published on May 16, 1949, where the average price was ¥176 21 with a divisor of 225
31	Jordan	IDGPJOPL Index	S&P Jordan Global Index	This index represents the S&P Jordan Global Price series The term Global indicates that the country index selects constituent stocks by virtue of their liquidity and market capitalization, without reference to the stocks availability to foreign investors The target coverage of the S&P Global index is about 65-75% of total market capitalization, drawing on stocks in order of their liquidity
32	Korea, Republic	KOSPI Index	Korea Stock Index	The KOSPI Index is a capitalization-weighted index of all common shares on the Korean Stock Exchanges The Index was developed with a base value of 100 as of January 4th, 1980.
33	Kuwait	KWSEIDX	Kuwait Stock Exchange Index	Kuwait Stock Exchange Un weighted Index is a price-weighted index The index measures the performance of all companies listed at the Kuwait Stock Exchange.

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Sl. No	Countries	Index Ticker	Name of the Index	Description of the index
34	Lithuania	NSEL 30	Lithuania NSEL 30 Index	NSEL 30 Index is a cap-weighted index composed of 30 stocks with the largest free-float based market capitalization that listed on the Vilnius Stock Exchange NSEL 30 Index is rebalanced quarterly Index is adjusted for splits, distributions, breakups, spinoffs, exchanges, and it includes dividends. Index reflects approximately 97% of the free float shares on the Vilnius Stock Exchange.
35	Luxembourg	LUX XX	Luxembourg X Index	The Luxembourg (Lux) X Index is a weighted index of the most capitalized (by free- float) and liquid Luxembourg stocks The index was developed with a base value of 1,000 as of January 4, 1999
36	Malaysia	KLCI Index	Kuala Lumpur Stock Exchange Composite Index	The Kuala Lumpur Stock Exchange Composite Index is a broad-based capitalization weighted index of 100 stocks designed to measure the performance of the Kuala Lumpur Stock Exchange. The index has a base value of 100 as of January 2, 1977.
37	Mauritius	SEMD EX	SEMDEX Index	The SEMDEX Index is a capitalization weighted index including all shares traded on the Stock Exchange of Mauritius Index = Current Market Value of all listed shares/Base Market Value of all listed shares*100 (where the market value of any shares is equal to the number of shares outstanding multiplied by the market value) The base value is adjusted to reflect new listing and rights issues.
38	Mexico	MEXB OL Index	Mexico Bolsa Index	The Mexican Bolsa Index, or the IPC (Indice de Precios y Cotizaciones), is a capitalization-weighted index of the leading stocks traded on the Mexican Stock Exchange The index was developed with a base level of .78 as of October 30, 1978.
39	World Index	MSCI	Morgan Stanly Capital International World Index	MSCI World Index has been calculated since 1969 with gross dividends reinvestable. It is a stock market Index of 1500 world stocks of both developed and emerging countries.

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Sl. No	Countries	Index Ticker	Name of the Index	Description
40	Netherlands	AEX	Amsterdam Exchanges Index	The AEX-Index is a free-float adjusted market capitalization weighted index of the leading Dutch stocks traded on the Amsterdam Exchange. The index was adjusted to the Dutch Guilder fixing rate. The old value as of 12/31/98 was 1186.38 and the new value at start of trading on 1/4/99 was 538.36, after conversion. HP and GP can be adjusted back to Dutch Guilders by typing NLG.
41	New Zealand	NZSE	New Zealand All Ordinaries Index	The New Zealand All Ordinaries Index is a capitalization-weighted index of all domestic stocks traded on the New Zealand Exchange Limited. The index was developed with a base value of 1,000 as of July 1, 1986
42	Nigeria	NGSEI NDX	Nigeria Index	The Nigerian Stock Exchange (NSE) is home to about 260 companies The Exchange, made up of 10 Government Stocks, 55 Industrial Loan Debenture/Preference) Stocks and 195 Equity/Ordinary Shares of Companies. Most of the listed companies have foreign/multinational affiliations and represent a cross section the economy, ranging from agriculture through manufacturing to services With regards to the All Share Index, only ordinary shares are included in the computation of the index The index is computed daily
43	Norway	OBX	OBS Stock Index	The OBX Index is a capitalization-weighted index of the largest companies traded on the Oslo Stock Exchange. The equities use free float shares in the index calculation Note that effective April 21 2006, OBX Stock Index became a total return index and had price history split by a factor of 4
44	Oman	MSM 30	Muscat Securities Market Index 30	The Muscat Securities Market Index, MSM 30, is a capitalization-weighted index of the 30 most highly capitalized, liquid and profitable companies listed on the Muscat Securities Market The index was developed with a base level of 1000 as on June 1990.
45	Pakistan	KSE 100	Karachi Stock Exchange 100 Index	The Karachi Stock Exchange KSE100 Index comprises the top company from each of the 34 sectors on the KSE, in terms of market capitalization. The rest of the companies are picked on market cap ranking, without any consideration for the sector to make a sample of 100 common stocks with base value 1,000

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Sl. No	Countries	Index Ticker	Name of the Index	Description of Index
46	Peru	IGBVL	Peru Lima General Index	The IGBVL Index is a value weighted index that tracks the performance of the largest and most actively traded stocks on the Lima Exchange. The index was developed with a base value of 100 as of December 31, 1981
47	Philippines	PCOMP	Philippine Stock Exchange PSEi Index	The Philippine Stock Exchange PSEi Index is a capitalization-weighted index composed of stocks representative of the Industrial, Properties, Services, Holding Firms, Financial and Mining & Oil Sectors of the PSE. The index has a base value of 2922.21 as of September 30, 1994 Free-float adjusted as of 4/3/06 *New industry classification effective 1/2/2006 Formerly named PSE Composite
48	Poland	WIG20	Waisaw Stock Exchange 20 Index	The WIG20 index is a modified capitalization-weighted index of 20 Polish stocks which are listed on the main market The index is the underlying instrument foi futures transactions listed on the Warsaw Stock Exchange The base value was set to 1000 as of April 16, 1994
49	Portugal	PSI20	Portugal 20 Index	The PSI 20 Index is a capitalization weighted index of the top 20 stocks listed on the Lisbon Stock Exchange The equities use fiee float shares in the index calculation The index was developed with a base value of 3,000 as of December 31, 1992
50	Romania	BET	Bucharest Exchange Trading Index	Bucharest Exchange Trading Index (BET) is a capitalization weighted index, comprised of the most liquid 10 stocks listed on the BSE tier 1 The index was developed with a base value of 1000 as of September 22, 1995
51	Russian Federation	RTSI$	Russian Trading System Index	The Russian Trading System Index is capitalization weighted index that is calculated in USD The index is comprised of stocks traded on the Russian Trading System and uses free-float adjusted shaies. The index was developed with a base value of 100 as of September 1, 1995
52	Saudi Arabia	SASEIDX	Tadawul All Shaie Index	This is the Tadawul All Share Index It is disseminated by the Saudi Stock Market
53	Singapore	STI	Straits Times Index	The revamped Straits Times Index, calculated and disseminated by FTSE, compiises the top 30 SGX Main board listed companies selected by full market capitalization. The index was revamped effective January 10, 2008

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Sl. No	Countries	Index Ticker	Name of the Index	Description of the index
54	Slovak Republic	SKSM	Slovak Share Index	The Slovak share index (SAX) is a capital-weighted total return index that compares the market capitalization of a selected set of shares with the market capitalization of the same set of shares as of a given reference day The index was developed with a base level of 100 of September 14, 1993
55	Slovenia	SVSM	Slovenia Stock Exchange Index	The Slovenia Stock Exchange Index is the Ljubljana Stock Exchange total market index, measuring the performance of the entire Slovene organized securities market It is aimed primarily at providing accumulated credible information on the price movements of the biggest and most liquid shares on the official and semi-official market. Base value is 1000 as of 31 December 1993
56	South Africa	JALSH	FTSE/JSE Africa All Shares Index	The FTSE/JSE Africa All Shares Index is a market capitalization weighted index Companies included in this index make up the top 99% of the total pre-free float market capitalization of all listed companies on the Johannesburg Stock Exchange
57	Spain	IBEX	IBEX 35 Index	The IBEX 35 is the official index of the Spanish Continuous Market. The index is comprised of the 35 most liquid stocks traded on the Continuous market It is calculated, supervised and published by the Sociedad de Bolsas The equities use free float shares in the index calculation The index was created with a base level of 3000 as of December 29, 1989
58	Sri Lanka	CSEALL	Sri Lanka Stock Market Colombo All-Share Index	Sri Lanka Stock Market Colombo All-Share Index is a market capitalization weighted index. Base year is 1985
59	Sweden	OMX	OMX Stockholm 30 Index	The OMX Stockholm 30 Index is a capitalization-weighted index of the 30 stocks that have the largest volume of the trading on the Stockholm Stock Exchange The equities use free float shares in the index calculation. The index was developed with a base level of 125 as of September 30, 1986

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Sl.No	Countries	Index Ticker	Name of the Index	Description of the index
60	Switzerland	SMI	Swiss Market Index	The Swiss Market Index is a capitalization-weighted index of the 20 largest and most liquid stocks of the SPI universe. It represents about 85% of the free- float market capitalization of the Swiss equity market. The SMI was developed with a base value of 1,500 as of June 30, 1988.
61	Taiwan	TWSE	Taiwan TAIEX Index	The TWSE, or TAIEX, Index is capitalization-weighted index of all listed common shares traded on the Taiwan Stock Exchange. The index was based in 1966. The index is also known as the TSEC Index.
62	Thailand	SET	Bangkok Stock Exchange Traded Index	The Bangkok SET Index is a capitalization-weighted index of stocks traded on the Stock Exchange of Thailand The index was developed with a base value of 100 as of April 30, 1975
63	Tunisia	TUSISE	Tunisia Stock Index	The Tunis Stock Exchange TUNINDEX is a capitalization weighted index containing equities from the Tunis Stock Exchange. This index is open to all listed companies with minimum period of quotation of six months. The index was launched on December 31, 1997 with an initial base level of 1000.
64	Turkey	TKSMCOMP / XU100	Istanbul Stock Exchange	The Istanbul Stock Exchange National 100 Index is a capitalization-weighted index composed of National Market companies except investment trusts The constituents of the ISE National 100 Index are selected on the basis of pre-determined criteria directed for the companies to be included in the indices. The base date is January 1986 and base value is 1
65	United States	SPX	Standard and Poor's 500 Index	Standard and Poor's 500 Index is a capitalization-weighted index of 500 stocks The index is designed to measure performance of the broad domestic economy through changes in the aggregate market value of 500 stocks representing all major industries. The index was developed with a base level of 10 for the 1941- 43 base periods
66	Venezuela	IBVC	Venezuela Stock Market Index	The IBC Index from the Caracas Stock Exchange (Venezuela), also known as the General Index, is a capitalization-weighted index of the 15 most liquid and highest capitalized stocks traded on the Caracas Stock Exchange (Bolsa de Valores de Caracas)..

existence of high persistence of volatility as a result the shocks to conditional variance take a long time to die out. The GARCH coefficient of Bermuda, Venezuela, Ghana, Kuwait, Pakistan, Sri Lanka, Romania, Slovak Republic Belgium, Italy, Norway, Luxembourg, and Switzerland stock markets are also bit higher. Hence volatility in these stock markets persists for some time. But the stock markets of Bangladesh, Costa Rica, Mauritius and Israel have very small GARCH coefficients showing low persistence of Volatilities in these stock markets. A relatively higher ARCH coefficient and relatively low GARCH coefficient implies volatility tends to be spikier.

The ARCH-LM test of the variance equations of GARCH (1, 1) model for the stock markets suggests no ARCH effects in the GARCH residuals. Hence the null hypothesis of H_0: $\alpha_i = 0$ could not be rejected for the variance equations. The sum of ARCH and GARCH coefficients $(\alpha + \beta)$ for stock markets of Colombia, Costa Rica, Egypt, Ghana, Oman, Tunisia, Bangladesh, Lithuania, Romania, Germany, Netherlands and Luxembourg are greater than one indicating Integrated GARCH (IGARCH) models. In such cases, the GARCH error distributions are non stationary and hence follow random walk. But the ARCH-LM test of the variance equation of stock market of Ireland suggests the existence of ARCH effects in the GARCH (1, 1) error distribution. Hence it keeps an opportunity to go for a higher order GARCH models. It has been found that a GARCH (2, 2) model is able to capture the ARCH effects of Ireland stock market. But the ambiguity lies with the sign of the ARCH and GARCH coefficients estimated by a GARCH (2, 2) model. The second order ARCH and GARCH coefficient is negative which is not supposed to happen. This makes it clear that simple GARCH model is not sufficient for capturing the volatility of Ireland stock market. Probably an EGARCH or MGARCH model may be suitable to capture the volatile of Ireland stock market.

6.5 Concluding Remarks

The stock markets which are highly developed and highly liquid are stock markets of United States, Hong Kong, Switzerland, Britain, Japan, Korea Republic, Malaysia, India, Netherlands, Singapore, Spain, Canada, Sweden, South Africa, France, Finland and Australia. Except the stock market of Japan, Malaysia, India, Canada and France, the rest of the stock markets are found to be quite dynamically interlinked within their respective

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