On the Feasibility of Inflation Targeting in India

A Thesis Submitted for the Degree of Doctor of Philosophy in Economics

By

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To My Parents

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25th July 2002.

*This is to certify that I, Sanghamitra Sahu have carried the research embodied in the present thesis entitled "**On the Feasibility of Inflation Targeting in India**" within the full period prescribed under Ph.D. ordinances of the University of Hyderabad.*

I declare to the best of my knowledge that no part of the thesis was earlier submitted for the award of research degree of any University or Institute.

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Chapter I

Study Background and Problem Identification

1.0 Introduction

Monetary policy over the years has emerged as one of the most critical central bank responsibilities and the one that receives the maximum attention. Issues of monetary policy have always been complex and challenging, as it has to fulfill a variety of economic objectives over time. However the experience of 1970's encouraged the policy makers to focus on what monetary policy can do rather than on what it cannot do. The 70's were a period of rising inflation and rising average unemployment in many countries. Inflation in many developed countries such as United States was then twice what it is now. Economists underestimated the impact of demand, arguing instead of cost-push inflation and emphasizing the role of trade unions, monopoly business, and oil price shocks. Monetary policy's role was viewed as very limited as in the Keynesian tradition that emphasize the impotence of monetary policy during depression. The long run Phillips curve was still the dominant view, offering a permanently lower unemployment rate in exchange for accepting a higher rate of inflation. Monetary policy makers freed from the constraints of the Bretton Woods that collapsed in the early 70's, responded in different ways to the oil price shocks and other one time commodity price increases. But by the end of the decade, policy makers had given up any belief in their ability to manage a trade off between inflation and unemployment. Reducing inflation at acceptable social cost became a main policy goal of monetary policy. But the shift to an anti inflation monetary policy was also the effect of intellectual revolution that had taken place in sixties and seventies. The economics profession rejected the notion of long run Philips curve. The consensus shifted to the view advocated in 1968 by Milton Friedman that there is no long run tradeoff between unemployment and inflation. There was also the recognition of the power of monetary policy to reduce inflation by moving along a short run Phillips curve. However, with the revolution of the rational expectations it was viewed that the manipulation of the monetary policy for the short-term

stabilization goals will be counter productive. On the basis of these observations there is now considerable agreement that the most significant contribution monetary policy can make to achieve maximum economic performance, characterized by sustained economic growth and improved living standards, is to achieve and maintain low inflation.

In India, the Reserve Bank conducts monetary policy so as to maximize growth with price stability. Since 1985 monetary policy was conducted on the basis of monetary targeting to achieve these objectives. However, since 1998 monetary targeting approach was overthrown due to the proximate instability in the money demand function. A multiple indicator approach has been undertaken to achieve the goals. Adoption of interest rate targeting is also not considered as a viable option due to the non-existence of a benchmark interest rate. In light of this inflation targeting is viewed as an alternative (Kannnan, 1999; Bhoi, 2001; Mohanty, 2000) but a comprehensive study in this regard is clearly missing in India. Taking note of this gap in this area the present study makes an attempt to address the issue of adopting inflation targeting in India.

The scheme of the chapter is as thus. In section 1.1 the desirability of price stability is discussed followed by the need for inflation targeting in section 1.2. The operational definition of price stability is given in section 1.3 and the speed of transition to a low inflation rate is discussed in section 1.4. Section 1.5 presents the need for this study followed by objectives in section 1.6. Nature and sources of data is analysed in section 1.7 and methodology of the study in the subsequent section. Organization of the study is discussed in section 1.9.

1.1 Why Price Stability So Desirable?

The fundamental reason to pursue long run price stability is that inflation is economically and socially costly. There is a wide recognition that price stability directly raises the economic well being by increasing the efficiency of the monetary system and by reducing the uncertainty about the future. There are also macroeconomic benefits of price stability. Cross country evidence shows that countries with lower rates of inflation tend to have higher long-term economic growth rates (Taylor, 1997) Price stability is also desirable because it is easier to

maintain in the face of inflationary shocks than even a moderate rate of inflation because the public have more confidence in a central bank that has achieved price stability. Price stability also helps in making long-term financial planning in an environment of uncertainty or rinsing prices.

Some argue that establishing price stability as the primary goal of monetary policy means that a central bank would no longer be concerned about output or job growth. However, it is found that by ensuring a stable price environment monetary policy helps faster economic growth. The statement that long run price stability is the sole goal of monetary policy is probably best understood, as an attempt to deal with some of the logical and political difficulties raised by the existence of the short run tradeoff between inflation and output. Policy makers by aiming at long run price stability allow themselves a little leeway for short-term counter cyclical policy and remind proponents of short-term expansionary policies that the short and long run consequences of monetary expansion differ.

1.2 Why Inflation Targeting?

The emphasis on price stability gave rise to the question on how to achieve it. One of the solutions that has long bee proposed is to adopt rule based policies for monetary policy such as the constant money supply target and fixed exchange rates. The rationale behind adoption of intermediate targets was that since the effects of monetary policy are subject to long and variable lags, the outcome of the goal variable may not be as desired and hence it is unwise to anchor monetary policy to a rule for its behaviour. So case for policy rule in terms of behaviour of some intermediate variable, which is closely related to the goal variable was proposed. In this context a monetary aggregate was the typical choice for many countries during the aftermath of the collapse of the Bretton Woods system of fixed exchange rate. However, it was never practiced in terms of Friedman type rule of constant money growth. In practice, money growth indeed responds appropriately to other economic developments but the success of intermediate targeting procedure is dependent on the stable relationship between intermediate target and the goal variable. If the relationship of the intermediate target with the goal variable is unreliable then little advantage is gained by employing these

intermediate targets. This dilemma led to the abandonment of monetary targeting by a majority of countries in the 1980s. Hence to achieve price stability many countries directly established a nominal anchor in terms of an announced inflation rate known as inflation targeting. This decision of the countries to establish monetary policy regimes with official low inflation target indicate the preeminence of the goal of price stability. This stands in contrast with the current economic situation, as inflation has been lower in most countries than at any time in 1960 and growth rate have been reasonably good. But as indicated by (Beranake et al, 1999) "Good economic performance today, however does not guarantee good performance in the future, as history has shown many times". The central banks hence are striving towards developing strategies that will 'lock in' the gains of monetary policy in recent years and contribute to maintaining price stability. And countries with still moderate to high inflation are adopting policies to reduce inflation and achieve price stability. In this context being focused on the final objective inflation targeting has aroused considerable attention among central bankers and monetary economists. Inflation targeting has been adopted by a number of industrialized countries including New Zealand, Canada, the United Kingdom, Sweden, Finland, Israel, Spain and Australia. Moreover, now a days some developing countries such as Czech Republic and Chile have also implemented inflation targeting.

The targets vary, as do the time frames within which the target is to be achieved and the institutional arrangements under which the central bank operates. However, the common characteristics of these countries include the public announcement of an official quantitative target and a commitment to achieve the target within a few years. The other important features of the inflation targeting framework practiced are the instrument independence of the central bank and the high degree of transparency and accountability involved in the conduct of the monetary policy. Here specifically, under inflation targeting the policy decisions are guided by the future inflation relative to an announced inflation target. This type of policy setting behaviour makes the inflation targeting foreword looking in nature. The experience of countries that have taken this approach suggest that the benefits of inflation targeting to a great extent depends on the details of

implementation including the choice of target, the means of communicating with the public and the institutional arrangements that ensure central bank accountability and so on. This implies that the discussion concerning monetary policy has shifted from the inflation unemployment tradeoff and the choice of monetary control instruments to the institutional features affecting the central bank's activity and the information they disclose about their actions, aims and strategies. Notions such as precommitment credibility, reputation, independence and accountability have assumed a key role in inflation targeting central banks and the effectiveness of their actions.

It has been argued that inflation targeting can provide monetary policy with a nominal anchor that serves as an effective coordination device for price and wage setters and for financial market operators. Also it can be useful as it helps to focus a central bank's attention towards the objective that is most relevant from a long run perspective and because it helps to deflect political pressures that tend be short sighted and excessively deflationary. In addition an explicit commitment to price stability and specific numerical goals for inflation could help lock in low inflation expectations making future inflations and disinflations less likely. Also unlike monetary targeting, which relies on a foreword looking inflationary assessment where the weight attached to the monetary aggregate is unity and that attached to other variables are zero inflation targeting means using a mix of information variable with non zero weights assigned to both real and monetary magnitudes when forming an inflationary assessment. It is also not vulnerable to the change in the relationship between the intermediate target and the goal variable. Transparency and flexibility are other two major advantages of inflation targeting and these features have figured prominently in the rationales for adopting this approach. Inflation targeting central banks give enough effort to clear and timely communication of policy objectives, plans and tactics to the public. But at the same time central banks retain the ability to react effectively to short run macro economic developments within the broad constraint imposed by the inflation targeting framework. The case studies indicate that transparency often serves to contribute to flexibility of the policy in the long run.

1.3 Defining Price Stability

We have already discussed that the price stability must be the primary long run goal of monetary policy. This necessitates the price stability to be operationally defined. The universal acclaim is accorded to Alan Greensapan's definition of price stability as the level where inflation is not a factor in economic calculations. However there is little agreement on this definition to be implemented in practice. A strict definition of price stability suggests an inflation rate at zero. However several factors argue for a target measured inflation rate above zero. The first is that the long run Phillips curve is not vertical at low inflation rate. This implies that reducing the permanent rate of inflation requires a temporary loss of output. Estimates of the short run Phillips curve implies that reducing the inflation rate by two percentage points involves an output loss over time equal to the five percentage of GDP.

The second and the most important factor is the difficulty of the monetary policy posed by the lower bound of zero on the nominal interest rates that arises because cash carries a zero nominal interest rate (Summers, 1991). It is the expected inflation rate is zero, then it is very difficult for monetary policy to engineer a negative short run real interest rate, which may be needed during recession. Historically, negative real interest rates have played an important role in facilitating recoveries, particularly in situations of financial strain and ruling out this degree of freedom after the central bank by achieving zero inflation seems to have risks. The serious constraints placed on monetary policy in a zero inflation environments have recently been evident in Japan. The argument here is that inflation greases the wheels of monetary policy. The third argument is that the ordinary measures may be biased upwards. The error in measuring inflation stems from many factors including quality improvements and new products are in the price index. It is clear that if the bias is understood by the public agents, the need to keep open the possibility of negative real interest rates would argue for a higher target measured rate of inflation. Another possible reason that has been stressed in the literature is the nominal wage rigidities. With low inflation there cannot be real wage reductions without nominal wage cuts, making it harder to get the needed labour market adjustments during downturns

Another reason, which has not got adequate attention, is the importance of central banker credibility for effective monetary policy. Summers (1996) pointed out that over some range a non-zero inflation objective might increase credibility. Because not just the total but also the marginal cost of inflation rise with inflation rate, it will be easier to convince the public that the central bank will stick with a modest positive inflation rate. The implication of this observation is that expectational errors where the public anticipates more expansionary policy than is delivered are minimized at some non zero inflation rate. A more persuasive argument against setting an inflation rate of zero is that with such a policy, there is the risk of tipping the economy deflation in which the true price level is actually falling. History has shown that deflation can be extremely harmful in general and financial markets in particular.

Though there is a wide argument that price stability should be defined in terms of an inflation rate greater than zero there is little consensus on the level of the non zero inflation rate, that is consistent with price stability. If the inflation goal is set too high, there is the risk of allowing the start of an upward spiral in inflation expectations and inflation. It is very often argued that an appropriate number for this goal should be within the reasonable range of measurement error but also in the upper end of the range because of the dangers of deflation. Many also suggest for an inflation target in the range of one to three percent (Fisher, 1996; Bernanke et al, 1999). In practice also the inflation targeting countries set their inflation target around one to three percent per annum.

1.4 Operating with a Commitment to Price Stability

Whatever the agreed long term goal of inflation there is an important question of the appropriate pace of disinflation. This question essentially involves weighing the credibility benefits of rapid disinflation against the extra transitional costs involved with it. The costs are associated with the nominal rigidity of wages and prices. In general the economists emphasize that given the lags in the changes of the monetary policy and effects on expectations of the public, this speed of disinflation should be consistent with the speed of adjustment of the expectations of private sectors and decision makers. The faster those expectations adjust, the

less costly will be in terms of lost output given to any degree of monetary tightening and therefore more rapidly can monetary policy disinflate. However, the larger the time takes to achieve the price stability the more the central bank losses its credibility. Hence to reduce the cost of disinflation and to maintain credibility along with a long-term goal, another goal of monetary policy should be se in the medium terms. The goal of monetary policy in the intermediate terms is to put the economy on the path that moves it toward long term price stability, taking into account the economic and financial pressure on the economy. Therefore the path of the monetary policy in the intermediate term would have to be gradual. Integral to this course of strategy there should be increased efforts towards greater transparency in the conduct of monetary policy. Transparent measures should be taken to clarify any specific policy moves made at any time with reference to the numerical medium terms goal. The increased transparency will help in increasing credibility of the central bank where the announced target could be judged by the explicit inflation performance. Such an effect would indicate that even though an intermediate policy goal would change the underlying strategy and the long term goal of price stability would remain the same. This in result would ensure stable inflation expectations.

1.5 Need for Present Study

It is sometimes argued that inflation targeting is inappropriate for developing countries due to the presence of fiscal dominance and practice of multiple objectives. But the successful introduction of inflation targeting in Chile and Czech Republic with high fiscal dominance, implies that to focus monetary policy in keeping inflation low, is not impossible in countries where government has high dependence on the inflation tax. With regard to the second constraint of multiple objectives, it is found that encouraging economic growth and marinating competitive exchange rate are crucially important objectives in all the countries whether developed or developing. Inflation targeting by keeping inflation low helps in achieving economic growth and exchange rate stability.

It is also sometimes suggested that inflation targeting is unsuitable for developing countries because most of the institutional and operational requirements such as

inflation forecasts, developed financial system, reliable measure of inflation are non-existent. However, experience showed that these measures were also not there in the industrial countries when they adopted inflation targeting. The central banks have to develop the required infrastructure to adopt inflation targeting.

In India, the annual growth rate of broad money is considered as an intermediate target under the monetary targeting framework since mid 80s. However, since 1998 the RBI is following a multiple indicator approach where it takes into account the developments in a host of macroeconomic variables such as money, credit, prices et cetera in the conduct of its monetary policy. In the presence of stable money demand function in spite of the ongoing financial liberalization, the monetary targeting through indicator approach is used as an optimal strategy in India. It is quite often argued that monetary policy has performed quite well in the recent past without being tied down to inflation targeting. Hence, in the context of India this remains as an issue to be discussed and verified.

1.6 Objectives of the Study

In the light of the above background the objectives of the present study are:

- To analytically examine the feasibility of inflation targeting in India.
- To identify a set of leading indicators for the purpose of inflation targeting in India and to analyze the inflation forecast targeting in India.
- To trace the optimal horizon for inflation targeting in India.

1.7 Nature and Sources of Data

The study uses annual as well as monthly data for carrying out empirical exercise. The annual period of study spans over a period 1951 through 2001. The monthly analysis is confined to the period January 1985 through March 2001. The variables used in the study are: Gross Domestic Product (GDP), Wholesale Price Index (WPI), US Consumer Price Index (USCPI), and bi-lateral nominal exchange Rate (Rupee. Vs. Dollar), Broad Money (M3), Call Money Rate (CMR). However for the monthly case, index of industrial production (IIP) is used as the proxy for GDP. The data are collected from various issues of *Reserve Bank of India Bulletin*

and *Economic Survey*. Besides, the data on US Consumer price index are collected from *International Financial Statistics* (IFS) CD-ROM data base.

1.8 Methodology of the Study

The study proposes to use a variety of econometric methods to carry out empirical analysis. At the outset, we intend to employ the Hodrick-Prescott (1997) Filter to measure the potential output of the economy as well as to compute the long run equilibrium velocity. As further empirical analysis necessitates checking for the possible non-stationarity in the data, we propose to use Augmented Dickey Fuller (ADF) as well as Phillips-Perron (PP) tests to detect the order of integration. Once we have established the order of integration we proceed to use Vector Auto Regressions (VARs) method to carry out further analysis. In this, we rely primarily on two tools, viz. variance decomposition, and impulse response functions. Apart from the VAR analysis, we also use Johansen-Jussilieus (JJ) cointegration technique to trace the long run equilibrium relationship among different variables of interest.

1.9 Organization of the Study

The thesis comprises of five chapters. The introductory chapter highlights the background for analyzing inflation targeting and sets the ground for the present study. In particular, the chapter presents a broad overview of inflation targeting procedure as a final target of monetary policy. The second chapter considers in greater detail the rationale for inflation targeting. The pros and cons of other intermediate targets vis-à-vis are also considered here. The theoretical underpinnings of inflation targeting under the rules vs. discretionary monetary policy are discussed in this chapter. The third chapter constitutes the core of our study as it takes up different operational issues and the experiences of various countries. This case study approach provides the ground for making generalizations and the case for India is derived from this. The fourth chapter goes to discuss one of the most important requirements of the inflation targeting framework that is the construction of an inflation forecaster. First an effort is made to find out a number of leading indicators of inflation by using VARs, on the basis of which an inflation forecasters model is developed. Also the validity of

the widely used P-star (P*) model, which measures the inflationary potential of the economy is tested through the use of the Johansen-Juselius (1991) cointegration test. In chapter five we have tried to investigate another operational issue of the inflation targeting framework that is the selection of the optimal horizon, the period over which the forecast inflation reaches the target level. Here we have again employed the VARs to find out the optimal horizon. The final chapter presents the summary of our findings and scope for further research. This is followed by the summary and scope for further research.

Chapter II

Rationale for Inflation Targeting

2.0 Introduction

During the nineties many countries such as New Zealand, Canada, the UK, Sweden and Finland have adopted inflation targeting framework to achieve and maintain price stability. A central tenet of inflation targeting framework is that price stability must be the primary concern of monetary policy. This increased emphasis on price stability however, arises not because other macroeconomic goals such as high real growth, low unemployment and financial stability are less important but because policy makers and economists are now convinced that monetary policy cannot be used effectively to moderate short run fluctuations in the economy which was not the case in sixties. Prior to the breakdown of the Bretton Wood system policy makers and economists supported activist monetary policy. According to this view the monetary authorities could maintain output and unemployment close to their full employment levels by accepting some degree of inflation. But the experience of a number of developed countries during the sixties and seventies indicated that the short run manipulation of monetary policy could be counter productive. Furthermore, the intellectual revolution at that time contributed against the activist monetary policy. Also it was argued that in the long run inflation rate is the only macroeconomic variable that monetary policy can affect. These developments led to the preeminence of price stability as the long run goal of monetary policy. This justifies the inflation targetor's case for giving stress on price stability.

In the present chapter we are going to discuss the developments that contributed to the fading reputation of activist monetary policy. Besides these theoretical arguments, adoption of inflation targeting is perceived as a response to the inadequacies of intermediate target. Taking note of this, the pros and cons of

different forms of intermediate targeting are discussed to set the ground for the motivation behind inflation targeting.

The rest of the chapter is as follows. In the next section, a discussion is made on theoretical underpinnings of inflation targeting. We describe the rationale for inflation targeting in section 2.2 followed by intermediate targeting procedures in section 2.3. Section 2.4 concludes the chapter.

2.1 Theoretical Underpinnings of Inflation Targeting

The strategies for conducting monetary policy are always characterized as being a form of either rules or discretion. Monetary policy rules are automatic in nature, requiring little or nothing in the way of macroeconomic analysis or value judgments by the monetary authorities. A target value for a variable that is to be sustained indefinitely into the future like the constant money growth rate associated with Milton Friedman which required the money stock to grow by a fixed percentage each year irrespective of the economic and financial condition, is one of the policy rules. Another reputed example of such a rule is the gold standard, in which the conduct of monetary policy amounted to little more than marinating the price of gold at the official level. It is argued by the proponents of monetary policy-rules that the rule-guided policy is preferable to the discretionary policy as the former creates discipline and makes monetary policy more credible. By adhering to a policy rule the authorities assure the public that it will not engage in inflationary policies or otherwise abuse its powers. In this case if people are foreword looking, it reduces the uncertainty about policy actions and makes it easy for the public to forecast future actions and interpret actions of policy makers. Also policy rules are argued as providing a way to increase accountability of policy makers. Critics, however argue that a rule-based policy reduces the central banks ability to deal with unusual and unforeseen circumstances.

The opposite of a rule-based strategy is an approach based on discretion. In case of discretionary monetary policy, the policy makers make no public commitment to their objectives and retain the right to set monetary policy according to the policy makers' assessment of current conditions. The advocates of discretionary

approach argue that this kind of policy making preserves flexibility and enables the central banks respond to new information or unexpected developments. But advocates of rule-based policies point out that pure discretionary policies lack discipline inherent in a rule based policy, which may foster uncertainly in the public mind and increase the economy's tendency toward inflation. This distinction between rules and discretion has played a major role in debates about monetary policy over many decades. However, this contrast between rules and discretion is not quite clear. In practice, it is difficult to spot real world examples of a strict rule or absolute discretionary monetary policy having been adhered to by any country. For example, even the gold standard permitted moderate policy discretion in practice, particularly for countries with ample gold reserves. Moreover, the gold standard was routinely suspended during wars and other emergencies before it collapsed completely during the Great Depression. Recently, the fixed exchange rates of the European Monetary System (EMS) also did not remain fixed during the exchange rate crises of 1992 and 1993 when the official rates were altered or abandoned as central bankers reacted to changing conditions.

The discussion made above, however does not imply that monetary policy regimes are all discretionary. Discretion is defined in two ways. First, discretion may manifest itself as the relatively undisciplined approach, leading to policies that change with the personal views of the central bankers or with the direction of the political forces. Second, it may operate within a more clearly articulated framework, in which the general objectives and tactics of the policy makers, although not their specific actions are committed in advance. Such kind of framework is termed as 'constrained discretion' by Bernanke et al (1999).

In this context of rules verses discretion many economists have interpreted inflation targeting as a policy rule [see for example, Svensson (1997)]. However, Bernanke et al (1999) argue that inflation targeting cannot be treated as a policy rule in the classical sense. In practice the loss function used in inflation targeting also put some weight on the output gap or on the stability of the real economy in general. This form of inflation targeting is referred as flexible inflation targeting by Svensson (1996, 1999) There is now considerable agreement in the literature

that inflation targeting involves concern about real economic activity. Given that governments and central banks give importance to production employment and exchange rates and other variables, inflation targeting cannot be treated as ironclad rule. Also from the operational point of view, inflation targeting does not provide simple, mechanical operating instructions to the central bank. Rather it requires the central bank to use structural and judgmental models of the economy and takes into account whatever information it deems relevant to pursue price stability objective. Bernanke et al(1999) point out that inflation targeting is very much a look at everything strategy but are with a focused goal (pp 22).

Bernake et al. (1991) again point out that as implemented in practice, inflation targeting confers a considerable degree of discretion on policy makers. Indeed, inflation-targeting central banks maintain significant scope for applying discretion in the conduct of monetary policy, as the inflation targets typically need to be attained only over a multi year horizon and in may cases specified in terms of bands rather than point targets. Again as evidenced from the case studies of different inflation targeting countries inflation targeting central bankers, within the constraints imposed by their medium to long term inflation targets, have left themselves with considerable scope to respond to unemployment conditions, exchange rate fluctuations and other short run concerns.

Inflation targeting as practiced can be seen as combining a number of the advantages of the rules and discretion. Like rules the inflation-targeting framework enhances policy transparency. In inflation targeting, the policy makers are supposed to communicate and inform the public the policy objectives and plan actions of the monetary authorities to achieve the objective. This clarity in the policymaking makes the policy actions more transparent and hence credible. Inflation targets are also readily understood by the by the public and help keep the goal of price stability in view. The achievement of inflation targets convinces the public that low and stable inflation is the normal outcome and that deviations are likely to be transitory. Increased transparency in turn, increases the accountability of monetary policy makers to the public, thus making them less likely to engage in opportunistic behaviour in the short run. But it is also far more flexible than a simple rule as the inflation targeting central banks also give some importance to

the outcome of other goals. However, this flexibility does not permit the exercise of unbridled discretion by the central bank. The strategy of hitting an inflation target by using the inflation forecasting procedure, forces the policy makers to be forward looking rather than narrowly focused on current economic conditions. Further the increasing transparency of monetary policy works as a double-edged sword. As it does not allow the policy maker to engage in opportunistic behavior owing to political pressure, an increase in transparency also increases the central bank accountability, which in turn creates political pressures that prevent the central bank from ignoring the long run consequences of its actions. Thus inflation targeting as implemented can be characterized as a framework for conducting monetary policy rather than a specific policy rule within which constrained discretion can be exercised.

2.2 Rationale for Inflation Targeting

Although maintaining price stability was attributed to the central banks as early as in late eighteenth century, the importance pf price stability has grown significantly for both the central banks and the public since the high inflation days of 1970s. Price stability today is viewed as a pre condition for lasting economic growth. In case of inflation targeting the central bank makes explicit its precommitment to long run price stability. The inflation targetors' case for stressing long run price stability in formulating monetary policy rests on mainly the experiences of many countries in sixties and seventies with high inflation rate and subsequent theoretical developments. Particularly, the fading reputations of activist monetary policy and the increased understanding of the potential importance of central bank credibility to the effectiveness of monetary policy also have contributed tremendously to the use of inflation targeting. Milton Friedman's monetarist critic and his observations that monetary policy works with long and variable lags have downplayed the benefits of activist or discretionary policy. Friedman et al. (1963) argued that monetary policy, though have powerful effects on the economy cannot be used with precision as the effects set in only with lags that are long and variable. Hence he argued in favour of using monetary policy rules and more specifically maintenance of constant growth rate of money supply.

The case for monetary policy rules and against activism again strengthened with the rational expectation revolution in macroeconomics in early seventies. The introduction of rational expectations by Lucas led to rest the notion of a long run tradeoff between the rate of inflation and the rate of unemployment as first put forth by Friedman and Phelps. Friedman in 1967 Presidential address to the American Economic Association rejected the assumption that permanent reductions in unemployment could be achieved by accepting a higher level of inflation. However, he accepted the existence of a short run tradeoff between unemployment and inflation. He agreed that higher level of inflation might stimulate the economy and lower level of unemployment for shorter periods, because in the short run, given fixed wage, unexpected inflation implies an unexpected decline in the cost of production and hence increase in profit margins. This gives incentives to the firms to produce more. However, once workers realize that inflation has risen they will demand more wage increases to compensate for their lost purchasing power. As the rate of increase in wages begins to match the rate of increase in prices, the profit margin of the firms and hence their rate of production will return to normal level. As a result in the long run only the inflation has been increased because of expansionary monetary policy whereas outputs and unemployment hover around their natural rate. Experience with inflation and unemployment during seventies and eighties in the United States and many other countries conformed this view. For example, inflation in the US in 1950s was low and so also unemployment. In the sixties and seventies the inflation was high, unemployment, however was no lower than fifties. In nineties also inflation was low again and unemployment was not higher than seventies. Moreover, a non-existence of a long run tradeoff between inflation and unemployment does not mean that inflation does not have long run impacts on economic growth and efficiency. Friedman (1977) argues that this relationship goes in the wrong way. As he pointed out and the cross country evidence showed that countries with higher rate of inflation tend to have lower long run economic growth rates and high level of unemployment. Friedman also argued that and which is widely accepted that the economic costs of bringing down inflation is high and this increase the economic instability. Hence Friedman concluded that in the long run inflation rate is the only macroeconomic variable that monetary policy can affect

and this view is now accepted by most researchers. Similar arguments are also made by Phelps (1968) in his cost benefit analysis of inflation. In that the short run output and employment costs of bringing inflation down are compared to the long run benefits accruing from having a lower rather than a higher, stable and predictable inflation rate. He concluded that once inflation had embedded in the economy the welfare maximization policy would probably be to stabilize and to live with it.

Also, though it is agreed that monetary policy has short run important effects, the exact nature of their effects are not well understood. The reason is not only that the 'economics profession does not have a well tested quantitative model of the quarter to quarter dynamics, but there is also no basic agreement about the qualitative nature of the mechanism' (McCallum, 1997, Pp. 225). There exists a number of models of the economy such as real business cycle models, monetary models, NAIRU models and so on but to be made operational each of them has to be combined with capacity output. This again involves competing approaches and with several critical assumptions regarding the nature of different types of unobservable shocks and the time series processes generating them. Thus given the existence of a number of competing specifications regarding the precise nature of the connection between monetary policy actions and their real short-term consequences it is difficult to select the model that truly captures the impact of monetary policy. Consequently, a conclusion emerged the monetary policy strategies should be designed in a manner that is primarily concerned with their long run effects rather than the short run or temporary effects about which little is known. Since the long run effects are primarily price level or inflation rate effects, it is argued that monetary policy should be dedicated to the goal of achieving an inflation rate that is consistent with price stability.

The other reason for the use of inflation targeting arose out of the time inconsistency problem introduced by Kydland and Prescott (1977) which was later analyzed by Barro and Gordon (1983). The analysis assumes that aggregate output depends upon the unexpected component of monetary policy and the central bank's objective is to keep both inflation and output close to their target values. At any point of time it is argued that expectations regarding the policy will be given,

so that monetary conditions easier than previously expected would yield an output bonus whereas conditions tighter than expected would result in an output loss. Consequently, the optimal choice by the central bank will be a policy setting that reflects a compromise between the value that would yield inflation objective and some other setting that would be preferable because of its stimulating effects on output. But the same type of discretionary choice will be repeated period after period, so that rational agents would come to expect about this. This implies an average monetary conditions would be easy but not easier than expected and consequently there will be no output bonus realized even though a greater than desired inflation rate is generated. This is the problem of inflation bias. In the presence of short run tradeoff between inflation and unemployment in present day democracies, there is a tendency of politicians to over manipulate monetary policy in achieving short run benefits of growth and unemployment, as these variables are popular. However, though the central bank realizes it is behaving sub optimally but it cannot do nothing about this as it has no ability to pre commit its future policy actions. In order to eliminate the inflationary bias problem and not to succumb to political pressures, it is necessary for external constraints to be placed on the central banks. An inflation target, it is argued, provides a convenient vehicle for imposing such constraints.

Another motive to pursue long run price stability is that inflation is socially and economically costly. Fischer (1981) and Feldstein (1996) provide a detailed listing of economic costs of inflation. Among the cost of high inflation are: the over investment of resources in the financial sector which implies that resources are diverted from the productive sector to non-productive sector. The expansion of financial system that stems from rising inflation is vulnerable to crisis. Poor functioning of product and labour markets, the costs of re pricing, the distributional effects caused by inflation induced reduction in the real rates of return on saving are some other costs of inflation. Also, the desire for low inflation stems from various analytical and practical considerations such as although there is no necessary theoretical connection between average rates of inflation and prevailing levels of inflation variability and uncertainty, in practice it is evidently true that more variability occurs at high rates. It is also true that a

substantial fraction of individuals are confused by non zero inflation and so make sub optimal choice of various types.

In recent years there has emerged a consensus that even a low rate of inflation is harmful to economic growth. It is argued that the absence of complete indexation in all legal and contractual arrangements make inflation even at low level to have adverse effects on the economy and many have calculated the social costs of inflation at low rates (Bernanke et al, 1999; Fischer, 1994). Judson and Orphanides (1996) suggest that a greater unpredictability of price changes associated with inflation may significantly hamper economic growth even at low levels.

However, the increased emphasis on price stability does not absolutely justify the use of inflation targeting, though it has increased the receptivity of central bankers to inflation targeting as a strategy for monetary policy. The strongest argument for inflation targeting is instead, that it can help to provide monetary policy with a nominal anchor.

In the conduct of monetary policy, once a commitment has been made to price stability as the goal of monetary policy, there are several possible approaches to implement the goal. For many of these approaches, what guides monetary policy is an announced target. The procedure of targeting variables numerically has acquired general interest as it has become increasingly clear that an all too flexible conduct of monetary policy has led to very undesirable results. In general such flexibility is apt to accommodate inflationary price expectations in order to avoid temporary depressing effects of non accommodation and once the market figures this out, inflationary price expectation and cost trends tend to be steeper. There is therefore a growing awareness of the fact that price expectations and cost trends need to be anchored to a consistent course of demand policy. This implies that policy needs to target certain variables and the targeted variable can help to provide monetary policy with a nominal anchor. A nominal anchor may be defined as a constraint on the value of domestic money. It helps in increasing credibility by conveying the public the commitment to price stability and thereby locking inflation expectations. However, more broadly a nominal anchor can be

thought as a constraint on discretionary monetary policy that helps in reducing the time inconsistency problem so that in the long run, price stability is more likely to be achieved. A nominal anchor can take the form of a quantity constraint such as a limit imposed on the amount of paper money to be put into circulation, i.e. targeted growth rate for monetary aggregates or of price constraint which fixes the value of paper money in terms of some goods or assets, e.g., gold standard, exchange rate target *et cetera*. Though it is possible to conduct monetary policy without a nominal anchor, it has been found that monetary policy is most effective in the presence of a firmly established nominal anchor and the more understandable that anchor to the public the better. An effective commitment to price stability is just such a nominal anchor, since a target rate of inflation communicates to the public the price level the central bank is aiming to achieve a specified dates in the future. However, there are other nominal anchors such as intermediate targets that could also provide monetary policy with the same advantages. A discussion on the advantages and disadvantages of the major alternatives to inflation targeting is given below.

2.3 Intermediate Targeting Framework of Monetary Policy

The use of intermediate targets is based on two reasons. First since the structure of the economy is unknown, the exact effect of a policy cannot be obtained from the structure. However, the policy maker may be reasonably certain of the relationship between some observable endogenous variable and the goal variables. He then can use this information and choose the observable endogenous variable as a target variable and adjusts the instruments until this variable reaches its desired level. It is assumed that this desired level would be the one that is consistent with the goal variable reaching its desired level. Second since goal variable are observably only after considerable lag, the effect of policy will be seen only after the policy has been pursued for some time. However, during this period, occurrence of any exogenous changes may make the effect of the policy chosen very different from it otherwise would have been. It was argued that using an intermediate targeting procedure the policy maker can remove some of the uncertainties in the effect of policy on the goal variables. A basic question underlying any discussion on targeting is what are the conditions a variable should

satisfy to be a good target. For a target variable, to guide the monetary policy as described above must be (i) readily observable (ii) highly related to the goal variable. (iii) rapidly affected by the policy instruments. (iv) be easy to control. (v) highly visible or transparent to the public. In this respect, monetary aggregates, exchange rate, interest rate and nominal GDP are used as intermediate targets. All the targets have been used with success in some countries while meeting with failure in others. In this context it is useful to examine the advantages and drawbacks of the different targeting frameworks, to make out a case for inflation targeting.

(1) Exchange rate targeting

Exchange rate targeting is a monetary policy with long history. This is the one regime used by the largest number of countries especially small countries. It can take the form of fixing the value of the domestic currency to a commodity such as gold, which was a key feature of the gold standard. More recently fixing the value of the domestic currency relative to that of a low inflation country usually a major trading partner is one approach central banks have used to pursue price stability. The logic behind fixed exchange rate is that if exchange rate is maintained at a fixed value, then automatically the low inflation of the anchor country will be transmitted to the domestic country, given that the movements in real exchange rates are not too large. Another alternative is to adopt a crawling peg in which the exchange rate is allowed to depreciate at a fixed rate so that inflation rate in the pegging country is higher than that of a anchor country.

Exchange targeting has several advantages. One important advantage of exchange targeting is its simplicity and clarity that make it easily understood by the public.. As stressed by Melitz (1998), and Bruno (1993) it is also highly visible and observable on a daily basis. Also as an exchange rate target fixes the inflation rate for internationally traded goods and thus directly contributes to keeping inflation under control [Mishkin (1999)]. When credibility is maintained, an exchange rate target can lower inflation expectations to the level prevailing in the anchor country to whose currency it is pegged. Exchange rate targeting provides a rule for monetary policy which significantly constrains short run manipulation by the

policy makers and hence helps in reducing the time inconsistency problem. In practice, it obliges the policy makers to tighten the monetary policy when there is a tendency for the domestic currency to depreciate and loosening the policy when there is a tendency for the domestic currency to appreciate so that purely discretionary policies are not undertaken.

In view of these advantages, exchange rate targeting has been successfully implemented to control inflation in many industrialized countries. It has helped both France and UK, for example in keeping inflation low and at the same level of the anchor country Germany within a very short span. The UK was able to lower its inflation rate from 10% in 1990, the time when it pegged to the German Mark to merely 3% by 1992. Also in case of France, its inflation rate was at 3%, two percentage points above the Germany inflation rate in 1987, the year when France pegged its exchange rate to the German Mark. By 1992 its inflation rate had fallen to 2%, a level that is consistent with price stability and was even below that in Germany.

Exchange rate targeting has also helped the emerging market economies in reducing inflation quickly. A strong form of exchange rate peg, known as currency board which was established by Argentina in1991 to provide a means of controlling monetary policy is an important recent example of the usefulness of exchange rate targeting for emerging market economies. The currency board has a striking difference with the exchange rate peg. It requires the monetary authority to announce both a fixed exchange rate with a particular foreign currency and its willingness to trade the foreign and domestic currency at that rate in unlimited quantities. In order to credibly meet the demands, the authorities have to maintain high levels of reserves of the foreign currency, sometimes exceeding 100% of the domestic currency issue. This strategy helped Argentina to bring inflation down form hyperinflationary levels (i.e., 1000 percent annual rate) in 1989 and 1990 to under 5% by the end of 1994. Along with achieving low inflation, the country also experienced rapid economic growth, averaging almost an annual rate of 8% from 1991 to 1994.

Despite these inherent advantages of exchange rate targeting, experiences with fixed exchange rates, point to a number of drawbacks. A country under fixed exchange rate targeting surrenders control of its domestic monetary policy . It can not use the monetary policy to respond to shocks that are not felt by the anchor country. In this situation exchange rate pegs do not solve the problem of maintaining price stability rather they shift the problem of another country. This requires, the existence of a nominal anchor for the system as a whole. Furthermore, under an exchange rate targeting along with the low inflation of the anchor country, the shock to that country also gets transmitted to the domestic country. This was also the reason for the collapse of the Brentwood of fixed exchange rate in 1972. The system that emerged after the Second World War and survived until 1971, was a dollar standard which tied the monetary policies of the participants to that of the United States. That system collapsed when the monetary policy objectives of the United States began to differ significantly from those of Germany and other countries, just as the ERM are under extreme pressure In 1992 and 1993 when German monetary policy goals diverged from those of other members. These problems are experienced during the unification of Germany in 1990. The probable emergence of inflationary pressures made Germany to follow a tightening monetary policy and an expansionary fiscal policy was also needed to rebuild East Germany. These two policies led to an increase in interest rates. Those rates were transmitted through the exchange rates pegged to the Mark, to members of the Exchange Rate Mechanism (ERM). The continuance adherence to the exchange rate that resulted in slowing of economic growth and rising unemployment in France and other member countries of ERM.

An exchange rate targeting has the additional disadvantage of lack of accountability of the central bank under this regime. This can make it difficult to ascertain the policy stance taken by the central bank as occurred in Thailand before the currency crisis. Mishkin (1999) argues that due to this lack of the accountability of the central bank, the exchange rate peg instead of reducing the time inconsistency problem makes it more severe. He points out that indeed an exchange rate depreciation when the exchange rate is not pegged can provide an early warning signal that monetary policy is over-expansionary, and fear of

depreciation can make over expansionary, time inconsistency policy less likely. Another problem with exchange rate targeting as emphasized in Obstfeld and Rogoff (1995), McDonough (1997) and Mishkin (1999) is that in the environment of open global markets, fixed exchange rate are subject to sudden speculative attacks to their currencies, when markets perceive that domestic needs and exchange rate commitment diverse. The one aftermath of German reunification was the foreign exchange crisis of September 1992. These speculative attacks can be very disruptive to an country's economy. In case that the central bank finds itself with not so efficient strategies, either it can defend the peg by raising the interest rate or it can depreciate the currency. The former strategy is highly damaging to the economy as it increases the unemployment rate and declines the growth rate. Abandoning the peg is also destabilizing as it leads to an increase in inflation and increases the domestic value of debts denominated in foreign currencies. This was the situation both in Mexico and East Asia which lead to the Mexican crisis in 1994 and East Asian crisis in 1997.

It is very often argued that the emerging market economies would be better off by adopting an exchange rate targeting system. Because many emerging market countries are politically as well as institutionally have less ability to use discretionary monetary policy successfully, hence they may have little to gain from an independent monetary policy but a lot to lose. Indeed, this is one of the reasons that so many emerging market countries have adopted exchange rate targeting.

However, Mishkin (1998) argues that even for an emerging market economy this policy will be dangerous as it will lead to financial crisis. He argued that, because of the uncertainty about the future value of the domestic currency, may non-financial firms, banks and governments in emerging countries find it much easier to issue debt if it is denominated in foreign currencies. With debt contracts denominated in foreign currencies, as in emerging market economies, when there is a devaluation of the domestic currency, the debt burden of the firm increases. On the other hand, since assets are typically denominated in domestic currency, there is no simultaneous increase in the value of firm's assets. This results in deterioration in balance sheets and a decline in net worth both for non-financial

firms and financial firms which are now unable to collect on their loans to non financial firms. But in the most developed countries, devaluation has little direct effect on the balance sheets of households, firms and banks because their debts are denominated in domestic currency. In addition devaluation also can lead to a rise in both actual as well as expected inflation in emerging market countries due to lack of central bank credibility to price stability.

Another potential danger from an exchange rate target is that by providing a more stable value of the currency, it might lower perceived risk for foreign investors and thus encourages capital inflows. But in emerging market countries, with inadequate bank supervision which play a key role in intermediating those capital inflows the likely outcome of a lending boom is substantial loan looses and a deterioration of bank balance sheets. This makes a currency crisis more likely which can trigger a financial crisis as in East Asia and Mexico. These problems make exchange rate targeting in emerging market countries highly dangerous.

Given the above problems, a fixed exchange rate approach is effective when the country adopting it has an economy closely tied to the anchor country and is thus subject to similar shocks. This approach could also be worthwhile if a country's political and monetary institutions are particularly weak and is unable to make a credible commitment to price stability on a domestic basis alone. However, this requires that the country must have a large low inflation country whose currency can serve as the nominal anchor.

(2) Monetary Targeting

In the second half of the 1970's following the breaking down of the Bretton Woods system of fixed exchange rates, many countries adopted the monetary targeting approach to achieve price stability. Besides the breakdown of the Bretton Woods system, the other main reasons for the adoption of monetary targeting was the changing nature of the shocks affecting the economy, originating mainly in the goods market and the increasing difficulty in setting a target rate for inflation in conditions of high and variable rates of inflation. However, the intellectual roots of monetary targeting lie in Milton Friedman's monetarism. Friedman (1959) recommended that the bank should maintain a constant rate of money growth. In

practice however, no central bank adopted a Friedman type rule for determining money growth.

Under the monetary targeting strategy the central bank announces a target for the quantity of money in the coming year and tries to achieve that quantity which is consistent with the final goal of price stability. Both narrow as well as broad measures of money stock have been targeted in many countries. There are two conditions for the approach to be effective: first the central bank must be able to control the money supply and second, there must be a sufficiently stable relationship between money growth and inflation. Given these conditions satisfied, this framework offers a number of advantages like exchange rate targeting an announced monetary target is easily understood by the public. Monetary target has the additional advantage of focusing policy on a quantity that a central bank can control quickly, easily and directly. A major advantage of monetary targeting compared to exchange rate targeting is that it enables a central bank to adjust its monetary policy to domestic conditions. It permits the central bank to choose goals for inflation that may differ from those of other countries and allows some response to output fluctuations. Also like an exchange rate target, information on whether the central bank is achieving its target is known almost immediately which helps in sending immediate signals to both the public and markets about the stance of monetary policy and the intention of policy makers to keep inflation in check. These information on the stance of monetary policy helps in stabilizing inflation expectations and ultimately achieving price stability. Monetary targets also help to build credibility and accountability of central banks in keeping inflation low and constrain the policy makers from falling into the time inconsistency trap.

However, the above advantages of monetary targeting are totally dependent on the existence of a reliable relationship between money growth and inflation rate. If there is a fluctuation in the velocity, then, the relationship between the monetary aggregate and the goal variable becomes unstable. The instability in the relationship implies that the monetary targeting will not bring out the desired result as hitting the target will not produce the desired outcome on the goal variable and thus the monetary aggregate will no longer provide an adequate

signal about the stance of monetary policy. Thus in presence of instability in the money demand function, monetary targeting will not help in tie down inflation expectations and be a good guide for assessing the accountability of the central bank. The break down of the stable relationship between the monetary aggregate and the inflation rate caused the abandonment of monetary targeting by many countries in the 1980s. The reasons for velocity instability are attributed the rapid financial innovations, deregulation and other changes in the banking system. In case of the frequency of velocity shifts, a monetary targeting central bank must either revise or miss its targets or alternatively must accept extremely poor outcome for its goal variables.

This approach, however, is successfully maintained by Germany, which was the first to adopt it in 1974. Over the years the Bundesbank has formulated and presented the rule with varying degrees of stringency but it has never abandoned it. Similarly, the other country that is also equally successful in implementing monetary targeting is Switzerland. Both the countries have been able to maintain price stability by implementing this strategy. The success of monetary policy in these two countries in controlling inflation is the reason that monetary targeting still has advocates. However, it is vigorously argued that the implementation of monetary targeting in Germany and Switzerland are very far from a typical monetary targeting regime. Many observers have also cited that many features of the Germany and Swiss monetary regimes, in fact refer to the features of inflation targeting (Bernanke, 1999). This will be evident through a discussion on the monetary targeting as practiced by these two countries and at the same time the experience could provide useful lessons for the central banks trying to achieve price stability by pursuing inflation targeting.

Germany

Freed from the external constraints of the Bretton Woods system of fixed exchange rate, Germany in late 1974 adopted and announced a monetary target for 1975. From 1975 to 1987 the Bundesbank announced targeted growth rate of Central Bank Money (CBM). However, since 1988 the Bundesbank is using the growth rate of M3 rather than CBM as an intermediate target. The Bundesbank

has always set the monetary target for the next year at the end of the current year. The derivation of the monetary target is based on the quantity theory of money and the target growth rate for the chosen monetary aggregate (either CBM or M3) is derived by estimating the growth of expected long run potential output, adding the rate of unavoidable increase in prices and subtracting the change in trend velocity over the year. The concept of unavoidable price increase measures prices according to the consumer price index (CPI) was adopted till 1984 in view of the prevailing high inflation. The Bundesbank did not try to bring down the inflation immediately but it pursued a gradualist approach. However, "once price stability was virtually achieved at the end of 1984, the Bundesbank abandoned the concept of unavoidable price increases. Instead, it has since then included a medium term price assumption of 2%" (Deutsche Bundesbank, 1995c, Pp. 80-81). This figure has been reduced to one-half percent to two percent since 1997. However, "this figure should not be regarded as the optimum inflation rate, but as the maximum rise in prices which can be tolerated" (Schmid, 1999, Pp. 10).

The target set for 1975 was a target for CBM growth from December 1974 to December 1975. From 1976 to 1978, the Bundesbank also formulated the money stock target in the form of annual average. However, in 1979 Bundesbank reformulated the target as growth rates of the average money stock to a four-quarter target starting from the fourth quarter of the previous year to the same in current year. This indicates, "the direction in which policy is aiming more accurately than an average target does" (Deutsche Bundesbank, 1979b, Pp. 8). The other operational feature of the Bundesbank's monetary targeting is that, it started with setting point targets for 1975 and continued with it till 1979. But with then exception of 1989, the money stock target has been expressed in terms of a target range of 2% to 3% since 1979. This seems appropriate since it would give the Bundesbank some flexibility to respond to other economic developments. On the other hand, setting targets in a range can create problems of credibility and the damage to it caused by missing a target range is more than missing a point target. However, the Bundesbank for that reason has sometimes specified during the year whether it intends to aim more towards the upper end or towards the lower end of the range. Coming to the controllability of the aggregates, the Bundesbank uses

the two-step implementation procedure of controlling short-term money market rates and bank reserves to achieve annual monetary targets.

The survey of Bundesbank's monetary policy since 1975 suggests that it on occasions, deliberately allowed deviations from the announced target path to occur in order to support the other economic objectives. "However, the fact that the Bundesbank deliberately accepted the risk of a major divergence from its quantitative money target does not imply that it abandoned the more medium term orientation which has marked its policies since 1975 ... There may be periods in which the pursuit of an 'intermediate target variable' as reflected in the announced growth rate of the central bank money stock cannot be given priority" (Deutsche Bundesbank, 1978a, Pp. 22). During the monetary targeting period, the Bundesbank either overshot or undershot its annual monetary aggregates approximately half the time. Since 1975, only 12 of 23 money stock targets have been attained. But in the initial stages of experimentation the ratio of target misses was high followed by a relatively long period in which targets met the specified level. However, the Bundesbank faced some difficulties in the late 1980s and 90s following the increasing globalization of the financial markets and financial innovations. Also a number of domestic factors such as German unification resulted in major fluctuations in money growth.

Notwithstanding the difficulties in controlling the monetary aggregate and missing the targets, the Bundesbank has been successful in maintaining low inflation In view of the difficulties in controlling M3, the Bundesbank has focused more on the long-term relationships. Furthermore, it analyzes other monetary aggregates, besides the intermediate target variables. More recently, it has also begun to reports on 'extended money stock M3' a broader aggregate, which also includes other forms of money market accounts such as holding in the Euro market in the short-term bank bonds and in the money market bonds. In addition to this, the Bundesbank also monitors that may provide early indications of inflationary pressure. "On the whole, the Bundesbank's response function is thus not determined solely by the moments of the money stock M3 but also by a multitude of additional information and control variables" (Schmidt, 1999, Pp 14) However, the Bundesbank's success has also been supplemented by the stable

money demand function which is more stable in Germany than in other countries which adopted monetary targeting. It has attributed the success to the earlier deregulations of financial markets, to the lack of inflationary or regulatory inducements for financial firms to pursue innovation.

The experience, thus suggests that the main concern of the Bundesbank is to achieve the ultimate target of price stability and not to bother about attaining the intermediate targets as such. This attitude has brought the name for the Bundesbank as pursing as an explicit monetary targeting with an implicit inflation targeting.

Switzerland

The shift to a floating exchange rate enabled the Swiss National Bank (SNB) to pursue an autonomous monetary policy to control inflation. With the fixed exchange rate abandoned, it adopted the target growth rate for money supply as the nominal anchor of monetary policy. At the end of 1974, it publicly announced a target for the growth rate of narrow money stock, M1 over the following year and continued with it until 1978. The pressure on the appreciation of the Swiss franc led to the rejection of monetary targeting in 1979. However, at the end of the year it returned to monetary targeting but substituted the target variable of M1 with monetary base as it considered the monetary base to more stable and less interest elastic than M1. At the end of 1990, once again it changed its targeting procedure by replacing the annual growth target for the monetary base with a medium term expansion path but without specifying the time horizon of the target However, at the end of 1994, the bank announced that the growth objective of monetary base applied to a 5-year rather than a 1-year period.

The SNB has repeatedly emphasized that maintaining price stability is the primary goal of its monetary policy as "the primacy of price stability also finds expression in the bank's decision to allow a monetary target to be undershot or overshot when a conflict arises between adhering to the target and marinating price stability" (Bernanke et al., 1999, Pp. 64). The aim of the SNB during the period of M1 target was to reduce the annual growth of M1 gradually to 2 to 3% per year. After changing to monetary base, the SNB determined the growth rate of monetary base

at 2% per year. The SNB derives the target growth rate from the implicit inflation objective of 1% and the expected potential growth of GDP. The formulation of monetary targeting in Switzerland shows that the SNB has always adhered to a point target rather than a target range and the instruments used to control the growth of M1 from 1975 to 1978 was the monetary base. The monetary targeting pursued by SNB also differs from a monetary target proposed by the monetarists as is based on a rule with feedback. This is evidenced as it occasionally departed from the targeted growth rate of the monetary aggregate in response to unexpected disturbances.

The other important feature of Swiss monetary policy is that the bank's regular announcement of targets has served as a communication device to the public. The SNB has made it clear that in the short run the main purpose of monetary target is to convey the policy intentions and objectives to the public given the possibility of deviations from the target. However, similar to the case of Germany, notwithstanding that the target misses, the SNB has been able to maintain a low level of inflation.

The experience of Germany and Switzerland with monetary targeting suggests two lessons that may be applicable to any targeting regime in which an inflation goal plays a prominent role. First, inflation can be controlled in the long run even when the authorities permit target misses in response to short-term objectives. Indeed, the approaches of both countries to monetary targeting represent significant departure from a typical monetary targeting that is based on rigid policy rule in the classical sense. Second, a key element of the successful targeting regime is a strong commitment to transparency and flexibility. When a conflict arises between inflation rate and growth rate of money supply these monetary targeting countries, in particular Germany always try to achieve the inflation target instead of money growth rate. To this, Bernanake and Mishkin (1997) suggested that Germany and Switzerland might best be thought of as hybrid inflation targeters and monetary targeters rather than as strict adherents to a money targeting rule.

(3) Interest Rate Targeting

Targeting interest rate is another monetary policy strategy that was adopted for some time following the abandonment of the monetary targeting strategy, Interest rate targeting is justified on the ground that cutting down interest rate will help in increasing the investment and hence revival of the real sector. Several papers have analyzed the rationale of interest rate targeting. But the analysis was done by making the real GDP as the final objective. The most standard framework for comparing alternative monetary instruments in terms of their variability of income is the ISLM framework. Poole (1970), Waud (1973), Sellon and Teigen (1971), Halbrook and Shapiro (1970), and Cacy (1978) all have tried to explore the effectiveness of different targets within the context of simple IS-LM framework. All the papers found out that the choice of the target depends on the relative stability of the real (IS) and monetary (LM) sector of the economy. They all concluded that if the monetary sector (LM) is sufficiently stable the money supply target should be preferred over other targets. But if it is the real sector (IS) which is stable and the money demand function is subject to random shocks then an interest rate target is preferred to a monetary target. However, they recommended for a combination policy as in general, there will be stochastic disturbances to both the real and monetary sectors of the economy.

While adopting the non-discretionary monetary policy rule in mid 70's interest rate rule lost to monetary rule in the monetary framework of developed economies which pursued active anti inflationary policies. This strategy was adopted in the light of the stable money demand function at that time. However, by the mid 80's the money demand functions in several industrial economies had become unstable. This greater instability in the money demand function implies that the interest rate rule is a more preferable option to the money growth rule]. But theoretically it is argued as in Wicksell (1901), Sargent and Wallace (1975), that with interest targeting, the price level would be indeterminate, as freeing control over money supply can lead to ever accelerating level of inflation under rational expectations Wicksell (1901) argued that if one is concerned with price level stability and if expectations are rational a money supply rule gives a determinate course for the price level where interest rate rule leads to indeterminate price

level Under an interest rate rule, the public expects that the authorities will supply whatever nominal money stock is required to maintain the interest rate. Hence any exogenous shock to price level will be matched by money supply fluctuations to make the price level equilibrium one. Sargent and Wallace (1975) while reinforcing the conclusions of Wicksell also added that such indeterminacy can be addressed by specifying an initial level of money stock. It has also been argued that for setting an interest rate rule but associating it with the attainment of a target rate of the money supply. McCallum (1981) similarly pointed out the possibility that a target for the interest rate may be a viable monetary policy rule provided that interest rate rule is in some way connected with the behavior of money supply. He concluded that, merely, by including the money supply somewhere in the specification of the policy, one could avoid the indeterminacy result Under such an interest rate feedback rule, the price level is determinate regardless of how small a weight placed upon the money supply.

In general open market operations is an effective instrument to target the interest rate. Broadly the open market operation is conducted in two different ways. First, the monetary authority decides the desired level of stock of the securities they prefer to hold. In this process money supply is targeted Second, the authority decides the price at which it buys whatever is supplied and sells whatever the market needs. In this process interest rate is being targeted whereas the stock of the securities held is determined by the liquidity position in the market. Hence the success of the interest rate targeting depends on the willingness of the market to buy the securities at the price fixed by the central bank. Also interest rate targeting can help in reviving the real sector when the investment expenditure is interest elastic. Interest rate targeting cannot be effective in bringing the price stability if demand for money is interest elastic. Otherwise any measures to bring down the interest will result in larger volumes of liquidity fuelling inflation. Further interest rate targeting is possible when the economic agents expect prices to be stable in the future. In case of inflationary or deflationary expectations targeting nominal interest rate can give conflicting indications of the stance of the monetary policy. Friedman and other economists have long recognized this In this situation it can be a misleading indicator to characterize the monetary policy as tight or easy. For

example, take the case of USA during 1970's. During 1970's USA experienced a period of high inflation along with a high level of nominal interest rate. During most of the decade the Fed implemented monetary policy by targeting federal funds rate. As inflation accelerated and market interest rate rose, the Fed followed suit by raising its federal funds rate target. This policy action was interpreted as a substantial tightening of monetary policy. Despite sharply higher interest rates however, the growth rate of monetary aggregates and inflation rate increased Hence by money growth measures, the monetary policy was becoming easier not lighter.

This conflict is also often more apparent during periods of extreme economic distress as inflation expectations and the growth of real economic activity influence the level of interest rates. If expected inflation declines or economic activity slows down, nominal interest rate lend to fall unless the central bank attempts to offset these forces If the central bank desires to maintain the interest rate target, it must drain reserves from the banking system, which would result in a slowing of monetary growth Central banks usually lower their interest rate target when economic weakness or disinflation put downward pressure on interest rates. But unless central bank lowers its targets sufficiently, the growth of bank reserve sand and money stock could decline. In such circumstances, the behavior of interest rates and the growth of monetary targets can give conflicting signals. The reduction of the target rate suggests that the policy has eased whereas a slowing of the growth of reserves the money stock suggests policy has tightened.

The successful implementation targeting also depends on a number of conditions such as a fair degree of financial market integration so that a rate of interest rate that can represent the market can be evolved, an accurate idea of the elasticity of response of real magnitudes to interest rate changes, an adequate control over inflation and inflation expectations and a sustainable fiscal policy.

During the mid 80's, a number of countries tended to move in the direction of interest rate targeting. US which stopped using monetary targeting following the instability of the money demand function since 1994 is targeting the federal funds rate. Like US, Japan also had the interest rate targets its daily operating target

while also using monetary aggregate (M2 + CDs) as a medium term intermediate target. However with persistent deflation and negative output growth, as the stance of monetary policy becomes unclear, in March 2001 the bank of Japan abandoned interest rate targeting and adopted an explicit monetary targeting with an explicit target for reserve growth.

(4) Nominal GDP Targeting

As an alternative to monetary or interest rate targeting, several economists have proposed that central bank should target the growth rate of nominal GDP [see for example, Taylor (1985), Hall and Mankiw (1994), MaCallum (1997)] If nominal GDP growth rate were kept close to a target value equal to the expected long term average growth rate of real GDP, it was argued that, inflation in terms of the GDP deflator would be kept close to its desired level With a nominal GDP target, a decline in projected real output growth would automatically imply an increase in central bank's inflation target which would tend to be stabilizing, because it would automatically lead to an easier monetary policy Ceccchetti (1995) also suggested that attempting to stabilize nominal GDP growth should give better overall economic outcomes than targeting inflation would in part because of the difficulty in forecasting inflation This happens because long run growth rate are independent of monetary conditions and are predictable with high accuracy over a period. It was also argued in MaCallum (1997) that since prices of goods and services are widely believed to react more slowly than output in response to monetary action, cyclical and dynamic instability are more likely to occur with a price level an inflation target. In other words, the problem of "instrument instability" which would render the targeting attempt entirely unsuccessful is intensified. He preferred for a nominal GDP targeting if inflation control is not the sole concern of monetary policy.

However, an often expressed objection to GDP targeting is that national income statistics are not produced often enough quickly enough and are significantly revised after the first release. Also having a nominal GDP requires an estimate of the potential real GDP growth But it raises some difficult technical issues, as estimates of potential GDP growth are far from precise. From a political

perspective, announcing a value of expected growth in potential real GDP is also problematic. A lower estimate of potential growth may lead to the accusation that the central bank or the government is pessimistic and not trying to maximize the potential of the economy; whereas a high estimate can lead to expansionary and consequently inflationary policies. Most importantly, the concept of nominal GDP is not properly understood by the public and can easily be confused with real GDP. Hence it is most unlikely that communication would be better served by using a nominal GDP. This type of policy regime, however has got no serious consideration in practice.

The above discussion implies that the success of intermediate targeting procedures depends on reliability of the relationship between the intermediate target variable and the goal variable. Moreover, this relationship should be visible and understandable by the public agents But as we have seen this requisites are missing in the intermediate targeting procedures. Hence, the achievement of the intermediate target will not have the desired effect on the goal variable. Therefore, it was argued that the goal variable should directly be targeted and thus subsequently inflation targeting was introduced in the early nineties to provide monetary policy with a nominal anchor. Also, being focused on the final goal of monetary policy, inflation targeting simply happens to be the most direct and obvious means for establishing the anchor. This is particularly important when the relation between money and prices is relatively unstable. The other advantages of inflation targeting are its transparency to the public. The commitment to price stability is made clear in policy terms and helps avoid the inflation bias problem. Along with this long term commitment to price stability, it also provides monetary policy with the necessary flexibility to respond to economic needs in the short run. This approach has been adopted by a number of central banks over the past several years and they are able to maintain price stability which will be evident from this study in the subsequent chapter.

The adoption of inflation targeting in many countries is associated with the institutionalization the price stability as the primary long run goal of monetary policy. This raises the question of what exactly price stability implies in practical terms. In this regard, in the literature, price stability has been interpreted in

different ways. For example, Greenspan had defined that price stability exists when inflation is not a consideration in household and business decisions. This definition of Greenspan is consistent with price level stability, that is a stationary price level with low variance. But in practice it has often been interpreted as low and stable inflation. Given the differences in the definitions of the price level, there is a ongoing debate over whether targeting should be of the inflation rate peg or of the price level. A monetary policy regime is defined as price level targeting or inflation targeting depending upon whether the goal is a stable price level or a low and stable inflation rate.

In the real world there are currently several monetary policy regimes with explicit or implicit inflation targeting but there are no regimes with explicit or implicit price level targeting. Sweden during the 1930's may so far be the only regime in history with explicit price level targeting [Jonung (1979)]. Not withstanding the fact that there are no current examples of price level target regimes, price level targeting has received increasing interest in the monetary policy literature and several recent papers compare inflation targeting and price level targeting [Duguay (1994)].An emerging conclusion of these papers in that the choice between price level targeting and inflation targeting involves a trade off between low frequency price level variability on the one hand and high frequency inflation and out put variability on the other. Thus the advantages of price level targeting are reduced long-term variability of the price level. Also a targeted price level need not imply a constant price level. The targeted level could be allowed to drift upward over time. analogous to a crawling peg for the exchange rate. [Goodhart and Vinals (1994), Svensson (1996)

However, though the low variability of price level is beneficial to long term nominal contracts and inter temporal decisions but it covers at the cost of increased short term variability of inflation and output. Because strict price level targeting requires that overshoots or undershoots of the targets be fully made up that is higher than average inflation must be succeeded by lower than average inflation. These results in higher inflation variability and through nominal rigidities, this higher inflation variability makes the output more variable. In particular these might have to be periods of deflation to compensate for periods of

inflation greater than the target. The disadvantages of inflation targeting is that unanticipated shocks to the price level may be treated as bygones and never offset. As a result Long-term forecasts of the price level might show a large variance that could distort private sector planning. But given the cost of inflation and output variability under price level targeting, in practice central bank set inflation rather than price level targets but tend to compensate partially for target misses at short term horizon.

2.4 Concluding Remarks

To sum up, the roles of inflation targeting can be viewed as a nominal anchor, which provides a framework for conducting monetary policy. However on a practical plane the adoption of inflation targets can be viewed as meant to fill the gap left by the abandonment of intermediate targets motivated in turn by their inadequacies in achieving price stability. Inflation targeting on the other hand by linking policy to medium and long-term horizons but without reducing the central banks ability to respond to short run developments, creates a compromise between the discipline and accountability of rigid rules and the flexibility of the discretionary approach

Chapter III

Inflation Targeting: Issues, Evidences and Case for India

3.0. Introduction

The absence of a long run tradeoff between inflation and output and the inadequacies of intermediate targets in maintaining price stability provided the required background for the central banks to choose a target for inflation in the early 1990s Since then inflation targeting has gained considerable popularity among the monetary economists and central bankers. It has been argued that inflation targeting encourages both public and policy makers to focus on what monetary policy can achieve in the long run. At the same time the move towards inflation targeting is seen as a way to improving the record of controlling inflation and to make monetary policies more transparent and accountable. In practice, inflation target is to serve as a means of explaining to the public, the costs of an expansionary monetary policy and the need to pre-empt any inflationary pressures

This chapter examines whether this policy can be applied in India. However, before reaching any conclusions. it is first necessary to consider a conceptual framework to understand inflation targeting. Also the experience of countries suggests that the benefits of inflation targeting to a great extent depend on the details of its implementation. Hence we have discussed the operational issues involved in inflation targeting by looking at the arrangements in various countries

The scheme of the chapter is as follows. Section 3.1 provides the framework for inflation targeting followed by experiences of economies with inflation targeting in section 3.2. In section 3.3 a discussion on operational issues involved is made. Section 3.4 goes to discuss on pros and cons of inflation targeting In section 3.5 we examine the case for developing countries followed by the discussion on

current monetary policy framework and the feasibility of inflation targeting in India in section 3.6. Section 3.7 gives the concluding remarks.

3.1 Inflation Targeting Framework

Inflation targeting as a strategy of monetary policy to achieve price stability is currently receiving considerable attention. It is described as a framework in which the central bank (i) makes an institutional commitment to price stability as the primary, long run goal of monetary policy and to achievement of the inflation goal; (ii) makes a public announcement of an explicit quantitative inflation target; (iii) uses an information inclusive strategy with a reduced role of intermediate targets such as money growth: (iv) exercises the freedom to choose the means to pursue the target; (v) is accountable to reaching its goal; and (vi) try to make the monetary policy strategy more transparent through the communication with public and markets about the plans and objectives of monetary policy makers. Some of these important characteristics are discussed below.

An Explicit Quantitative Inflation Target: The main feature of an inflation targeting framework, is that, the authorities announce an inflation target or more typically a target range for future inflation that is consistent with the ultimate policy objective of price stability. Any other goal can only be pursued to the extent that is consistent with inflation target. The authority announces its intention to hold inflation in the future within the specified range, possibly with some additional escape clauses for pre-announced contingencies. Any contingency in this case allows for price changes outside of the announcement range resulting from shocks to the economy.

Instrument Independence of Central Bank: Another important element of an inflation targeting framework is that central bank is given a clear mandate to concentrate on achieving an explicit inflation target as the overriding objectives of monetary policy. Given that short run manipulation of monetary policy is counter productive in terms of increasing inflation with no benefits in terms of employment or output to compensate, there are good reasons notably insulation from short run pressures for the central bank to have some degree of independence, and there is indeed a world wide trend toward increased

independence for the central banks This trend is supported by academic literature that holds that economies with independent central banks enjoy lower rates of inflation than other countries, with no higher volatility in employment and output [Alesina and Summers (1993)]. However, though arguments that central bank independence is an important institutional device for assuring price stability has recently gathered remarkable momentum, the practical economic arguments for central bank independence coexists with the conjecture that government policies should be made democratically. In the context of a conflict between the need for central bank independence on the one hand and the regard for democratic principles on the other, it is useful to follow the distinction made by Fischer (1994), and Debelle and Fischer (1994) between goal independence and instrument independence of the central bank. A goal independent central bank is one that is free to set the objectives of monetary policy. Under instrument independence, policy goals are set by the government alone or by the government in consultation with the central bank In this kind of arrangement the central bank is solely responsible and free to set the instruments of monetary policy, such as the interest rate needed to achieve those goals.

It is very often argued that instrument independence would be more likely to minimize short run political interference and maximize central bank accountability while still leaving the ultimate goals of policy to be determined by democratic processes. Because ultimately policy objectives in a democracy must reflect the popular will they should be set by the elected representatives. Consequently, it is argued that in a democracy the central bank should not exercise goal independence. However, it is pointed out that since the central bank has the best information and expertise on how to go about achieving the policy objectives, it should be free to choose the settings of the instruments needed to achieve the policy objectives. Hence for efficient and accountable policy making, the central bank should enjoy instrument independence. Inflation targeting as practiced in the real world is fully compatible with instrument independence of the central bank. In the inflation-targeting framework, the central bank is fully accountable to the government who in turn have primary responsibility for setting the goals of monetary policy. At the same time the inflation-targeting framework

ensures that the objectives set by the government are feasible and that they are considered within the appropriate long run perspective. So, for example this framework requires the government to choose objectives for the long run inflation rate rather than for, say the long run unemployment rate. Finally, under inflation targeting the short term operational decisions belong solely to the central bank as must be the case if it is to be accountable for achieving its assigned objectives. Thus, inflation targeting promotes instrument independence for the central bank. But the degree of independence enjoyed by the central banks varies a quite a bit in practice. Some central banks such as Bundesbank, command significant goal independence as well as instrument independence. Where as in Canada, in contrast the government retains some control over even the settings of monetary policy.

Use of Conditional Inflation Forecast Targeting: Along with the advantage of inflation targeting being focused on the final objective, it also faces some serious problems with regard to both its monitoring and implementation. Inflation targeting may be difficult to implement because of the imperfect control of the monetary authorities over inflation due to variable lags in transmission mechanism. Normally current inflation is determined by previous decisions and contracts of firms and households, which implies that current monetary policy actions can only affect the future levels of inflation. This long and variable lags in the effect of monetary policy on future inflation makes decisions on current instrument setting quite difficult. Again inflation is also affected by factors other than monetary policy, in particular disturbances that occur within the control lag between the instrument change and the resulting effect on inflation.

This imperfect control over inflation makes monitoring and evaluation of the monetary policy by the public inherently difficult, since it is hard to extract how much of observed inflation is due to monetary policy some two years ago rather than to shocks and other factors those have occurred during the control lag. With monitoring made difficult the accountability and transparency of inflation targeting is reduced, and many potential benefits of inflation targeting may not materialize.

In Svensson (1997), it is argued that use of a conditional forecast of inflation can provide a solution to this problem and effectively functions as an intermediate target. He argues that inflation forecast satisfies the characteristics of a good intermediate target as it is highly correlated with the goal variable, easier to observe and hence transparent. From an operational point of view, inflation targeting therefore can be seen as a two step process in which the monetary authority first makes an inflation forecast to assess whether, under current policies, inflation is likely to remain within the announced target range. The second step is needed when the inflation forecast over the appropriate horizon judged is likely to differ from the target. This requires the change in policy stance of monetary authorities. In this instance a feedback rule that links policy actions to projected inflation is used to determine a path for monetary policy instruments that will bring the projected inflation rate to the announced target.

However, unlike the monetary targeting procedure, where only the stability of the money demand function is used to form the inflation forecast, inflation targeting framework requires that all relevant information relating to inflation forecast is used in conducting monetary policy. It also implies that there is no explicit rule, that is, in other words, the current instrument setting is not a prescribed explicit function of current information. Instead it depends on much more information i.e. on anything that goes to affect the central bank's conditional inflation forecasts. In case of an open economy the reaction function also depends on the foreign variables, for instance, other countries inflation, output and interest rates since these variables also have some effects on the domestic inflation.

The most common early criticism of inflation targeting using inflation forecasts as an intermediate target variable was that it was backward looking that by feeding back from actual inflation in the past, monetary policy was driving the economy to destabilizing and inflationary situations. However, in practice the monetary authorities in inflation target countries feed back from expected rather than actual inflation. This type of policy setting behavior makes inflation targeting forward looking in nature.

Because inflation targeting involves feeding back from the expectations of future inflation, it requires the identification of a set of indicators that contain information on future inflation. Also forecast targeting requires that central bank have a view of what the policy multipliers are, that is, how interest rate adjustments affect the conditional inflation forecast. However, Svensson (1999) argues that it does not imply that forecasts must be exclusively model based. Instead it allows for extra model information and judgmental adjustments in forming the inflation of forecasts. In general any information that is relevant for inflation forecast is looked upon. Von Hagen (1998) emphasizes that an intermediate target provides a focal point in the monetary policy discussion and defines the admissible arguments in monetary policy decisions. Hence the advantage of relying on conditional inflation forecast is that this induces some discipline while applying judgments and extra model information. The use of conditional forecasts, therefore renders some discretionary powers on the central banks that help the central banks in responding to new information but at the same time helps in maintaining credibility.

Accountability and Transparency: The practice of inflation targeting regimes is characterized by a high degree of transparency and accountability. Transparency measures are an important part of the inflation targeting policy framework since given the rates of inflation targets to provide an anchor or coordinating device for inflation expectations, the success of inflation targeting also depends in part on whether private agents accept the officially announced target. As discussed above, inflation targeting leaves scope for the policy discretion and this freedom could tempt the monetary authorities to raise output in the short run through the expansionary policies which makes inflation targeting approach neither credible nor enforceable. However, the inflation targeting countries have undertaken credibility enhancing measures such as transparency and accountability. Increased transparency of the policy objectives and actions helps in increasing credibility of the central bank. By being clearer and more explicit about its goal, methods of operations and interpretations of economic developments the central bank can increase the understanding by the market and the public of its objectives and its tactical actions and reduce the likelihood of an unfavorable response to its actions.

Freedman (1996) opines "transparency can be thought of as a bridge to credibility, where the later is not yet built up or as a support to credibility where it already exists" (Pp. 276). There are a number of benefits of transparent policies. Transparency about the objective of price stability can help long-term savers and investors plan their behaviour on the basis of the commitment by the central bank to stable prices in the long run. Clearer explanations by the central bank of the benefits of price stability will also help build public support for the objective. Transparency with respect to the views of the monetary authorities regarding the transmission mechanism and the economic situation is likely to result in the market having better understanding of the tactics which the central bank is using and why it is changing the actions in case of any contingencies. Svensson (1999) summarizes the above discussion as transparency facilitates public understanding of monetary policy and also allows the private sector to infer the central bank's actions with greater precision and this makes the private sectors inflationary expectations more sensitive to the bank actions. This in turn increases the cost for the central bank deviating from the announced inflation target. Hence increased transparency, it is argued, increases the incentives for the central banks to pursue the announced goals for monetary policy and thereby to improve the credibility of the central bank.

Central banks pursuing inflation targeting have recognized that regular communication with the public would increase transparency. The central banks in targeting countries communicate in a variety of ways. They have frequent communication with the government, some required by law and some in response to informal inquiries, speeches by senior officials, publish regular reports explaining and motivating their policy to the public. Through these channels of communication central banks provide the general public and financial market participants comprehensive information on inflation prospects, central banks' plans and objectives, the reasons for deviation from the targets et cetera. The central banks also explain the technical details such as determinants of numerical values for the targets and construction of inflation forecasting models. These efforts by the central banks to improve transparency and communications have been crucial to the success of the targeting regimes.

Transparency and communication together enhance accountability of the central bank. If the central bank receives independence over the setting of instruments of monetary policy, the target setter can call the central bank to account for any misses. The bank's accountability is assured under inflation targeting by announcing the central bank's conditional inflation and output forecasts which allows outsiders to monitor and scrutinize the conditional forecast, both with regard to their being consistent with the inflation target and their having been constructed in a professional and unbiased manner for example by comparison with reputable outsiders competing forecasts. Also the central banks obligation to provide the public with the convincing rationales for the policy choices they make increases the accountability of the central banks.

High level of accountability has been evident in the majority of inflation targeting countries. The inability of inflation targeting central banks to deny the outcome of the inflation figures, thus forces the central banks to live or die by their success in hitting the target, none more so than in New Zealand, where the government and the central bank sign a formal agreement setting out the objectives of policy and the government has the right to dismiss the Reserve Bank governor if the inflation targets are breached. However, in other countries the central banks accountability is less formalized. In sum, transparency and more open communications can be very helpful in building up credibility and in obtaining the desired outcome from policy actions. With transparency and accountability, inflation targeting can help to bring discipline in the monetary policy and makes it more effective.

Building on the above discussions inflation targeting is seen as a framework capable of improving the design, implementation and actual performance of monetary policy compared to the conventional procedures followed by the central banks. It does so by providing a vehicle that is consistent with a number of recent analytical developments in the area of monetary economics such as the importance of credibility and central bank independence. Also it appears to be a commitment to a systematic and rational monetary policy to a greater extent than any other monetary policy regimes so far. This is because (a) the loss function is explicit, (b) use of conditional inflation forecast that is based on more information.

(c) the high degree of transparency and accountability associated with inflation targeting. Thus inflation targeting can be described as a framework creating mechanisms for commitment to stable loss function, with transparency about it and the decision framework as crucial ingredients.

3.2. Inflation Targeting Arrangements - Country Experiences

The realizations of the potential benefits of inflation targeting as a strategy of monetary policy, however depend on how effectively the strategy is designed and implemented. But the adoption of inflation targeting has not been much influenced by academic discussion as in the case of monetary targeting. While inflation targeting is obviously a manifestation of the principle of long run neutrality of money there is paucity of literature on operating monetary policy with explicit inflation targets compared with discussion on monetary targets and exchange rate targets. Hence, an attempt is made to observe the working of the strategy in practice on a case study approach. A formal statistical analysis of the impact of inflation targeting is not a viable option due to the fact that most of the national experiences with this approach are short, i.e., ten or so years at the most. Moreover, many of the questions of how best to implement inflation targets and how the political authorities and public respond to inflation targeting cannot be fully addressed by quantitative methods. It is found that the experiences of other countries provides information about the broad features and effects of inflation targeting and about the practical implementation and operational issues involved in this approach.

The first countries to announce an objective in terms of inflation were New Zealand and Canada, between 1989 and 1991. In late 1992 and early 1993 they were followed by the United Kingdom, Sweden and Finland, which had abandoned their exchange rate anchors in the European Currency System. More recently central banks of other countries such as France, Spain, Chile, Chez Republic have announced an explicit objective for inflation. The broad features of the operational framework of these countries are presented in chart 3.1. A detailed discussion is given below.

3.2.1 New Zealand

In 1990 New Zealand became the first country to adopt formal inflation targeting. This framework for New Zealand monetary policy was set forth by the Reserve Bank of New Zealand act of 1989 enacted by the parliament. The passage of the act was the result of the general sense of crisis about the New Zealand's economic performance. Like many other economic policies of New Zealand, monetary policy also did not have a proud record in the 1970's and 1980's. New Zealand experienced double-digit inflation for most of the period since the first oil price shock. With the formulation of a new government in 1984 there was a popular will for a change in the prevailing monetary policy, which had multiple objectives and in the following years a consensus emerged inside the government and in the Reserve Bank about the proper objectives of monetary policy as well as the institutional framework needed to achieve those objectives. A key outcome of this consensus was the need to increase focus on price stability and consequently the Reserve Bank act was established in 1989. The act established the framework within which monetary policy is to be conducted. It requires the Reserve Bank of New Zealand to formulate and implement monetary policy directed to the objective of achieving and maintaining stability in the general level of prices.

Operational Framework: The act specifies stability of the general level of prices as the sole objective of monetary policy and also requires the bank's governor and the Minister of Finance to make public a Policy Targets Agreements (PTAs) regarding the price index to be targeted and its allowable range. The act also provides authority for the governor to formulate and implement monetary policy to achieve that objective without further reference to the government but the announcement of the objective of the monetary policy remains in the hands of the public's elected representatives. Another notable feature of the act is the provision whereby the governor who must report on inflation performance twice each year may be dismissed prior to the end of his five year term if inflation rate falls outside the specified target band. This shows the importance of accountability in monetary policy. This combination of a public contract and formal accountability for producing outcomes in accordance with that contract, provide very powerful

incentives for the governor to ensure the monetary policy decisions are indeed consistent with the PTA. Within this same structure also the minister of finance can direct the governor to take account of other economic objectives in addition to price stability. But such instructions are to be issued formally and publicly and will lapse after twelve months unless renewed.

Since the adoption of inflation targeting in 1990, the PTA has been instrumental in achieving price stability. At the time of signing of the first PTA in March 1990 the Reserve Bank had succeeded in bringing the underlying inflation down from almost 17% at the beginning of 1985 to 5% during 1989. Thus the decision to announce inflation targets occurred after most of the disinflation had already taken place. This shows that the adoption of inflation targets was intended less to promote disinflation than to forestall a rise in inflationary expectations.

Initially the goal of price stability was defined as an annual rate of inflation between 0-2 percent ranges, with both the floor and the ceiling to be taken seriously. Also initially the decision was to define the inflation target in terms of the All Groups Consumer Price Index, which is best understood and monitored most closely by the public. However the first PTA admitted that the headline CPI is not a suitable measure as it also incorporates prices and servicing costs of instrument related expenditures. But still it concluded that the CPI will be the measure for setting the targets. Despite this official role of the headline CPI, however the current PTA recognizes the use of an underlying or a core inflation that is, the inflation excluding relatively temporary influences on the price level. Again, though the requirement is to keep 12-month increases in the CPI in the 0-2 percent ranges, there are some exceptions and caveats. Specifically the PTA recognizes a number of shocks, which are quite outside the direct influence of monetary policy. To deal with this situation the PTAs have escape clauses that allow the Reserve Bank to accommodate the effects of certain shocks on prices, without raising inflationary expectations as well as without being concluded that the RBNZ is failing to meet the requirements of the PTA. The covered shocks on the PTAs include changes in the terms of trade, an indirect tax rates, economic crisis induced by factors such as natural disasters and changes in the interest rate component of the CPI.

However it is very often argued that though the uses of caveats are sensible in practice there are some problems with this practice. An important drawback of using adjustments in the target definition is to determine which shocks policy should offset and which it should accommodate is that it may reduce transparency and credibility of the policy. In terms of its policy feedback procedure for achieving the inflation rate targets, the RBNZ adjusts monetary conditions index in response to discrepancies between expected future inflation rates and the targeted rate. The main indicator variable used in gauging monetary conditions is the exchange rate which is believed to have the greatest predictive and explanatory power for the inflation rate. Short term interest rates also serve in this indicator capacity but to a substantially lesser extent. The main instrument of direct control is the RBNZ's target level of commercial bank settlements balances at the Reserve Bank of New Zealand

With the freedom of setting instruments the central banks accountability to the public and government also increases The Reserve Bank of New Zealand recognizes that transparency of the objective setting and policy formulation and implementations process is clearly the key to effective accountability. In case of RBNZ the transparency mechanism works through providing information on monetary policy to the public. It publishes the semi annual monetary policy statements, which reviews the implementation of monetary policy during the preceding period, specify the means by which the bank intends to achieve the objectives of the PTA in future and state the reasons for adopting those policies and means. These statements are required to be referred to parliament and may be discussed by a parliamentary select committee. In addition to this, the RBNZ publishes semiannual forecasts and expository articles regarding monetary policy in its quarterly bulletin. The governor also gives numerous speeches regarding the fundamental policy issues.

The RBNZ under the 1989 act was designed to operate as a relatively rule oriented central bank. There is relatively little exercise of discretion in the short run by the bank except as allowed by the caveats in the PTAs. Moreover, that limited discretion is to be exercised after formal communication with the government Consequently the relative role of direct communication with public is

considerably less in NZ. Bernanke et al. (1999) says that in New Zealand, the support of the government for the Reserve Banks decisions, rather than its explanations to the public is the principal source of policy flexibility.

The structure of inflation targeting has yielded New Zealand significant advantages in tackling a long history of high inflation. However the experience suggests that the institutional structure plays an important role in the reform of monetary policy. The experience also shows that transparency has been fundamental to the outcome of price stability. However, all this improvement cannot be ascribed to the adoption of inflation target. Significant progress in the fight against inflation was being made in the years immediately prior to 1989. Inflation targeting was adopted after a successful disinflationary situation had occurred. More over the package of reforms in New Zealand also promoted and sustained economic growth with price stability.

3.2.2 Canada

The adoption of inflation targeting by Canada in 1991 followed a three year campaign by the bank of Canada to promote price stability as the long term objective of monetary policy. This change in policy approach was the result of difficulty in controlling inflation with the other policy measures. However, unlike New Zealand, inflation targeting in Canada was not the result of formal legislation but was developed gradually and informally. However, over time the new regime has taken an official status with the inflation target being jointly determined and announced by the government and the central bank. The participation of the government was significant because it signaled, "that the government was supportive of the price stability goal" (Freedman, 1995, pp 21). The bank of Canada is solely responsible for achieving the target, however, the Minister of Finance can not dismiss the governor for target misses as in case of New Zealand but can issue policy directives, but such a directive would be used only in extraordinary circumstances not as a routine measure by the government to influence the conduct of monetary policy.

Operational Framework: As in New Zealand, inflation targeting was adopted in Canada after substantial progress in reducing the inflation rate was already evident, so that success in achieving the initial targets already appeared. The series of target announced in 1991 are in the form of target bands with the midpoint of the inflation target was specified to fall to 3% in 1993 to 2.5 % as of mid 1994 and finally to 2% at the end of 1995. Since then the target band of 1-3% is maintained. The use of a target band is explicitly intended to allow for control problems and it would also provide sufficient flexibility for monetary policy to deal with supply shocks. The rate of change in the CPI was chosen a primary target because of its headline quality i.e. being the most commonly used and understood price measure in Canada. However, a core inflation rate that excludes food, energy, prices and the contribution from changes in indirect taxes has also been used extensively in assessing whether the trend inflation rate is on track for the medium term.

The Bank of Canada is also granted the freedom to act with reference to the target bands in whatever way it can justify to the public. It also does not specify beforehand the circumstances under which the bank should deviate from its target. The inflation targeting in Canada also allows price level shifts in the face of supply shocks. Hence the Canadian inflation targeting regime is quite flexible in practice with real output growth and fluctuations taken into consideration in the conduct of monetary policy. In implementing the inflation targeting regime, the central bank uses a monetary conditions index, a weighted average of the exchange rate and the short term interest rate as a short run operational target, which helps in assessing the economic situation.

Accountability is a central feature in the inflation targeting regime in Canada but the cetral bank is more accountable to the public than the government. The bank has a strong commitment to transparency and to the communication of monetary policy strategies to the public. The introduction of monetary policy report in the Bank of Canada's Annual Report in 1994 was designed to bring increased transparency and accountability to monetary policy. The semiannual report reflects the framework used by the Bank of Canada in its conduct of monetary policy with technical boxes explaining various concepts and procedures. The Bank of Canada also regularly reports the progress a reducing inflation and on its

monetary policy actions through speeches and in the extracts from the Minutes of Meetings of the board of Directors of the Bank of Canada. In addition an analysis of inflation developments relative to the targets is also published periodically in the Bank of Canada Review.

The above discussion shows that the Banks inflation-targeting framework has been exceedingly flexible with a marked trend toward greater transparency over time. This operational procedure has helped the Bank of Canada in keeping inflation low even though the inflation targeting framework is quite flexible. That flexibility has allowed the Bank of Canada some room to deviate from the inflation targets when unforeseen shocks to the economy occur. It is found that the commitment to transparency and accountability has helped to permit this flexibility. The success is also made possible by the co-operation of the Ministry of Finance.

3.2.3 United Kingdom

The United Kingdom followed Canada in adopting inflation targeting. But unlike Canada, the adoption of inflation targeting in UK was not gradual i.e. through a process of experimentations and discussions. The establishment of new monetary policy framework in October 1992 was a response to the failure first of money supply targets and then of exchange rate link to the ERM. More particularly British adoption of inflation targeting was provoked by the foreign exchange crisis in September 1992 which resulted in the floating and depreciation of the Pound. Inflation targeting was then adopted to restore credibility of British monetary policy, that was lost in the speculative crisis and to provide an alternative nominal anchor. Like the other countries examined in this study, the UK adoption of targets also followed a period of successful disinflation, which made hitting the initial targets relatively easy. This shows, that the primary concern was to lock in previous reduction in inflation in the face of a one-time rise in price level due to devaluation.

The institutional arrangements in UK were also significantly different from those in Canada, which have important effects on the operation of the new policy regime Unlike the bank of Canada, the bank of England did not have the

unilateral authority to manipulate the instruments of monetary policy. Hence at the time of the adoption of inflation targets there was more governmental involvement and the initial announcement in October 1992 of inflation targets was made by the Chancellor of the Exchequer rather than the Governor of the Bank of England.

Operational Framework: The target variable in UK is the annual change in the retail price index excluding mortgage interest payments (RPIX). The RPIX inflation was to remain in range of 1 to 4 percent, with the rate to be below 2.5 percent by the end of 1997. But in practice the real target of the Bank of England's policy is not current RPIX inflation but the expectation of RPIX inflation. Success in meeting the target is judged by whether the banks own inflation forecast over the successive two years falls within the specified range. This way of assessing the success is consistent with the forward looking nature inherent in inflation targeting and with the belief that it takes monetary policy about two years to influence inflation. The two year horizon may also be regarded as a shorthand for a feedback rule in which monetary policy responds to deviations of inflation from target and to other variables.

The specified and announced target of the United Kingdom's inflation targets is consistent with price stability "that the rate of inflation anticipated by economic agents is unimportant to savings, investment and other economic decisions" (Leigh – Pemberton, 1992, pp 446). However, target rate of zero inflation was dismissed as unduly restrictive due to the failure of standard price indexes to capture fully the extent of quality change. Consequently price stability was operationally defined as growth in RPIX of 2.5% per year or less. No consideration of other goals such as exchange rate stability or smoothing of the business cycle is explicitly acknowledged within the targeting framework. Like every other central bank, however, the Bank of England stressed that the Bank aims to stabilize business cycle within the target constraint. The Bank of England adjusts the money market condition so as to keep the expected inflation rate within the target band in the future, where money market conditions are measured in terms of interest rate alone.

In making the policy transparent and tracking the progress toward the inflation target, the Bank of England publishes a *Quarterly Inflation Report* that presents analysis and views of its staff. The Bank of England in its inflation report details the past performance of the UK economy, compares actual inflation outcomes with forecasts by the bank, identifies the factors that are responsible for any deviation in the inflation target, and forecasts the likelihood that inflation will in two years time be within the target range. Also the *Quarterly Bulletin* publishes policy speeches and relevant research. In addition since April 1994 the Minutes of the Monthly Meetings between Chancellor and Governor were released, the publication date being two weeks after the subsequent meeting.

The experience of the UK during 1992 to 1997 shows that inflation targeting was quite successful in achieving the goal. But the control of monetary policy by the government made the policy decisions more difficult due to conflict of commitment to objectives and forecasts. Also the issue of accountability was not clear as there was some confusion over whether the agency that made public forecasts i.e. Bank of England or the agency that made the policy decisions i.e. the Chancellor of the Exchequer will be held responsible for any target misses.

This lack of clarity created much confusion about the degree of commitment to inflation targets and suggested that in the present setup short run political considerations will influence monetary policy. Due to these problems, which were arising form the division of the responsibility, the Labour Government that took office at the beginning of May 1997, modified the monetary policy framework, granting the Bank of England operational independence while preserving the key elements of the existing inflation targeting framework.

Experience of UK shows that inflation targeting has been associated with declining inflation, despite lower short-term interest rates. It is suggested that this success of inflation targeting in UK is due to the Bank of England's focus on transparency and its reliable explanation of monetary policy strategy [Bernanke et al (1999), Lane and Heuvel (1998)].

3.2.4 Sweden

Like the United Kingdom, Sweden's adoption of inflation targets was announced by the Riksbank in January 1993, following the break down of exchange arte peg. The decision to adopt an inflation target was supported by all the governing parties which are represented in the Riksbank's Governing Board.

Operational Framework: Inflation was at a low level of 3% per year, when the inflation target was adopted. This made it possible to achieve the target without further drastic measures. The target rate was set at 2% with a tolerance band up or down of 1% points. This target rate was scheduled to apply to the 12-month inflation rate of the headline CPI rather than a modified price index that exclude effects of the certain shocks. Nonetheless since 1997 measures of underlying inflation have played a greater role in Riksbank's decisions and explanations. The announced target of 1992 was to be achieved in 1995because outcomes in 1993 and 1994 were viewed as already determined to a large extent. The inflation targeting process in Sweden is not highly institutionalized in comparison to New Zealand and Canada. The government though maintains legal control of the Riksbank, in practice the Riksbank exercises reasonable autonomy and set the inflation targets and interest rate instruments to achieve it. The Riksbank also intervenes in exchange rate stabilization. But given that the members of the governing body are appointed by the government the Riksbank's Governing Board is seen in the same respect as an arm of the government. Hence, Swedish central bank is not a fully instrument independent central bank. Accountability is ensured through parliamentary elections, since the performance of monetary policy helps to determine the electoral fate of the government.

The Riksbank reports to the public on monetary policy through inflation reports, which it published three times a year from June 1993 to December 1995 and four times since then. In its present form the report surveys various measures of inflation, covers measures of current inflationary pressures, developments in important sectors. in the labor market, fiscal policy and monetary aggregates. It also contains inflation forecasts by the central bank. In addition to this the experience of inflation targeting shows that it was not implemented in isolation

from the pursuit other objectives. The long transition period between the adoption of inflation targets and its achievements, served as an escape clause, consequently the other objectives could also be pursued without affecting negatively to the long-term goal of price stability. Also the use of headline inflation. publication of inflation reports made the policy more transparent while retaining the flexibility of inflation targeting.

3.2.5 Three Small Open Economies - Israel, Australia and Spain

Inflation targeting has spread beyond its original proponents to a diverge set of countries such as Israel, Australia and Spain. In all the three cases, the transition to inflation targeting was gradual and adoption of inflation targeting was seen as a means of balancing the uncertainties of their external environment, particularly the behaviour of exchange rate with the need to anchor public's inflation expectations. In this section, we are not going to discuss the case of all the three countries rather some important salient features are presented.

Israel, Australia and Spain adopted inflation targeting in December 1991, September 1994 and November 1994 respectively. All the countries chose an inflation goal greater than zero – both at the short run and long run. Israel and Spain target inflation as measured by headline CPI with target ranges whereas Australia chose a point target with reference to underlying inflation. In Israel, the finance minister in consultation with the Bank of Israel announces the target whereas in Australia and Spain the adoption of inflation target was unilateral decision by the central bank. To maintain transparency of policy all three central banks have published regular reports on monetary policy and inflation. Both Israel and Spain experienced a brief conflict between exchange rate targets and inflation targets, however, thy managed to keep both inflation expectations and interest rate stable by not responding to short term exchange rate fluctuations. Australia also faced a similar problem in 1995 when the current inflation and forecast inflation diverged due to short run price rise. Keeping in focus on inflation target, and by giving explanation to the public, however the Australian Reserve Bank did not react to this increase in prices. This shows that transparency tends to enhance the flexibility and effectiveness of monetary policy in the long run.

3.3 Operational Issues Involved

The experience of various countries, as discussed above provides a backdrop to identify a number of operational issues involved in the practice of inflation targeting. For instance, the analysis of the case studies enables us to address issues such as how the inflation targeting should be defined, to whom the responsibility of setting the target to be assigned, how the monetary authority should deal with various macroeconomic shocks and how they communicate their goals and intentions to the public In fine, we are able to trace certain vital operational issues that are discussed below.

3.3.1 Introduction of Inflation Target

It is a widely perceived notion that shifts in monetary policy regimes only takes place under pressure. So it might seem that the best time to adopt the inflation targeting would be when inflation is going to run out of control. However, a common feature of inflation targeting countries is that inflation targeting was introduced in situations where the inflation rate was fairly low. This timing has usually reflected a tactical political decision since to achieve credibility for an inflation-targeting regime, it is important to have some initial success in achieving inflation targets. It also reflects the fact that one of the main benefits of inflation targets is that they may help to lock in earlier disinflationary gains. For example, the increase of inflation in the UK and Sweden following their exit from the European Exchange Rate Mechanism (ERM) seems to have been avoided by the announcement of inflation targets that helped to anchor public's inflation expectations and to give an explicit direction for monetary policy. The specific thrust for the introduction of inflation targeting has varied substantially. In some cases the introduction of inflation targeting followed the collapse of exchange rate regime as in the UK and Sweden. In other cases the new approach was evolved gradually in response to dissatisfactions with the existing regime such as in Canada, Israel and Australia. But whatever may be the origins of the adoption of inflation targeting, best results seem to be obtained when the inflation targets are introduced with some success in initial disinflation. This decision helps in increasing the credibility of the central bank, as it is important to be able to meet the initial inflation targets with high probability.

3.3.2 Assignments of the Targets

The issue of who assigns the inflation target is closely linked to the independence of the central bank which is one of the characteristics of inflation targeting framework Independence of the central bank need not be associated with the freedom to choose its own rules. In practice, the inflation targeting central banks are not goal dependent but have instrument independence, that is, the operation of monetary policy in pursuing the assigned goal is unconstrained. The announcement of the target has varied across the countries. In some of the countries such as Australia, Finland and Sweden, the inflation target was first announced by the central bank without any explicit endorsement from the government. However, subsequently it has been endorsed by the government. In others such as Canada and New Zealand the target announced was the result of a joint agreement between the Minister of finance and the Governor of the central bank. This is beneficial as it promotes the agreement between the two policy-making institutions. A unilateral announcement of the target by the central bank may decrease the effectiveness and the credibility of the framework if it is not approved by the government.

3.3.3 Price Index to be Targeted

There are a variety of consumer and producer price indices such as WPI, CPI, GDP deflator et cetera that can be used as the basis for setting inflation target. Hence an important step in implementation of inflation targeting is to decide on the price index whose rate of change is to be targeted. It is always argued that the targeted index should be easily understood, accurate, broad based and should exclude price changes in narrowly defined sectors and first round effects of price changes that are unlikely to affect trend or core inflation. While there is obviously no ideal price index, most countries have used the CPI or a variant of the CPI to target inflation. The emphasis on the CPI is based on arguments relating to the fact that the CPI is the best-known price index by the public; it is released on a frequent basis and is rarely revised. It is also argued to be the closest to the cost of living of households. But one argument that has been made against the use of CPI as the measure of inflation for policy purposes is that it is too narrow since it focuses only on the prices of currently produced goods and does not take into

account the prices of future goods and services. According to this line of reasoning monetary policy should focus on measures of prices that puts some weights on the asset prices because such asset prices reflect expectations of future prices of goods and services. However, this approach has not gained grounds because of difficulties in measuring asset prices and existence of factors other than future prices of goods and services that affect current asset prices. There is also the possibility of bubbles in asset prices that are unrelated to future developments. Again, the CPI includes some components which are vulnerable to supply shocks. Some countries, in this context use a measure of CPI that excludes volatile items in order to focus on core inflation. The purpose of focusing on core inflation is to exclude from inflation rate the non-monetary determinants of inflation. In practice, measures of core inflation excludes the first round effects of supply shock but not the second round effects of those shocks on wages on prices. The use of core inflation increases policy flexibility as when there is a supply shock to the economy, the monetary authority can publish the inflation rate in terms of the price index which excludes the components affected by supply shocks and in turn will help prevent the rise in inflation expectations.

3.3.4 Level of the Targets

In choosing a numerical value for an inflation target central bankers have usually stressed price stability as their major policy objective. In theory, zero inflation would appear to be equivalent to price stability but in practice targeting inflation at zero would create some serious problem due to bias in measurement and nominal rigidities. These biases include those due to introduction of new goods, quality bias and those caused by the adjustment of consumers to relative price changes. These issues are important to the calculation of price indices and in general cannot be removed. The bias in measurement of the index implies that inflation target would have to be greater than zero. Also the economic risks of very low inflation are as costly as risks associated with too high inflation. Akerlof et al. (1996) pointed out that as nominal wages are rigid downward, any reduction in real wages can occur only through inflation. That implies a very low rate of inflation might prevent real wages from falling in response to declining labour demand, thereby leading to increase in unemployment and blocking the

reallocation of labour from declining sectors to expanding sectors. Also, they found out that inflation rate close to zero might increase the natural rate of unemployment. The possibility of downward rigidity in prices and wages implies that a small positive inflation rate allows for the necessary relative price adjustment. Again a zero inflation rate implies that the potential for negative real interest rate is ruled out which is necessary to support an economic recovery in the event of a recession. A stronger argument against zero inflation is that such a policy may lead the economy into a deflationary situation. Persistent deflation, particularly if unanticipated can create serious liquidity problems that may interfere with the financial system's normal functioning (Bernanke and James, 1991; Mishkin, 1991). This implies that undershooting a zero inflation target is potentially more costly than overshooting a zero inflation target of the same magnitude. The risks associated with low inflation, therefore suggest that inflation target should be set above zero. In general, the inflation targets of practicing countries have centered on an inflation rate of two percent per annum.

3.3.5 Interaction with Other Policy Goals

In inflation targeting regime the primary goal of monetary policy is the achievement of the specified inflation target. The successful implementation of inflation targeting requires the absence of firm commitment by the authorities to target any other nominal variable, for example nominal exchange rate. But any other goal can be pursued to the extent that is consistent with the inflation target The variants of fixed exchange rate system such as crawling peg allows the authorities to manipulate monetary policy so as to achieve other nominal objective, in principle inflation rate in addition to the exchange rate. In theory, a nominal (non-fixed) exchange rate target, hence could co exist with an inflation target "as long as it is clear that the inflation target has the priority if a conflict arises" (Leiderman and Svensson, 1995). But Masson et al (1997) argue that such coexistence might be problematic since the authorities will be unable to convey in advance those priorities to the public in a credible manner. Therefore, they suggest to avoid these problems the policy maker should refrain from making strong commitment on nominal exchange rate. However, Brash in his 6th L K Jha Memorial address held that the achievement of price stability will contribute to

real exchange rate stability. Debelle (1997) finds that a full employment goal is not inconsistent with an inflation target. In the long run the achievement of the inflation target may be the best contribution that monetary policy can make to the full employment objective. He also holds that the response of monetary policy to a demand shock is generally the same under both a full employment goal and an inflation target. Also the use of underlying inflation rate in the monetary policy reaction function implies that response to supply shocks by the inflation target is not incompatible with the full employment goal.

The achievement of inflation target also depends on the effect of fiscal policy on inflation. Fiscal policy needs to be supportive of the inflation target. Hence, in inflation targeting regime there is an implicit interaction between the goals of monetary policy and fiscal policy. The recent experience of New Zealand shows this. The New Zealand government announced a large tax cut to take effect in 1996 prior to the election. It estimated the effect of this tax cut on demand and concluded that monetary condition would need to remain tight longer than if the tax cut had not occurred. Thus any changes in fiscal policy will also induce the change in monetary policy to the extent fiscal policy affects inflation target.

3.3.6 The Loss Function

Inflation targeting is viewed as involving an attempt to minimize inflation from the explicit inflation target. Whereas, there may previously have been some controversy about whether inflation targeting involves concern about real variability, there is now considerable agreement in the literature that this is indeed the case. Inflation targeting central banks are not what King (1997) called, 'inflation nutters', for instance, Fischer (1996), King (1996), Taylor (1996) and Svensson (1996) all discuss inflation targeting with reference to a loss function which puts some weights on output stabilization and there seems to be considerable agreement among academics and central bankers that the loss function is of the conventional form:

$$L_t = \frac{1}{2}\left[(\pi_t - \pi^*)^2 + \lambda y_t^2\right]$$

where π_t is the inflation in period t, π^* is the inflation target, y_t is the output gap and $\lambda \geq 0$ is the relative weight on output stabilization. This implies that the monetary authority, under inflation targeting wishes to minimize future deviation of inflation and output from the inflation target and the natural output level respectively. This is motivated by the existence of target bands in actual inflation targeting regimes, indicating that some short term inflation variability may be acceptable due to imperfect control over inflation and minimize output fluctuations. Svensson (1999) points out that when the weight on output gap stabilization is zero ($\lambda = 0$) and only inflation enters in the loss function, the inflation targeting is called strict inflation targeting. Under this, the monetary authority should adjust its instruments such that the conditional inflation forecasts over the policy horizon always equals the inflation target. But when $\lambda > 0$, and the output gap or concern about stability of the real economy, in general enters the loss function, the inflation targeting is called flexible inflation targeting. The monetary authority under this should adjust the instruments such that the conditional inflation forecasts over the policy horizon gradually reaches the long run inflation target. The higher the weight on the output gap stabilization, the slower the adjustment of the conditional inflation forecasts towards the long run inflation targets. It is often suggested that the weight on the output stabilization in the central banks' loss function should be directly related to the rate at which inflation is to be adjusted towards the inflation target.

In practice, this flexible inflation targeting has been implemented. Thus in the inflation targeting countries, if inflation is away from the target it is more gradually brought back to the target rate. To make it possible the central banks lengthen their horizon and aim at meeting the inflation target further in the future. As further discussed in Svensson (1999) concern about output gap stability, model uncertainty and interest rate smoothing all have similar effect under inflation targeting, namely a more gradualist policy. Sveriges Riks Bank (1997) has explicitly expressed similar views. The Minutes from Bank of England's Monetary Policy Committee (1998) are also explicit about stabilizing the output gap. Ball (1998) and Svensson (1998) give example of a gradualist approach of

the Reserve Bank of New Zealand. Thus it seems uncontroversial that real world inflation targeting is actually flexible inflation targeting.

Although, inflation-targeting central banks initially were quite non-transparent and evasive the weight on output gap stabilization, which has been emphasized by Fischer (1996), the above instances show that inflation-targeting central banks have by now become quite transparent and explicit on this point. Svensson (1999) argues that this type of loss function used by the central bank does not induce an average inflation bias, since the implicit output target is taken to be capacity output and therefore consistent with the natural rate hypothesis, i.e. the monetary policy cannot systematically affect unemployment rate or capacity utilization. Indeed, motivation for inflation targeting was based on the natural rate hypothesis and it can be argues that the hypothesis constitutes one of the foundations of inflation targeting. The inflation targeting central banks ensure that any concern about the real economy is consistent with the natural rate hypothesis and therefore reduces or eliminates any inflation bias. This highlights a fundamental asymmetry between inflation and output in inflation targeting. There is both a level and a stability goal for inflation and the level goal that is the inflation target is subject to choice. For output, however, there is only a stability goal and no level goal. To put differently, the level goal is not subject to choice but it is given by the capacity of the output level.

3.3.7 Response to Shocks

The experience of inflation targeting countries shows that inflation targets are sometimes missed and some of the misses are the result of decision by the monetary authorities. This implies that sometimes target misses are legitimate. The question that arises then when to allow the inflation rate to exceed the target. Inflation targeting, being a framework with constrained discretion concerns about macroeconomic variables other than inflation sometimes justify missing or changing a previously announced target. The decision about whether to change the target however depends on the type of shock hitting the economy. The conventional wisdom is that monetary policy should be neutralized in case of aggregate demand shock since these move inflation and output gap in the same

direction. With regard to supply shocks the response of monetary policy depends on the weight on output gap stabilization. With a positive weight it is optimal to partially accommodate supply shocks since they affect inflation and the output gap in opposite directions but with a zero weight on output gap the supply shock effect on inflation should be neutralized.

Given the lags in the effect of monetary policy, however it requires the conventional wisdom to be modified (Svensson, 1999). The monetary authority cannot affect the first round effects on inflation and the output gap of supply and demand shocks due to these lags. It can only moderate the second round effects. Targeting the price index that excludes the first round effects of common supply shocks as it is seen in case of inflation targeting countries can reduce this conflict to some extent. The preannounced response to contingencies may also be an important factor in determining the action required in response to certain kind of shocks. But a supply shock that is large enough or that arises from some unanticipated source will justify missing an announced target. Missing a target, however need not imply that the entire inflation targeting strategy should be abandoned. As long as the central bank is able to explain that the miss is the result of unforeseen events the credibility of the central bank with the public must not be compromised. As in the case of Bundesbank, resetting a target may communicate to the public how the central bank intends to accommodate the unforeseen contingencies and at the same time define the transition path back to price stability. Such a strategy though may not eliminate the short run inflationary effects of supply shocks, will limit those effects and prevent them from feeding into the trend rate of inflation. Svensson (1997) has shown that gradual adjustment of the medium term inflation target towards the long run inflation goal is good approach for policy makers concerned about both minimizing output fluctuations and maintaining low and stable inflation.

3.3.8 Speed of Disinflation

The speed of disinflation has to be chosen by the central bank given that monetary policy affects real output and employment in the short run but not in the long run. Also there are costs of disinflation and moreover those costs increase more than

proportionally with the rate of disinflation. If there is a prolonged period of inflation the cost from a change in monetary policy regimes would be high because private sector agents expectations do not adjust with the policy actions. An unanticipated disinflation will depress output because wages and prices take time to adjust to the new lower price level relative to the expectations. Disinflation in both the United States and the United Kingdom in the early eighties proved costly in term of lost output and employment. There is one additional cost of disinflation in which actual inflation falls faster than the expected inflation. With government debt fixed in nominal terms the burden of debt rises when there is unanticipated disinflation. King (1995) called this "unpleasant fiscal arithmetic". Too rapid a disinflation can therefore, add to the fiscal burden.

The speed at which expectations adjust during the transition period will influence the magnitude of the output loss. A central bank can lower those costs by reducing the gap between private sector expected inflation and the inflation target set by its own. The optimal speed of disinflation depends, therefore on the real output costs of changing expectation held by the private sector about the intentions of the central bank to reduce inflation. Those costs reflect the existence of a short-term tradeoff between inflation and output. Such a tradeoff reflects in turn nominal rigidities in wages and prices. The existence of nominal stickiness means that the central bank can affect output in the short run because monetary policy is able to respond to at least some of the shocks hitting the economy before wages and private sector agents adjust prices. Hence the central bank may be able to respond to a shock before all wages and prices have adjusted and it is that speed of response that enables monetary policy to influence the impact of shocks on output or inflation. Nevertheless, Sargent (1986) has argued a sharp disinflation may be preferable to gradualism because expectations adjust quickly as advocated by the rational expectation approach. In his view, "gradualism invites speculation about future reversal or U-turns in policy" (Pp. 150). King (1996) points out hat excessive gradualism will have similar policy impacts but so also the effect of excessive radicalism. He favoured for a gradualist path to price stability. In practice, the inflation targeting countries have also undertaken the similar path to achieve price stability.

3.3.9 Point Target versus Target Range

As with the choice of horizon and the numerical values of the targets, the inflation targeting central bank has some discretion about whether to announce its targets as a single point or as a range. In Finland, for instance, the framework focuses on a particular point target for the inflation rate whereas Canada, the UK and New Zealand have all specified a target range. The implications of this choice are much debated. A point target, it is argued, communicates greater commitment by the central bank to achieve the inflation goal than a target range. However, it reduces the bank's ability to respond to unforeseen events. In the event that the central bank chooses to announce a range for its targets a narrow range also communicates greater commitment by the central banks to achieve inflation goal than does a broader range. At the same time, like a point target it also reduces to a certain extent the flexibility of the central bank in conducting monetary policy. Also, the adoption of narrow range or point target may induce instability in the instrument of monetary policy. To achieve a given movement in the inflation rate larger change in the instruments are required. Such actions may destabilize the real economy and financial markets even though inflation target is met. However, the damage to credibility of missing a target range is greater than that of missing a point target. In this context, the choice of the target band reflects a tradeoff between credibility and flexibility. But in practice, given the long and variable lags of monetary policy and the imperfect control over inflation, it is argued to specify the target with a range.

3.3.10 Horizon of the Inflation Target

Inflation targets can be set for one for more horizons. In practice, target set for a too short or for a too long horizon are not meaningful because inflation is not controllable by monetary policy at such short horizons and distant targets would have little credibility. The choice of target horizon is influenced by the tradeoff between transparency and flexibility. With fixed targets over the short run the central bank's communication to the public will have much clarity, however the bank will have less freedom to deal with any unforeseen conditions. In this context, a variety of choices are observed in practice. Also the horizon of the inflation target adopted in various countries has depended in part on the inflation

rate at the time of the initial inflation target Those countries where the initial inflation was high they opted for a longer horizon given the costs of disinflation whereas the countries with low inflation rate adopted targets that were to be implemented immediately. Given the lags in the effects of monetary policy on inflation the horizon in general is set at two years. The horizon of inflation target also reflects the ability of monetary policy to offset deviations due to short-term supply shocks. In practice, when a supply shock occurs the inflation targeting central banks in general increase the annual inflation goal thereby not demanding too rapid progress on inflation in the short run. Specification of the horizon is an important issue of inflation targeting since any vague horizon as in case of Australia. where the time horizon for the inflation target is the length of the business cycle, will make assessment of the central bank's success in achieving the target more difficult. This also raises the question if there should be a short run or long run accountability for the achievement of the inflation target.

3.3.11 Inflation Forecasts

Given the lags in the effect of monetary policy, an inflation target happens to be forward looking. Changes in the instrument of monetary policy must be met before the inflation rate begins to rise. Consequently, the central bank's forecasts of inflation plays an essential role in policy formation in such a regime. Svensson (1996) further argues that the official inflation forecast of the bank functions as an intermediate target. In practice, an inflation forecast has become a cornerstone of the inflation-targeting framework. The detailed discussion pertaining to this is carried out in earlier discussion on inflation targeting framework.

3.3.12 Communication Issues

One of the benefits of inflation targeting is that it promotes transparency and accountability of monetary policy. Achieving this benefit however requires the authorities to communicate to the public on issues related to inflation targeting. Beyond the announcement of inflation target, to maintain credibility the central bank needs to provide timely information about its monetary policy, policy intentions and the stance of the economy at large. Inflation targeting banks also communicate the rationale behind the choice of the inflation target, inflation

forecasts and also provide reports on its success or failure in meeting the target with explanations of why target has been missed or changed. In this way by encouraging the public to understand and get involved in the policy making process, the accountability of the policy makers to public increases and this leads to better policy outcomes.

The success of the inflation-targeting regime depends highly on this institutional and operational issues rather that on theoretical arguments. On the basis of these issues associated with inflation targeting any generalization for the feasibility of inflation targeting in other countries can be made.

3.4 Pros and Cons of Inflation Targeting

Inflation targeting which is the result of the failure of earlier monetary policy regimes practiced, has been gaining popularity in recent years and has several major advantages. It enables monetary policy to focus on domestic considerations, as does the monetary targeting. Inflation targeting also has the additional advantage that velocity shocks are largely irrelevant because monetary policy strategy no longer relies on a stable money demand function. In practice, inflation targeting allows monetary authorities to use all available information to forecast inflation. However, many have criticized inflation targeting as being non-operational since the central banks' control of inflation is relatively imperfect and take effect after long lags. But while it is true that it is more difficult to control inflation, that point is of little help for justifying the other strategies. Because of the unstable relationship between the intermediate targets with the goal variables, then little benefit will be gained by employing the intermediate targets.

Inflation targeting also has the key advantage that it is readily understood by the public and thus highly transparent. Again the announcement of the explicit numerical inflation target increases the accountability of the central bank, which also helps in reducing the likelihood that the central bank will fall into the time inconsistency trap in which it tries achieve short run stabilization goals in terms of output and employment by pursuing over expansionary monetary policy. Also given that time inconsistency problem very often is the result of political pressures on the central bank, a key advantage of inflation targeting is that it can help focus

the political debate on what monetary policy can do in the long run (i.e controlling inflation) rather than what it cannot do (permanent rise of economic growth and the employment through expansionary monetary policy). Thus inflation targeting has the potential to reduce political pressures on the central bank to pursue inflationary monetary policy and thereby reduce the likelihood of time inconsistency policy making.

Also the arrangement of inflation targeting in various countries shows that, in practice all the inflation targeting countries have chosen inflation targets well above zero and not price level targets. This reflects the monetary policy makers concern that too low inflation can have substantial negative effects on real economic activity. Targeting inflation rates above zero makes periods of defilation less likely.

Another important feature of inflation targeting regimes is that they do not ignore traditional stabilization goals. Central bankers responsible in inflation targeting countries continue to express their concern about fluctuations in output and employment, and the ability to accommodate short run stabilization goals to some degree is built into all inflation targeting regimes. All inflation-targeting countries have taken a gradualist approach to disinflation in order to minimize output declines by lowering medium term inflation targets towards the long run goal slowly over time. In addition, many inflation targets have emphasized that the floor of the target range should be taken seriously as much as the ceiling, thus helping to stabilize the real economy when there are negative demand shocks. In fact, inflation targets can increase the flexibility of the central bank to respond to declines in aggregate spending. Because declines in aggregate demand that cause the inflation rate fall below the floor of the target range will automatically stimulate the central bank to loosen monetary policy without fearing that its action will trigger rise in inflation expectations.

Another element of flexibility in inflation targeting regimes is that deviations form inflation targets are allowed in response to supply shocks. The price index on which the official inflation targets are based is often defined to exclude or moderate effects of supply shocks. However, in case of any deviation from the

target the central bank tries to explain the reasons for the deviation and its actions to the public. This helps in maintaining credibility of the central bank as well as controls the inflationary expectations of the public. Inflation targeting regimes also put great stress on making policy transparent and on regular communication with the public. These communication efforts have improved private sector planning by reducing uncertainty about monetary policy, interest rate and inflation. They have promoted public debate of monetary policy by educating people about what a central bank can and cannot achieve and also have helped to clarify the responsibilities of the central banks and of politicians in the conduct of monetary policy. This regime is also characterized by high level of accountability of the central banks. The accountability and transparency of the central bank are instrumental in building public supports for the central bank independence. The central banks of the inflation targeting countries being given operational independence ensure that monetary policy goals cannot diverge from interests of the society, yet monetary policy can be insulated from short run political considerations. An important benefit of an inflation targeting regime is that it makes the case for an independent central bank which focuses on long run objectives of but which is also consistent with democratic society because it is accountable.

The performance of inflation targeting regimes has been quite good. Inflation targeting countries have significantly reduced both the rate of inflation and inflationary expectations beyond that which would likely not have occurred in the absence of inflation targeting. However, though inflation targeting has helped in moderating and controlling inflation, it is not without problems. In contrast with exchange rate and monetary targeting inflation is not easily controlled by the central bank. This can create severe problems for a country that is trying to bring down inflation from a very high level. This suggests that adoption of inflation targets might be only after there has been some successful disinflation. Also all the inflation targeting countries have retained the same path.

Another problem with inflation targeting is that, because of long lags its effects on monetary policy van be visualized only after a considerable lag. This shows that inflation targeting does not provide immediate signals to both public and the

markets about the stance of monetary policy. However the use of conditional inflation forecast mitigates that problem.

3.5 Case for Developing Countries

As noted at the beginning, starting in the early 90s, a number of industrial countries adopted inflation targeting. The experience of those countries shows that inflation targeting leads to lower inflation and inflationary expectations. Also the strong economic growth in later part of the 90s in many countries that have adopted inflation targeting implies that it promotes economic growth in addition to maintaining price stability. However, this disinflations are not costless being accompanied by decline in output growth. But once disinflation has been achieved, inflation targeting countries appear to have better inflation performance than might have been expected from their past experience while output growth come back to the predicted level. Further, in the inflation targeting countries inflation rises less than expected during the subsequent period of renewed output growth. Hence, all these things considered, the adoption of inflation targeting as a framework for monetary policy appears to be a success. And the success of inflation targeting implies that it deserves consideration as a strategy for monetary policy in other countries.

It is sometimes argued that inflation targeting is inappropriate for developing countries due to the presence of fiscal dominance – a situation where the central bank is primarily concerned with assisting the government for raising revenue and practice of multiple objectives (Masson et al, 1997). However, Dr. Donald T Brash, Governor of Reserve Bank of New Zealand argued that it may be difficult to focus monetary policy in keeping inflation low, where government has high dependence on the inflation tax. But it is not impossible as in recent times several countries, for example Chile and Czech Republic with high fiscal dominance have successfully introduced inflation targeting. With regard to the second constraint of multiple objectives, it is found that encouraging economic growth and marinating competitive exchange rate are crucially important objectives in all the countries whether developed or developing. Also, as we have already discussed, inflation

targeting provides enough scope for achieving other macroeconomic goals and low inflation helps in achieving economic growth and real exchange rate stability.

Besides, it is also held that inflation targeting is unsuitable for developing countries because most of the institutional and operational requirements such as inflation forecasts, developed financial system, reliable measure of inflation are non-existent. However, experience showed that these measures were also not there in the industrial countries when they adopted inflation targeting. For example, when New Zealand began inflation targeting it had none of those operational requirements. The financial system had just been freed from direct controls and the measures of inflation included interest rates and house prices. To this, Brass argues that "poor tools make any monetary policy approach problematic but it is not obvious that inflation targeting is more difficult than the available alternatives" (Pp. 24). The central banks have to develop the required infrastructure to make inflation targeting successful.

3.6 Current Monetary Policy Framework in India

The working of monetary policy in India over the past several decades would reveal that the broad objectives of Indian economic policy have been to achieve a faster rate of economic growth and to maintain reasonable degree of price stability. Although the evidence suggests the ineffectiveness of monetary policy in influencing long run economic growth, it is argued that monetary policy can help to achieve the goal of growth through price stability and the Reserve Bank pursues these twin objectives. The rationale is given as, "first of all the price mechanism does not work in most of the developing countries. The prices of quite a number of essential commodities are administered for many reasons that distant the formation of price expectation in the economy. Allocation of resources is often done through centralized planning. User charges on number of public utilities are set below the average cost to meet the social objectives. These imperfections often compel the authorities to pursue multiple objectives and complicate the system almost leading to a cobweb of regulation" (Bhoi, 2001, Pp. 4). This argument shows that seeking to achieve multiple objectives would lead to the instrument

problem as it is well known that there must be as many instruments as the number of objectives if all are to be fulfilled simultaneously.

However, in the context of the need to control inflation, the Chakravarthy committee, which was set up in 1982 to review the structure and operation of the monetary system in India recommended that to control inflation the RBI should adopt the intermediate targeting path with broad money as the relevant target. Following the recommendation of the committee, monetary targeting was adopted in India in mid 1980s in much contrast to the abandonment of the same in many developed countries. But the situation prevailing in India was quite different from that prevailing in developed countries. The committee observed the existence of stable money demand function and rate of inflation to be directly related to the long run money supply which is viewed as one of the prerequisites for the implementation of monetary targeting. Also, the other important feature of monetary targeting in India observed by the committee is that unlike the targeting pursued by developed countries, it was not based on Friedman type monetary rule rather monetary targeting with feedback was advocated. Hence, monetary targeting recommended in Indian context was flexible one and to justify it the committee argued that in a developing country like India, where significant structural changes are sought to facilitate the growth process, the mechanical application of money supply growth rate can have no place.

The justification for the use of broad money aggregate (M3) is also given by Vasudevan (1998). He has argued that targeting narrow money aggregate would not serve the purpose from the policy perspective as the time deposits form a major proportion of banks' liabilities in India. The target was recommended to be set annually and this annual growth rate is derived from a few macroeconomic variables, i.e. the appropriate growth in money supply is estimated by taking into account the expected increase in real output, acceptable level of price increase and the feedback of an increase in money supply on output increase through the availability of credit. The money stock target was recommended to be set in ranges, which has been considered appropriate in order to cope with the exogenous influences to the economy but target was set either in point or in narrow range.

The adoption of monetary targeting in India was made in the mid 1980s that was characterized by high growth of M3 liquidity, large increase in reserve money due to the high level of fiscal deficit and an alarming rise in wholesale prices. These factors led to the delay of operationalising the monetary targeting. Though it was formally accepted in 1985, no specific monetary target was set during the period 1985-90 except fixing a ceiling on the average growth of broad money in the previous years. "The rationale for fixing a monetary ceiling over the period was the continued overhang of excess liquidity prompted by the sharp increase in primary money creation and the continuing pressures on prices" (Mohanty, 1999, Pp. 128). In such a situation credit policy was continued to support the monetary policy in checking the monetary expansion and increasing output. Monetary targeting was only actively pursued during 1990-1998.

The major instrument of controlling money stock in India has also been the cash reserve ratio. The indirect policy instruments were considered ineffective during mid 1980s, as the money market and government securities market were not developed. But the monetary authorities soon found the evils of over-dependence on CRR and the Narasimham committee, therefore recommended a low level of CRR and the use of alternative instruments. Hence in the post liberalization period, the RBI relied more on indirect methods to control money stock such as open market operation, bank rate, repo rate et cetera. The experience of India with monetary targeting for the past 13 years shows that in most of the years the growth rate of money supply exceeded the targeted growth rate. The targeted level of monetary aggregate, M3 was achieved during 1985-86, 1987-88, 1990-91 and 1995-96. The success of first three years were accompanied by lower rate of expansion in both net Reserve Bank credit to central government and net foreign exchange assets of the banking sector. The success of the fourth year, in spite of high net Reserve Bank credit to the central government was possible due to lower expansion in net foreign exchange assets of the banking sector. In all the other years of monetary targeting, the expansion of monetary aggregates was attributed to high level of fiscal deficit and its automatic monetisation. The problem was also aggravated by heavy capital inflows in 1990s. Furthermore, there was no significant improvement in case of inflation management as it remained at 8.1%

during the targeting period in contrast to 8.8% during the decade preceding the targeting period. This inflation rate of 8% is well above the optimal or threshold rate of inflation as found by Vasudevan et al. (1999). They found the threshold level to be 6% at which the growth is maximized.

The experience of India with monetary targeting shows that in spite of the presence of stable demand function for both broad and narrow money as found by Rangarajan (1989), Parikh (1994), Jadhav (1994), Arif (1996), Mohanty and Mitra (1999), Sahu and Kamaiah (2000) the implementation of monetary targeting has not been successful either in meeting the level of targeted monetary aggregate or bringing down inflation. The difficulties in controlling monetary aggregates, in addition to the high level of fiscal deficit, now also arise due to the opening of the economy which led to heavy capital inflows. But given the economic conditions in early 90s, in the event of a conflict between the liquidity effect of capital inflows and adherence to monetary targets, the former has taken precedence as inflows of foreign exchange were of overriding objective. Hence, the monetary authorities succumbed to fiscal adjustment. So, one may conclude that monetary targeting was never pursued seriously and there was no sincere efforts to check the growth in money expansion, given the need to meet other objectives of the economy. The other major point one may point out, in comparison to Germany and Switzerland, is that the monetary policy is neither credible nor transparent in India. The central bank never tried to communicate the objectives or implementations of the policy to the public.

In the light of the above difficulties faced by the authorities in controlling monetary aggregates, more recently the RBI has adopted a multiple indicator approach where the RBI takes into account the developments in a host of macroeconomic indicators such as money, credit, prices et cetera in the conduct of monetary policy. The Reserve Bank's annual report for 1997-98 declares, "... the Bank has explicitly preferred to adopt a multiple indicator approach wherein, movements not only in money supply but also in a host of economic variables will be tracked for policy responses". However, the adoption of interest rate targeting has been advocated by a few, but in addition to the disadvantages already discussed, the adoption also requires certain preconditions to be satisfied. These

are complete deregulation of the interest rate and the existence of a developed and integrated financial market. But in case of a developing economy like India, where financial markets are not fully integrated, it is difficult to select a rate of interest that would be a benchmark for the other market interest rates. Also, one of the basic objectives of the financial sector liberalization is let interest rates market determined and thus raises the difficulty to control interest rate. All these factors have rendered the authorities to go with the monetary targeting through indicator approach.

3.6.1 Feasibility of Inflation Targeting

In light of the unsuccessful implementation of monetary targeting in India and infeasibility of interest rate targeting as well, it is sometimes considered that the Bank may move towards inflation targeting approach, which has been emerged as an alternative framework for monetary policy (Kannan, 1999). Yet, parallel views also argue that monetary policy has performed quite well in the recent past so far as controlling inflation is concerned, without being tied down to inflation targeting. Hence, in the context of India this remains as an issue to be discussed and verified. Since it is not possible to test it empirically, feasibility for India is to be visualized on the basis of experiences of other countries. Our analysis in this regard is based on several arguments. First, the current level of low inflation which happens to be the foremost argument against change of monetary policy strategies, is not the outcome of any conscious effort on the part of policy makers rather it is the result of the decrease in the prices of the primary products which is a major component of the WPI measured inflation. Hence there are some apprehensions as to whether this performance will necessarily continue. We have also discussed that to maintain price stability the use of a nominal anchor is required and in this context the case studies reveal that inflation targeting helps to lock in the success of monetary policy and contribute to continued stability and growth in future. The current strategy of monetary policy of multiple indicator approach in India, in this regard does not provide an explicit nominal anchor and is not transparent. We have already discussed interest rate targeting cannot be pursued in India. Also, notwithstanding the stability of the money demand function, monetary targeting has been abandoned following the financial

liberalization that may render the money demand function unstable. Besides, it is found that countries that have adopted inflation targeting have done so not when inflation was rising but when they have already achieved some success in bringing inflation down. As the experience shows, it is advantageous to adopt inflation targeting when inflation is low because it increases the likelihood of achieving the target of low inflation rate without making a hawkish effort which results in more loss of output and employment.

With regard to the prerequisites of absence of multiple objectives in India there is now a growing consensus that the objectives of growth and price stability are not hostile. Price stability is considered sine qua non for achieving reasonably high and sustainable rate of growth. Increasingly, it is being recognized that the central bank would have to target price stability since real growth itself would be in jeppardy. If inflation rates go beyond a margin of tolerance (Reserve Bank of India *Annual Report*, 1996-97, Pp. 2). With regard to fiscal dominance in India though gross fiscal deficit as a percentage of GDP remains high, it is on the decline. Again in reference to the operational issues such as central bank independence and transparency, the reforms in nineties have conferred limited autonomy on the Central Bank and with it has come the consequent accountability (Pethe and Samant, 2001) as well as there is a greater degree of transparency and disclosure of the operation of monetary policy. In India, though exchange rate assumes considerable importance given the degree of our openness[1], exchange rate is not treated as a nominal anchor. But in the Indian context problems arise in choosing the price index to be targeted. Supply side shocks dominate price formation in India and the prices of a number of essential commodities are administered. Also we do not have a consumer price index that does not represent the whole population at large. The WPI included some volatile components. This requires measuring an underlying inflation rate. In this context some effort has been made by Mohanty et al (2000) and Samant (1999). However, as yet there is no official measure of core inflation. Also for implementing monetary policy through inflation targeting forecast of future inflation is required, which

[1] This is evident from the fact that India's share of imports and exports is around one-fifth of the GDP

necessitates the identification of a set of leading indicators of inflation as well as an inflation-forecasting model. In this case also attempts have been made by Pethe and Samant (2001), Samant (1999), Srimany and Samant (1998). Notwithstanding this, there is a strong need for developing an inflation forecasting model and an underlying price index. In spite of the absence of these requirements present conditions in India are appropriate for adopting inflation targeting as the central bank has substantial information and resources to develop the required infrastructure.

3.7 Concluding Remarks

Having made the above observations, now we sum up some specific aspects of the proposed inflation targeting in India. First, the long run inflation target should be announced and for India this may be set at five percent given the available literature on the impact of inflation on growth and the current trend of low inflation. (Vasudevan et al, 1997). However, over time this should be brought back to 2 – 3% range. Second, a short-term inflation target would be set and is required to converge to the long run inflation goal gradually. Third, the target for inflation should not be set for the flowing year given the lags in the effects of monetary policy. The price index used for inflation target would be a measure of core inflation As in case of other inflation targeting countries the Reserve Bank should publish a comprehensive inflation report. To make inflation targeting successful the government should get actively involved with the conduct of monetary policy.

Chart 3.1
Economies with explicit inflation targeting framework: Selected features

Country	Date of adoption	Price index	Target rate and horizon	Target announcement	Transparency measures
New Zealand	March 1990	CPI excluding interest cost components, indirect taxes, government charges and significant price effects from changes in terns of trade	0 – 2%, subsequently increased to 0 – 3% through the 5-year tenure of the Reserve Bank governor	Defined in policy target agreement (PTA) between the ministry of finance and the governor of the Reserve Bank	Monthly publication of monetary policy statements, quarterly release of inflation projection and frequent press statements by Reserve Bank officials
Canada	February 1991	CPI excluding food, energy and the effect of indirect tax charges	1 – 3% through 1998	Joint agreement between the ministry of finance and the governor of the central bank	Regular progress monitoring, particularly by the Bank of Canada's annual report, but official inflation forecast are not made public
United Kingdom	October 1992	Retail price index excluding mortgage interest payments (RPIX)	Lower half of the 1 – 4% range by spring 1997: 2 – 5% or less thereafter	Chancellor of the exchequer	Publication of quarterly inflation report by the Bank of England and monthly monetary report, and minutes of meeting between the Chancellor and the Governor by the treasury
Sweden	January 1993	CPI	2% with a tolerance band of + 1& in 1996 and beyond	Bank of Sweden	Publication of inflation reports thrice a year but reports lack explicit inflation forecasts.

Finland	February 1993	CPI excluding mortgage interest payments, indirect taxes, government subsidies, real estate prices	About 2% in 1996 and beyond	Bank of Finland	Publication of biannual monetary policy reports and a quarterly inflation report. Occasional publication of inflation forecasts.
Australia	1993	CPI excluding the impact of interest rates on mortgage and other interest payments, and certain other volatile price items	2 – 3% on average economic cycle	Set by Reserve Bank of Australia and endorsed by the government	Quarterly release of inflation figures but official inflation forecasts are not made public
Israel	1991	CPI	8 – 15% for 1995 (updated annually)	Target set by the finance minister in consultation with the Bank of Israel	NA
Spain	November 1994	CPI	Less than 3% by 1997, less than 2% thereafter	Bank of Spain	Publishes an inflation report in every 6 months since March 1995 but without any precise inflation forecasts.
Czech Republic	December 1997	CPI excluding regulated prices and prices affected by administrative measures	Control target of 5.5 – 6.5% in 1998. 3.5 – 5 5% by 2000.	Czech National Bank	NA

Chapter IV

Inflation Forecast Targeting in India

4.0 Introduction

The core of the argument for inflation targeting seems to be that the goal of price stability becomes the overriding goal of the central bank. At the same time an inflation-targeting framework allows for responses to cyclical fluctuations because of the short run Phillips curve mechanism. Inflation targeting therefore places the appropriate emphasis on price stability, provides for appropriate accountability, and at the same time avoids a straitjacket that could cause too much output volatility. Notwithstanding these advantages, inflation targeting, however, faces some serious problems with regard to both its implementation by the monetary authorities and its monitoring by the public. Implementation is difficult due to the imperfect control over inflation since inflation is affected by so many other factors than monetary policy. Monitoring becomes difficult as inflation reacts to the changes in monetary policy instruments with long and variable lags. In order to avoid these problems, Svensson (1996) pointed out that inflation targeting can be implemented as inflation forecast targeting, where the conditional inflation forecast made by the authorities is treated as an intermediate target. The monetary authority can then implement inflation targeting by simply setting the instrument such that its inflation forecast for a horizon corresponding to the control lag equals the inflation target. The public can also monitor and evaluate inflation targeting by observing and scrutinizing the monetary authority's inflation forecast.

The conduct of monetary policy under inflation targeting is then based on the inflation forecasts. If the forecasts are on target, then the monetary policy is appropriate. If the forecast is above (below) the target, then monetary policy should be tightened (eased). This improves monetary authorities communication with the public, the public's understanding of monetary policy and the predictability of monetary policy. This implies that once a central bank has settled down on an inflation target, it must turn to the practical problem of achieving that target which, in turn, requires information to forecast inflation. The countries that

pursue inflation targeting have relied more on variables that provide useful information on the future inflation, known as information or indicator variables. But these indicator variables are not treated as policy targets themselves. Examples include, the monetary conditions index in New Zealand and Canada, the broad money, Aggregate Level of Price (ALP) in Spain. In fine, though the targeting countries differ in the degree to which they emphasize on particular indicators of inflation in their decision making, all of them rely on a variety of sources of inflation when deciding on policy. One of the most interesting proposal in that sense is the P^* model developed by Hallman, Porter and Small in 1989 (HPS henceforth). The introduction of the P^* model has drawn new attention to the Quantity theory of money by explicitly linking the determinants of long run equilibrium prices to the short run dynamics of actual inflation. In this chapter an effort is made to identify the major indicator variables of inflation and estimate an inflation forecaster model.

The remainder of the chapter is as follows. In section 4.1, the formulation of the P^* model is presented followed by the discussion on Hodrick-Prescott (HP) filter used to measure potential output of the economy in section 4.2. Section 4.3 outlines an inflation-forecasting model that has been latter on applied for India. The empirical analysis for India is discussed in section 4.4. Section 4.5 concludes the chapter.

4.1 The P^* Model and Its Performance

The P^* model, developed by Hallman, Porter and Small in 1989 is used to identify the inflationary potential of the economy. This is a model of inflation dynamics that enables forecasting short run inflation changes as a process in which the actual price level adjusts to the equilibrium price level determined in line with the quantity theory of money whose basic identity is the equation if exchange i.e.

$$p + y = m + v \qquad \ldots (4.1)$$

where p is the aggregate price level, m is the money supply, v is the velocity of circulation of money and y the real output. All the variables are expressed in logarithms.

The model developed by HPS (1989, 1991) links the behavior of the price level to the growth of money supply by imposing two hypotheses on the equation of exchange given in (4.1), viz., (i) real output y_t fluctuates around potential real output y_t* and (ii) the velocity v has an equilibrium level v*, independent of time, that it tracks in the long run.

The long run equilibrium price level is then determined by the current money supply, potential output and the equilibrium rate of money circulation i.e.

$$p^* = m + v^* - y^* \qquad \ldots (4.2)$$

p^* is therefore the price level that will emerge when output and velocity are at their equilibrium level and no other disturbances occur.

According to the quantity theory, it is assumed that the actual aggregate price level tends in the long run towards this p^* value. From equations (4.1) and (4.2) the following relations among prices, real output and velocities will emerge i.e.

$$p - p^* = (y^* - y) + (v - v^*) \qquad \ldots (4.3)$$

Hence the price gap $(p - p^*)$ represents a combination of two other gaps i.e. output gap $(y^* - y)$ and velocity gap. The proponents of P^* model of inflation suggest that the discrepancy between the long run equilibrium price level P^* and the actual price level is the major cause of inflation. They argue that excess money that is not reflected in the current price level may depress current velocity below its long run level and/or raise output above its potential. This will generate an inflationary situation, since the current price level will be below its equilibrium value. As lags in money demand and interest rates adjust to clear the excess money supply, current velocity will revert to its long run equilibrium v^*. Similarly lags in the formation of inflationary expectations and adjustments in nominal wages will force current output to converge toward potential output. Hence in the long run, when all the adjustments take place, the price level will converge to its long run. Any divergence of the price level P^* from the actual price level, i.e. any

positive or negative price gaps p – p^* then suggest that the future price level will slowdown or accelerate. Unlike the traditional inflationary pressures indicators, which only take into account either the output gap or velocity gap, in the P^* model the price gap takes into account of both real as well as monetary factors. Hence the proponents of P^* model argues that P^* indicator offers more information and predictive power than maintaining increments in money supply.

The short run dynamics for inflation proposed by HPS are then

$$\pi_t = \alpha(p_{t-1} - p^*_{t-1}) + \sum_{i=1} \beta_i \Delta\pi_{t-i} \qquad \ldots (4.4)$$

where π_t is the change in prices. A less restrictive form of equation (4.4), which replaces the price gap with its components, is compared by HPS with equation (4.4). The unrestricted model is of the form:

$$\pi_t = \alpha_1(v_{t-1} - v^*) + \alpha_2(y^*_{t-1} - y_{t-1}) + \sum_{i=1} \beta_i \Delta\pi_{t-i} \qquad \ldots (4.5)$$

Equation (4.5) can be seen as a model that nests an accelerationist Philips curve with that of a monetarist model of inflation. In case of an expectation augmented Philips curve, α_2 would be set to zero and rate of inflation adjusts to the output gap. On the other hand, a monetarist specification would have only the velocity gap and therefore α_1 would be set to zero. In this case, the inflation rate adjusts to monetary disequilibrium. HPS constrain the output gap and velocity gap to enter the dynamic equation for inflation with equal weight i.e. $\alpha_1 = \alpha_2 = \alpha$.

HPS first estimated equation (4.5) by applying the US data and found both the velocity and the output gaps to be statistically significant. The study also does not reject the restriction that $\alpha_1 = \alpha_2$. The model has since then generated a broad literature analyzing some of the theoretical and econometrical aspects of the approach and testing its empirical performance for several countries. Some economists view P^* with a degree of skepticism. For example, Christiano (1989) finds that P^* does not perform better than the other models at forecasting inflation from one to three years ahead. He pointed out that P^* is not inflation forecasters 'Holy Grail'. Also some others such as Funke and Hall (1994), Hall and Milne

(1994) view P^* with a degree of skepticism. There are, however, a number of papers that support the usefulness of this model (HPS 1989 and 1991; Hallman and Bryden 1992; Hallman and Anderson 1993]. For instance, HPS (1991) found out the validity of the P^* model for the US. On the basis of the findings they advocated for a framework in which the determination of prices is the primary long run focus and in which short run stabilization actions can be evaluated and monitored for their consistency with long term objectives. Pallardo and Esteve (2000) tested the performance of the P^* model as an inflation forecaster for the Spanish economy. They concluded that the long run relationship works as expected according to the model and the quantity theory of money. The error correction model constructed by using the gap between actual prices and long term equilibrium price level offers a consistent explanation for the short run dynamics in prices. P^* approach shows a forecasting ability to that of the other countries. On the basis of their results they argued for an inflation targeting framework rather than a monetary targeting for the Spanish economy.

However, it is quite often contended that original P^* approach is that it does not take into account the importance of the prevailing exchange rate regimes for the determinants of prices and inflation. Under a system of fixed exchange rates, the domestic price level in a small country is determined abroad and the domestic money stock becomes endogenous and demand determined. In this context Kool and Tantom (1994) developed a generalized P^* model that accounts for the international effects. They tested using annual data from 1960 to 1992 for five European countries such as Austria, Belgium, Denmark, the Netherlands and Switzerland. They investigate the extent to which prices in these countries have been affected by developments in Germany and US. The results indicated that both their own price gap and a price gap based on equilibrium prices determined abroad affect the country's inflation depending on the exchange rates. Frait *et al.* applied the P^* model including the fixed exchange rate to the Czech economy for the period 1991 to 1999.The results suggests the validity of the P^* model for the Czech economy .The foreign component of the price gap seems to be more important than domestic component which supports the hypothesis that the

equilibrium price level in the Czech Republic to a large extent determined by the monetary policy in the EU via the exchange rate peg.

4.2 Measurement of Output Gap

Before proceeding further, it is important to note here that the *P** model as well as most macroeconomic models that are used for forecasting and policy analysis require an estimate of potential output. For example, estimate of potential output are important inputs in different "Phillips curve models", where the gap between actual and potential output a key variable in determining the role of inflation In turn, potential output represents an economy's steady state level of output i.e., the level of output to which actual output reverts in the absence of temporary shocks. In the framework of monetary policy, the output gap provides a measure of inflationary pressures in the economy. A level of real GDP above potential i.e., a positive output gap will often be seen as a source of inflationary pressures due to the demand pressures in key markets and a signal that monetary authorities interested in avoiding an acceleration of inflation should tighten monetary conditions. A level of real GDP below potential i.e., a negative output gap will have the opposite implication. The output gap can thus be defined as the component of real output that is associated with changes in inflation and is consistent with Okun (1970) who defines potential output as being "the maximum production without inflationary pressure or more precisely ... a point of balance between more output and greater stability" (page 98).

Potential output measures the productive capacity of the economy and is determined by factors such as the level of technology, the abundance and quality of productive resources and the microeconomic environment. However, because it is difficult to quantify technology, which is inherently unobservable, it has generally proven impracticable to estimate potential output on the basis of these fundamentals. Instead, economists used a variety of techniques to infer the level of potential output from observable macroeconomic data. In essence, the problem is one of decomposing real output into a trend and cycle component. The trend is interpreted as a measure of the economy's potential output and the cycle is interpreted as a measure of the output gap.

This is not a straightforward decomposition to effect There is little consensus in the economics literature about the most appropriate representation of the trend and cycle components of real output. Some of the earliest estimation techniques used some explicit or implicit assumptions about the dynamics of real output to identify the output gap. The methods simply assumed that the trend was a deterministic function of time that could be extracted using a simple linear regression. However, the findings of Nelson and Plosser (1982) indicate that trends in economic time series are generally not deterministic and are more appropriately method as stochastic process.

During past twenty years or so economists have developed a wide variety of techniques to extract a stochastic trend from real output such as those proposed by Hodrick and Prescott (1997), Beveridge and Nelson (1981), Chochrane (1994) and Blachard and Quah (1989). These techniques use a broad range of statistical criteria and assumptions about economic structure to identify the trend. All techniques for estimating potential output and the output gap are prone to potentially large uncertainties. Methods based on assumptions about economic structure approximate unknown features of the economy and are therefore subject to model uncertainty and specification errors. Conway and Frame (2000) and Quah (1992) argues that there are an infinite numbers of trend cycles decompositions that estimates of potential output based statistical criteria may be arbitrary from an economic perspective. Notwithstanding these apprehensions, the most popular of these techniques is that proposed by Hodrick and Prescott (1997) known as HP Filters. The HP filter decomposes a time series y_t into an additive cyclical component y_t^c and a growth component y_t^g

$$y_t = y_t^g + y_t^c \quad \ldots (4.6)$$

Applying the HP filter involves minimizing the variance of the cyclical component y_t^c subject to penalty for the variation in the second difference of the growth component y_t^g Hence Hp filter sets the potential component of output to minimize the loss function L,

$$L = \sum_{t=1}^{s} (y_t - y_t^g)^2 + \lambda \sum_{t-2}^{s-1} [(y^g_{t+1} - y_t^g) - (y^g_t - y^g_{t-1})]^2 \qquad \ldots (4.7)$$

where λ is the smoothness parameter and s is the sample size. In this case the HP filter trades off the degree of smoothness in potential output against the extent to which it tracks actual output. This trade off is determined by the smoothness parameter λ which can be set to an value between the extremes of zero, where potential output is always equal to actual output and there is no output gap and infinity, where potential output corresponds to a log linear time trend.

The advantage of HP filter is that it renders the output gap stationary over a wide range of smoothing values and it allows the trend to change over time. King and Rebelo (1993) show that the HP filter can render stationary any integrated process of up to the fourth order. But it can also have disadvantage that the selection of the smoothing weight is arbitrary, and it also matters to the estimate. The appropriate value depends on the relative size of the variances of the shocks to permanent and transitory components of output. For quarterly data, Hodrick and Prescott proposes setting λ equal to 1600. Guay and St Amant (1996) present Monte Carlo evidence, however, that a smoothing parameter of 1600 is only appropriate under implausible joint assumptions about the relative importance of demand and supply shocks and about the persistence of cycles.

There are also other doubts about the accuracy of the HP filter in decomposing time series into trend and cycle. For example, there is evidence that the accuracy of the decomposition varies over different data generating processes and different data sets [King and Rebelo (1993); Harvey and Jaeger (1993)]. Another problem to HP filter is that the estimates of potential output can change as new data come to hand since it contains leads and lags of output in the loss function. It is only a symmetric two-sided filter at the middle of the sample, with end points having more leverage. Using a sample of 128 observations, St Amant and Van Norden (1997) show that observations at the center of the sample at most a six percent weight while the last observations accounts for 20 percent of the weight. The end point problem implies that estimates of the gap at the end of the sample may be

subject to substantial revision as new data come to hand, the period, which is of most interest to policy makers. Fisher, Mahadeva and Witley (1997) pointed out that HP filter suffers from the additional disadvantage that it relies on extrapolations of data beyond the end of the period under consideration.

However, these problems have not prevented the widespread use of Hodrick and Prescott's filter to identify the cyclical component of output. Arguments commonly made to justify its use are that

i. it extracts the relevant business-cycle frequencies of output.
ii. it closely approximates the cyclical component implied by reasonable time series models of output.

4.3 Inflation Targeting: The Information Variable Approach

The P^* model, as it is found in the literature, has been proved to perform well for forecasting inflation in the long run. However, it is conditioned upon the assumption that the velocity is stable and the income elasticity of the money demand is unity. But in recent times there are ample evidence of instability of the money demand function and consequent shift in velocity. Again P^* model is also crippled by the measuremental difficulty associated with long run equilibrium velocity and at the same time velocity depends upon an array of other factors. Though the P^* model happens to forecast inflation well, it does that in long run only. However, the inflation targeting framework also requires a certain a short-term target, which will gradually converge with the long run goal. This implies that to monitor the behaviour of inflation the inter linkages among various related variables should be taken into account while forming inflation forecast model. Hence some economists have shifted their focus to search alternative forecaster models (Debelle and Lim, 1998; Leiderman, 1999; Bar-Or. 1999, Leiderman and Bar-Or, 2000 and) by taking into account the underlying determining factors of inflation. In the information variable approach the search is for a set of variables that can forecast inflation well. The same variable, depending upon the way it is used can serve as an intermediate target or an information variable. For instance, the exchange rate is an intermediate target under a fixed exchange rate regime whereas it can serve as an information variable under an inflation targeting

framework. So also, monetary aggregates are information variables if the focus is not on the causal relationship between money and inflation, but is mainly on whether changes in monetary aggregate predict inflation. Friedman and Kuttner (1992) point out that as long as movements of money contain the information about future movements about income and inflation, monetary policy can exploit that information by responding to observe money group regardless of whether the information it contains reflects any causation. The main advantage with the information variable approach that one makes use of a number of indicators including non-financial ones for implementing monetary policy. Variables which cease to predict inflation well can be removed from information set and where possible be replaced by other variables which predict better. Similarly under the information variable approach the central bank is not committed for credibility reasons to a particular nominal value of the exchange rate or growth rate in a particular aggregate. More generally, given the lack of consensus on the structural properties of the monetary transmission mechanism, the information variable approach provides stronger theoretical underpinnings for the conduct of monetary of policy. Given the emphasis on forecasting in line with the information variable approach a model of the inflation process which includes the information variables is required, to provide a forecast of inflation, which can be compared to the inflation target at the policy horizon. Taking note of this and following the contribution by Debelle and Lim (1998), we have made an attempt to estimate a model of inflation forecasting for India. The detailed description of such model is presented below.

We assume that wholesale price inflation in India (π) is a weighted average of domestic inflation (π^d) and imported inflation (π^m), with α as the share of imported goods in the wholesale price index:

$$\pi_t = (1-\alpha)\pi_t^d + \alpha\pi_t^m \qquad \ldots (4.8)$$

The price of imported goods is equal to the exchange rate times the foreign price level, so that imported inflation is equal to the change in the exchange rate plus the foreign inflation rate:

$$\pi_t^m = \Delta e_t + \pi_t^f \qquad \ldots (4.9)$$

Domestic inflation is determined by the standard expectations-augmented Phillips curve, where change in inflation rate depends on output gap and expected inflation as defined below.

$$\pi_t^d = \pi_t^e + \beta(y_t - y^*) + u_t \qquad \ldots (4.10)$$

where y is the level of output, y^* is the level of potential output and π^e are inflation expectations, which is approximated by lags of the inflation rate. The output gap $(y_t - y^*)$ is determined by interest rates and real exchange rate changes. Substituting equations (4.9) and (4.10) into (4.8) results in a model where inflation is a function of the output gap, exchange rate changes and foreign inflation. Monetary policy influences inflation through the impact of interest rates on output gap, and the exchange rate on inflation and output gap. Solving for π yields:

$$\pi_t = c_0 + c_1(y_t - y_t^*) + \alpha(L)\pi_t + b(L)\pi_t^f + d(L)e_t + \varepsilon_t \quad \ldots (4.11)$$

4.4 Empirical Analysis

On the basis of the discussions made so far, we have made an attempt to see the performance of P^* model for Indian economy. For this purpose, the study uses annual as well as monthly data. The annual data covers the period 1951 to 2001 whereas the monthly data set spans over January 1985 through March 2001. The monthly period has been so chosen keeping view in the adoption of monetary targeting in India in 1985. The variables included in the study are: Gross Domestic Product (GDP), Wholesale Price Index (WPI) to construct headline inflation, broad money (M3), monthly weighted average call money rate as a representative interest rate, US Consumer Price Index (USCPI) as a representative for import price and bilateral exchange rate of the US dollar verses Indian rupee. It may be noted that for monthly case the study uses Index of Industrial Production (IIP) as the proxy for output as data on GDP is not available.

The study uses primarily two techniques, viz., cointegration and Vector Autoregression (VAR). The cointegration techniques which are popular are the Engle-Granger (EJ) two step procedure and Johansen-Jusselius (JJ) maximum likelihood procedure. In the present study only the JJ approach is used[1]. Besides, we have also estimated VARs along with its two important tools, namely impulse response functions and forecast error variance decomposition to explore the relationship and dynamics among variables considered.

Prior to the analysis in line with the above discussion, it necessities that the variables must be checked for the order of integration. For this purpose we have employed two tests, viz. Augmented Dickey Fuller (ADF) and Phillips Perron (PP) to check for non-stationarity. The results of these tests are presented in tables 4.1 and 4.2.

Results of P* model

First we present the results due to the P^* model. In the P^* model, the measure of potential output is obtained by using the HP filter. Since the P^* model is based on the existence of a long run equilibrium level of velocity to which the current velocity tends, it requires a measure of long run equilibrium velocity (V^*). In their influential work, HPS (1989) considered that the velocity of money was stationary for the United States, which however has been discarded in the recent literature (Bordes et al, 1992, Attaa-Mensah, 1996). From the results presented in table 4.1, it is found that both ADF and PP tests reject the null hypothesis of non-stationarity is rejected for velocity in case of annual data as well as for monthly data. Hence the long run equilibrium for velocity is not the mere average of the series and hence, the existence of a unit root for velocity leads to an approach in which stochastic tendencies for the series are considered and calculated by means of Hodrick-Prescott detrending method. Besides, real *GDP*, broad money and prices are found to be non-stationary. For monthly case, *IIP* and broad money are stationary on level whereas price is integrated of order one. P^* is calculated by using current money supply *(M3)*, the long run equilibrium velocity *(V^*)* and

[1] For a detailed discussion on methodology see appendix

potential output as discussed above. The order of integration for P^* is also found to be one.

The validity of the P^* model requires that P and P^* form a cointegrating vector. In this sense some recent papers have investigated the P^* approach using multivariate cointegration analysis (Allen and Hall, 1991; Hall and Milne, 1991; and Funke and Hall, 1994). So to analyze the P^* performance for India we have used Johansen-Juselius (1991) cointegration method. For annual data, the results are presented in table 4.2. The trace statistics show that the null hypothesis of no cointegrating vector (r=0) between p and p^* is rejected against the alternative of one or more cointegrating vectors (r>0). Next, the null of r≤1 against the alternative of two cointegrating vectors cannot be rejected, since the 95% critical value exceeds the estimated value. At this point, we conclude that there are one cointegrating vector. But the exact number of cointegrating vectors will be conformed from the λ_{max} statistics. The results of the λ_{max} statistics show that the null hypothesis of no cointegrating vectors (r=0) against the specific alternative of r=1 is clearly rejected. In the next step, the test of the null hypothesis r=1 against the specific alternative r=2 cannot be rejected at 95% level of significance. Hence, by considering both λ_{trace} and λ_{max} statistics, we conclude that there is one cointegrating vector between p and p^*. The presence of one cointegrating vector shows the long run equilibrium relationship between p and p^*. Similar result is also obtained for monthly analysis, which is evident from table 4.4. The analysis of short run movements in prices through an error correction model where the inflation rate is explained by its own lagged values and by the gap between the actual value of overall price level and its long run equilibrium value requires that in the long run this gap vanishes. The results for the short run adjustment are given in tables 4.5 and 4.6. As expected, according to P^* model, the error correction coefficient is highly significant and negative. This implies that if prices are higher than the equilibrium value it will cause as low down in inflation. As a whole the results show that the short run price movements for the Indian economy are reasonably well described by considering their intrinsic movements and the P^* gap.

Results of VAR Analysis

Having discussed the need for forecasting inflation as well as for the use of multiple indicator approach, time series techniques in the econometric tradition of Granger and Sims are the tools that can be utilized in implementing monetary policy. As pointed out earlier, a full understanding of structural features of the transmission mechanism is not a necessary condition for targeting inflation successfully. Instead, the need is for identifying a set of variables that contain information on future inflation. Typically the multiple indicator approach has been tested by using Vector Autoregression (VAR) for various countries (e.g., Debelle and Lim, 1989). In similar line, here an attempt is made to identify a set of indicators that has predictive information on inflation on the basis of the tests of variance decomposition and impulse response function. While the forecast error variance decomposition provides information about the leading indicators of inflation by measuring the proportion of variance in inflation being explained by the variance of the indicator variable, the impulse responses assess whether the indicator variables contain information about inflation sufficiently far into the future to be meaningful.

Following the case made above for the use of VAR in the conduct of inflation targeting, we estimate the VAR system of the for both the annual as well as monthly case:

$$\Delta X_t = \alpha(L)\Delta X_{t-1} + \beta(L)\Delta Y_{t-1} + \varepsilon_t \qquad \ldots (4.12)$$

where X is the target variable, that is, the inflation in our case, Y is the vector of indicator variables which include broad money (M3), real output gap, call money rate (CMR), bilateral exchange rate (Rupee verses dollar), and US inflation. It may be noted that for constructing output gap, we have first used the HP filter to compute the long run potential output (GDP in case of annual data and IIP for monthly case). The choice of variables included in this framework is guided by a set of previous works Debelle and Lim, 1998; Hoffmaister, 1997). The inclusion of broad money (M3) follows from the fact that it is the monetary aggregate that has bees used by the Reserve Bank of India for targeting purpose. Also the conduct of monetary policy with the narrow aggregates is constrained given that

the major portion of the bank liabilities happens to be the time deposit (Vasudevan, 1998). The call money rate is included as it reflects the money market conditions better than other interest rates. The bi lateral exchange rate is included to capture the linkage with foreign exchange market. Specifically the Rupee-Dollar exchange rate is considered given the fact that the US is the largest trading partner of India. The output gap is included instead of growth rate of output because there has been enough evidences that changes in output gap is a major determining factor influencing the changes in inflation rather than the growth rate. The US inflation is included to capture the effect of import prices on domestic inflation. All the variables except call money rate are measured in logarithmic term.

Before going for estimating VAR system it requires to check for stationarity. The results of the unit root tests presented in table 4.1 indicate that for annual data real output gap, call money rate and domestic inflation are found to be stationary on levels whereas broad money, exchange rate and US inflation are found to be integrated of order one or non-stationary. However, for monthly case, broad money is found to be stationary and other variables report similar unit root results as in the annual case. Hence the VAR is estimated by measuring non-stationary variables on their first difference and the rest on their levels.

We follow two approaches in forecasting inflation. First we assess the predictive content of a wide range of variables using VAR analysis and second, we estimate an inflation equation along the line of equation 4.11. Given that the results of VAR are sensitive to the choice of ordering, the VAR hare is estimated using Choleski decomposition procedure for orthogonalzing the VAR innovations. Also to check the consistency of these results, different orderings are chosen. The order of variables has been identified from the theoretical justification of arranging indicator variables first and target variables later in VAR analysis, which follows as thus:

{Real output gap, Broad money aggregate, Exchange rate, US inflation, Call money rate, Inflation}

The lag length is chosen by using the likelihood ratio (LR) test and we settled for a lag length of 2 for annual case and the same for the monthly data is set at 12. After estimating the VAR, we have reported the results due to forecast error variance decomposition for varying forecast horizons, which are presented in tables 4.7 and 4.8 for both annual and monthly case respectively. It follows that the higher these values are, the stronger is the predictive content of the indicator variable for the targeted one under consideration.

The forecast error variance decomposition reported in table 4.7 indicates that the output gap contains higher degree of predictive content for inflation even over a very long period. Also its impact on inflation is relatively quick as evident from the larger forecast variance in the first period. Again both broad money aggregate and the exchange rate have greater predictive information on inflation. However, both M3 and the exchange rates have lagged impact, as they do not have any predictive content in the first year. Though this conforms the conventional notion that money affects inflation with lags, it contradicts the view that exchange rate pass through on inflation is fast in case of open economies. The US inflation and the interest rate have very little predictive power for inflation though it increases over time.

The results of monthly VAR estimation reported in table 4.8 show that the broad money aggregate has better predictive power for inflation and it increases over time. Also the interest rate contains more information on inflation over time. The exchange rate also has greater predictive power for inflation in short horizons and it decreases as the period increases. So this is treated as a good predictor of inflation. The output gap is a poor predictor for the short period whereas it increases to a substantial extent by the end of two years. Hence the output gap happens to be a reasonable predictor explaining 11 percent of the variance of inflation at the end of two years. However, the US inflation does not have any predictive information for any horizon.

The exercise so far has identified a set of variables that contain, in a statistical sense, information about future inflation. However, for these variables to be operationally useful as leading indicators, the time dimensions matters. In other

words. we are interested in knowing whether the movements in these financial and monetary indicators contain information about sufficiently far into the future, so that policy makers can operationally react to this information in a meaningful way. One way of arriving at judgments about the time dimension if the leading indicators are by estimating impulse responses, which trace out the time path of the target variable in response to a unit shock in the monetary or financial variables.

The results of impulse response functions for the indicator variables are presented in figure 4.1. From the figure 4.1 it is clear that the impulse response function for output gap is significant for about 6 years. This in turn can be taken up as an indication that movements in the output gap contains information on inflation between one to six years ahead which is a long enough time for the policy makers to respond to the movements in the output gap in a meaningful way. The impulse response function for broad money aggregate is not as statistically robust as in the case of output gap. The peak of the impulse response occurs between the second and the third year. However, given the fact that money affects inflation with lags and the evidence shows that the lag length happens to be two years, then movements in the broad money aggregate could also provide useful information on future inflation from an operational point of view.

Similarly, the impulse response for bilateral exchange rate is statistically significant in the period of first three years. This implies that the information on future inflation contained in exchange rate can be used for constructing effective feedback rules. In case of the impulse responses for US inflation and the interest rate. it is found that the peak occurs between 2 and 4 years which is a good policy horizon for these variables to have predictive information on inflation. Figure 4.2 presents the impulse response functions for the indicator variables for monthly data. The impulse response functions for output gap shows that the movements in the output gap contain information on inflation for a longer horizon of approximately 12 to 30 months and will be operationally useful for policy makers. The responses to any shock in broad money also happens to have information far into the future. However, the peak is traced in first 10 months though the impact persists over a period of 25 months. Hence the monetary aggregate can provide

information on future inflation over a reasonably good horizon. The impulse response functions for the bilateral exchange rate is significant for first 10 months which is also quite a short horizon to provide a systematic feedback rule for policy action. The impulse response function for US inflation suggests that it does not have any predictive content for inflation over any horizon. The impulse response function for interest rate shows that the peak which occurs very fast which is between 5 and 10 months persists for a long period. This implies that movements in interest rate can provide information on future inflation.

From the analysis, it is evident, both from annual as well as monthly analysis, that the real output gap and monetary aggregates appear to be the best predictor of inflation in India. Exchange rate and interest rate are also reasonably good predictors of inflation. However, the US inflation does not have such predictive content for domestic inflation. The impulse response exercise indicates that the variables with better predictive content such as money, output gap, and call money rate also contain information on future inflation but over a long horizon, so that policy makers can operationally react to this information in a meaningful way. The implication of these findings is that these results offer additional information for the conduct of monetary policy. However, to see if these indicator variable, if modlled as an equation can provide a better out-of-sampling inflation forecaster, we have estimated the inflation equation documented in equation 4.11 over the period 1951 to 2001 for annual data and for the period 1985:1 to 2001:3 for monthly data with the output gap, changes in the nominal bilateral exchange rate and the US inflation as explanatory variables. The monetary aggregate and interest rate are not included as they are treated as controlled variables.

However, there is some debate over the use of this information by the policy makers in forming the inflation forecast. In this context, it is very often argued that the most logical approach would be to weight the predictive information of different indicators on the basis of variance decomposition results, taking into account the lag structures implied by the impulse responses and conduct monetary policy on this information set. This strategy, however, may give rise to unstable feedbacks in the absence of implicit weights given to the plausible structural features of the transmission mechanism. The approach under these circumstances

should be to include judgments gathered from out of model information in conducting monetary policy.

Table 4.9 shows that the estimated inflation equation explains the inflation developments reasonably well with an adjusted R^2 of 89 percent for annual data. The comparison between actual inflation and the forecasted inflation is presented in figure 4.3. The results thus reported shows that the output gap variable is statistically significant and of expected sign with one lag suggesting that deviation of output from potential output feeds through inflation relatively quickly. The rate of depreciation of domestic currency vis-à-vis the US dollar has an important effect on inflation after one lag. The US inflation though being significant has low impact on domestic inflation. The out of sample forecast for the period 1985 – 2001 shows that barring the period 1991 – 1995, the equation predicts inflation developments reasonably well. The poor forecast for the period 1991 – 95 may be due to the crisis in 1991 characterized by vary high inflation with too low growth rate and its impact over subsequent periods.

The same equation for the monthly data, presented in table 4.10, also predicts inflation quite well with an adjusted R^2 of 88 percent. The significant value of lagged inflation coefficient indicates the presence of inertia in the inflation process and proxying for expected inflation. The output gap and the exchange rate are statistically significant with expected sign. The US inflation does not have much impact given the very small value of its coefficient. As a whole the inflation forecasting equation when estimated for monthly data gives a much better out of sample forecast inflation for the period 1997 – 2001 as evident from figure 4.4.

4.5 Concluding Remarks

In this chapter we presented a detailed discussion on the need for inflation forecasting to implement inflation targeting. Given the fact that inflation target must be proactive rather than reactive the central bank must focus on the forecast of inflation at the policy horizon. This implies that a set of indicators of inflation should be identified and forecasting models should be constructed to see the future developments in inflation. In this context the objective of the chapter was to forecast inflation development in India. At the outset, the performance of widely

used P^* model was evaluated for Indian economy and the results due to cointegration analysis indicates the validity of the P^* model for India. However, the stringent assumptions associated with P^* approach and its long run properties led us to consider the multiple indicator approach to forecast inflation. Invoking VAR for this purpose, we were able to find that real output gap, broad money and interest rate are able to provide better predictors of inflation whereas the exchange rate is a reasonable predictor. The US inflation has weak predictive content for domestic inflation. The inflation forecasting equation on the basis of indicator approach shows that it predicts the inflation developments quite well. However, the use of this forecasting equation is an illustration one. To implement inflation targeting the central bank has to develop its own forecasting model because as pointed out Woodford (1994) and Bernanke and Woodford (1997), the use of private inflation forecasting models may lead to multiplicity of equilibrium outcomes.

Table 4.1: Unit root test results for annual data (1951-2001)

Variables	On Levels		On first difference	
	ADF	PP	ADF	PP
Real output gap	-4.2001(4)	-3.5850(4)		
M3	-2.9079(4)	-2.8785(4)	-3.5879(2)	-3 5947(4)
Exchange Rate	-1.3200(4)	-1.4390(4)	-3.6105(3)	-4.8520(4)
US inflation	-0.8400(4)	-0.7095(4)	-4.6908(2)	--5.8281(4)
Call money rate	-3.7865(4)	-3.7063(4)		
WPI	-4.6880(4)	-5.6469(4)		
P-Star (P^*)	-3.2625(4)	-3.1026(4)	-3.9923(4)	-5.6760(5)
Velocity	-3 6571(4)	-2.6994(4)	-4.1142(4)	-6 8446(5)

Table 4.2: Unit root test results for monthly data (1951-2001)

Variables	On Levels		On first difference	
	ADF	PP	ADF	PP
Real output gap	-4.6041(4)	-8 4227(4)		
M3	-2 4940(4)	-4.6140(4)		
Exchange Rate	-1.8635(4)	-1.7534(4)	-5.6834(4)	-13.2918(5)
US inflation	-2.3113(4)	-2 3484(4)	-6.0289(4)	-9.2918(4)
Call money rate	-3.2199(4)	-3.6475(5)		
WPI	-0.9843(4)	-0.7696(5)	-5 3802(4)	-11.7359(5)
P-Star (P^*)	0.5293(4)	0.2699(5)	-5.6281(4)	-18.663(4)
Velocity	-1.3297(4)	-3.3524(4)	-9.1383(4)	-24.01739(4)

Note

1 The unit root test regressions include the intercept and trend.
2 The values in the brackets show the lag augmentation on the basis of AIC.
3 The critical values for ADF and PP tests at 1%, 5% and 10% are –3 51, -2.89, -2 58 (for annual data) and –3 46, -2 88, -2 57 (monthly data) respectively.

Table 4.3: Long run relationship between current price and long run price level (Annual Data)

Null Hypothesis	Alternative Hypothesis		95 % Critical Value
λ_{trace} tests		λ_{trace} value	
r = 0	r > 0	26.33	17.95
r ≤ 1	r > 1	3.95	8.18
λ_{max} tests		λ_{max} value	95 % Critical Value
r = 0	r = 1	22.37	14.90
r = 1	r = 2	3.95	8.18

Table 4.4: Long run relationship between current price and long run Price level (Monthly Data)

Null Hypothesis	Alternative Hypothesis		95 % Critical Value
λ_{trace} tests		λ_{trace} value	
r = 0	r > 0	18.33	17.95
r ≤ 1	r > 1	3.98	8.18
λ_{max} tests		λ_{max} value	95 % Critical Value
r = 0	r = 1	15.34	14.90
r = 1	r = 2	3.98	8.18

Table 4.5: Short run adjustment in the p-star model (Annual Data)

Variable	Coefficient	Prob.
C	0.033129	0.0018
LWPI(-1)-PSTAR(-1)	-0.667009	0.0000
D(LWPI(-1))	0.466492	0.0002
R bar - squared	0 833661	

Table 4.6: Short run adjustment in the p-star model (Monthly Data)

Variable	Coefficient	Prob
C	0.002153	0.0304
LWPI(-1)-PSTARM3(-1)	-0 135738	0.0000
D(LWPI(-1))	0.209005	0.0038
D(LWPI(-2))	0 099000	0.1730
D(LWPI(-3))	0 070990	0.3250
D(LWPI(-4))	0 068303	0.3410
D(LWPI(-5))	0 023069	0.7494
D(LWPI(-6))	0 157072	0.0281
R bar - squared	0 910509	

Table 4.7: Forecast Error Variance Decomposition test results (Annual Data)

Period	ROGAP	DLM3	DLERATE	DLUSINF	CMR
1	26.08489	0.423725	0 775479	0.382588	3.602364
2	18.76607	15.92223	13 42415	0.294373	2.560923
4	30.88712	10 95553	10.21017	5.800941	5.387438
8	28.23643	12 01837	10.88921	7.692496	6 591057

Note ROGAP, DLM3 DLERATE DLUSINF and CMR refer to real output gap first differenced logarithm of broad money, first differenced logarithm of exchange rate, first differenced logarithm of US inflation and call money rate respectively

Table 4.8: Forecast Error Variance Decomposition test results (Monthly Data)

Period	OUTGAP	LBM	DLERATE	DLUSINF	CMR
1	0.294199	4.462372	1.173364	0.317329	0.813058
2	0.252000	4 753789	9.185174	0.198869	1.711091
4	1.942102	7 773093	13 88258	0.911656	5.227585
8	1.826756	15 70608	10.26365	1.063255	12.35669
12	3 415590	15.11427	8 171859	1.271351	18.61761
16	7.866530	14.17101	8.347066	1.190038	19 90609
20	8 882613	16.08620	7.925053	1 304415	19.83961
24	9.000862	17.09681	7.774870	1.318223	19 46527
30	11.47146	16.55998	7.350884	1.780267	19.48316

Note ROGAP, DLM3, DLERATE, DLUSINF and CMR refer to real output gap, first differenced logarithm of broad money, first differenced logarithm of exchange rate, first differenced logarithm of US inflation and call money rate respectively

Table 4.9: Inflation forecaster model for annual data

$$\pi_t = c_0 + c_1(y_t - y_t^*) + \alpha(L)\pi_t + b(L)\pi_t^f + d(L)e_t + \varepsilon_t$$

Variable	Coefficient	Prob.
C	1.280548	0.0001
LINF(-1)	0.214884	0.1109
ROGAP(-1)	4.079378	0.0686
DLERATE(-1)	3.605497	0.0456
DLERATE(-2)	1.340958	0.4929
DUSINF(-1)	0.180258	0.0309
R bar - squared	0.893998	

Note LINF, ROGAP, DLERATE, and DLUSINF refer to logarithm of inflation, real output gap, first difference of logarithm of exchange rate, first difference of logarithm of US inflation

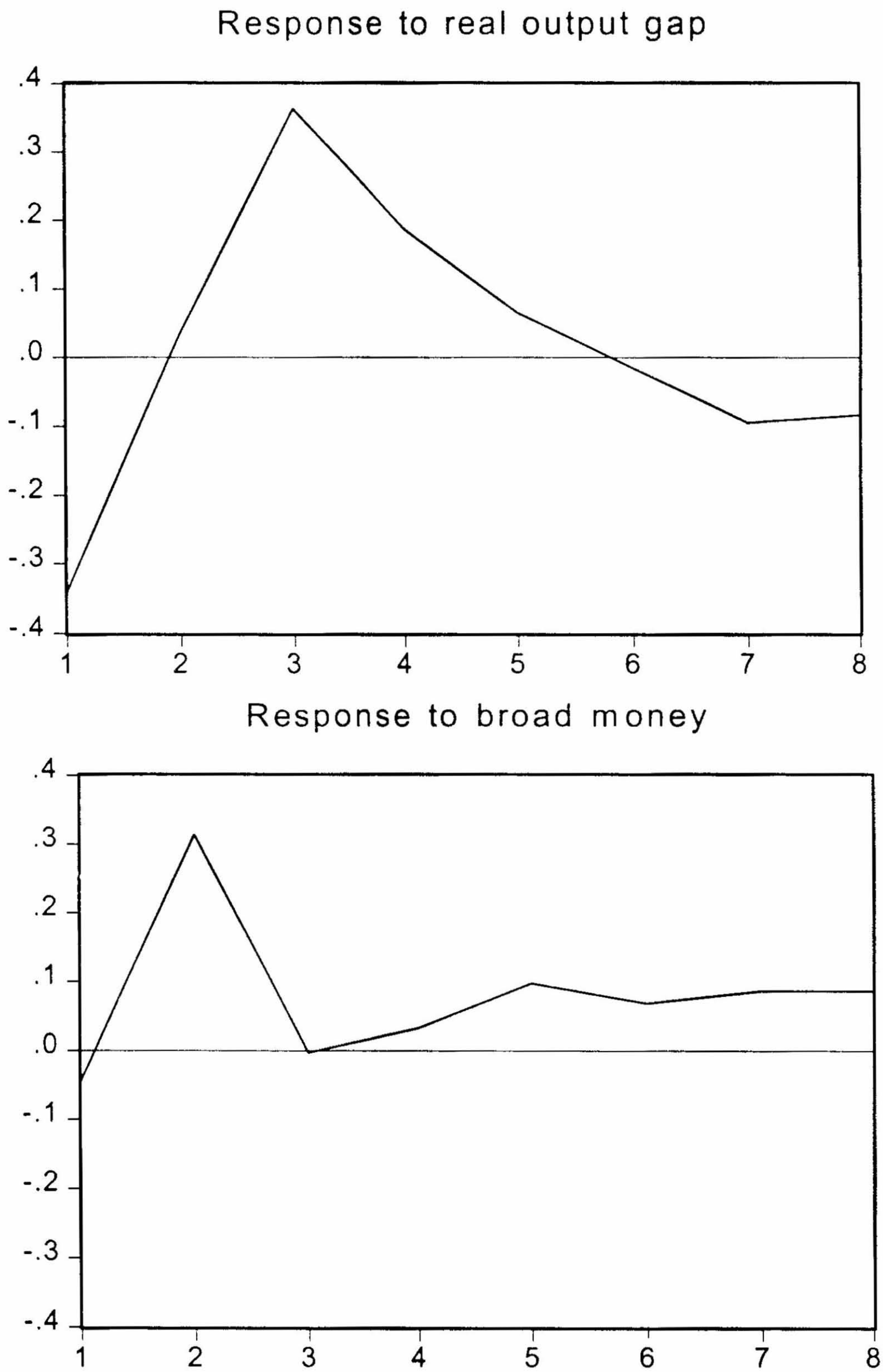
Table 4.10: Inflation forecaster model for monthly data

$$\pi_t = c_0 + c_1(y_t - y_t^*) + \alpha(L)\pi_t + b(L)\pi_t^f + d(L)e_t + \varepsilon_t$$

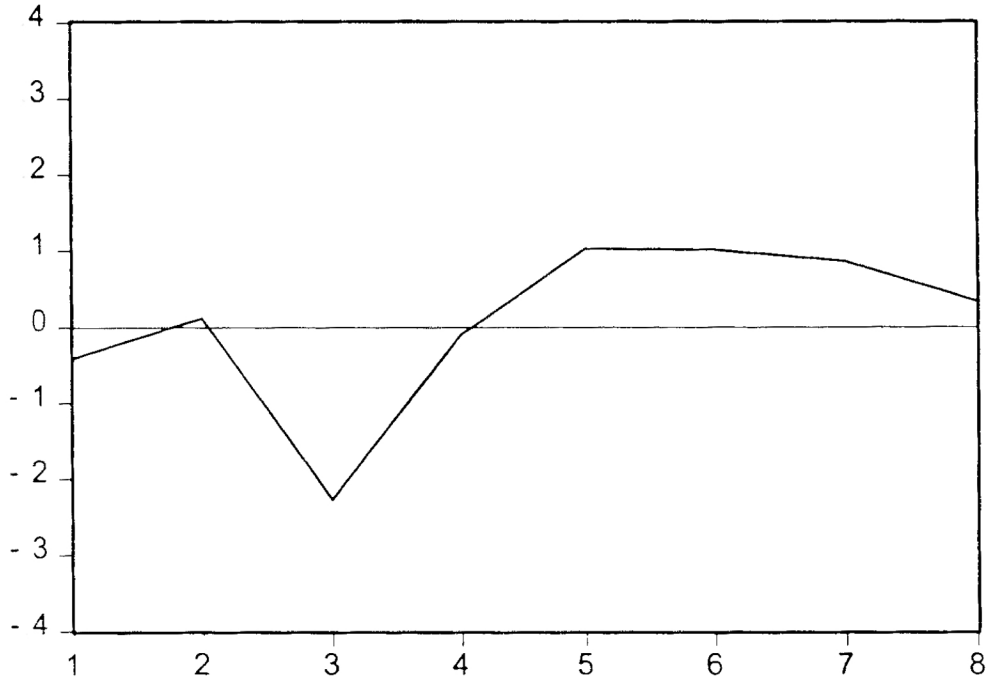
Variable	Coefficient	Prob.
C	0.162751	0.0054
LINF(-1)	0.906549	0.0000
OUTGAP(-1)	1.367933	0 0588
DLERATE(-1)	1 082646	0 1075
DLERATE(-2)	0.216192	0 7690
DLUSINF(-1)	0.203397	0 0955
DLUSINF(-2)	0.024026	0.9072
DLUSINF(-3)	-0 144163	0.4580
R bar squared	0.883315	

Note LINF, ROGAP, DLERATE, and DLUSINF refer to logarithm of inflation, real output gap, first difference of logarithm of exchange rate, first difference of logarithm of US inflation

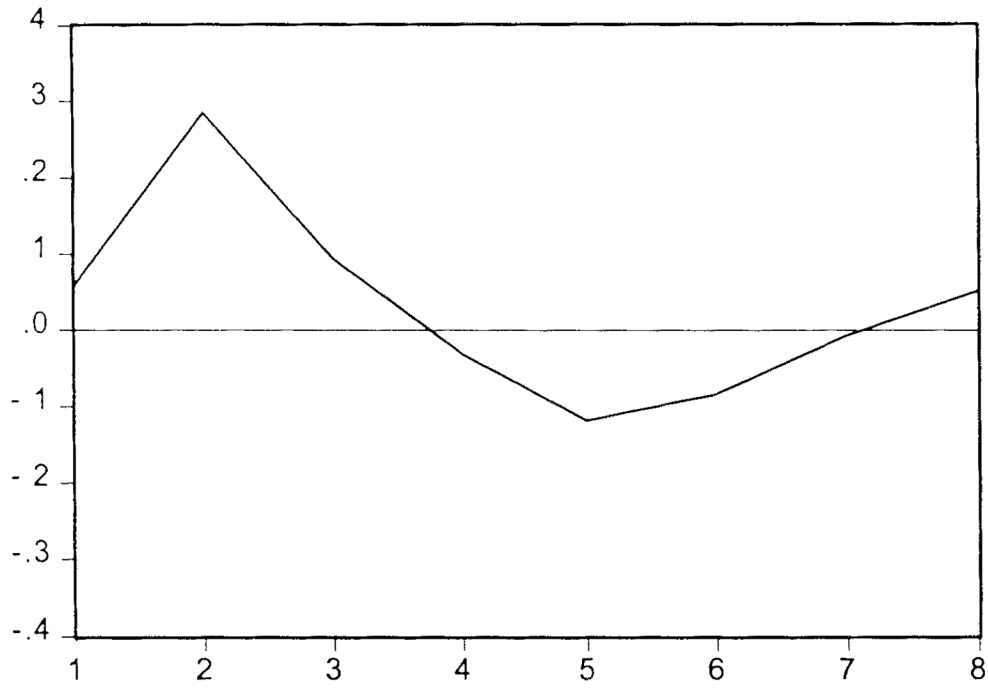
Figure 4.1 Response of inflation to one standard deviation shock in indicator variables (Annual Data)



Response to foreign inflation



Response to exchange rate



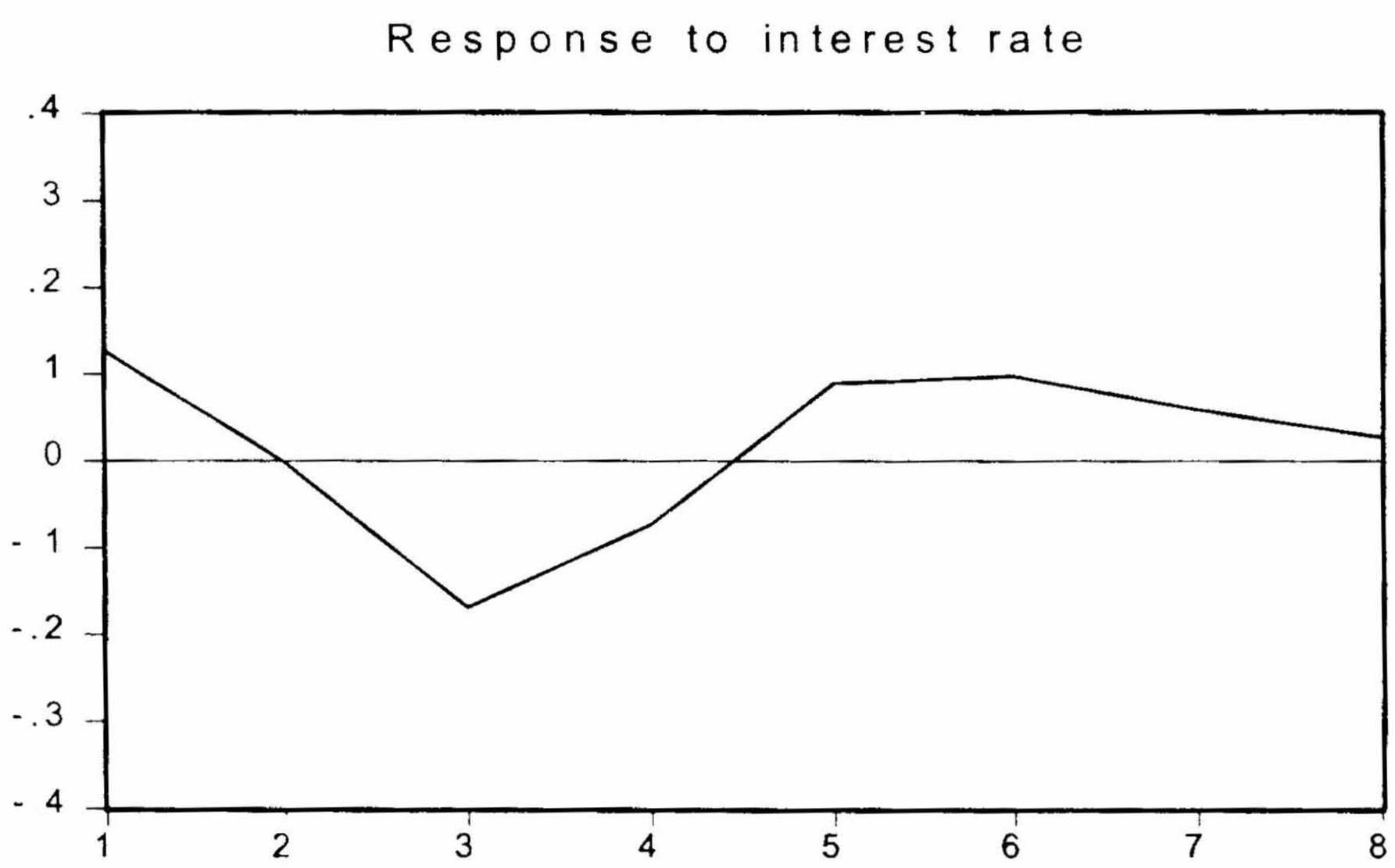
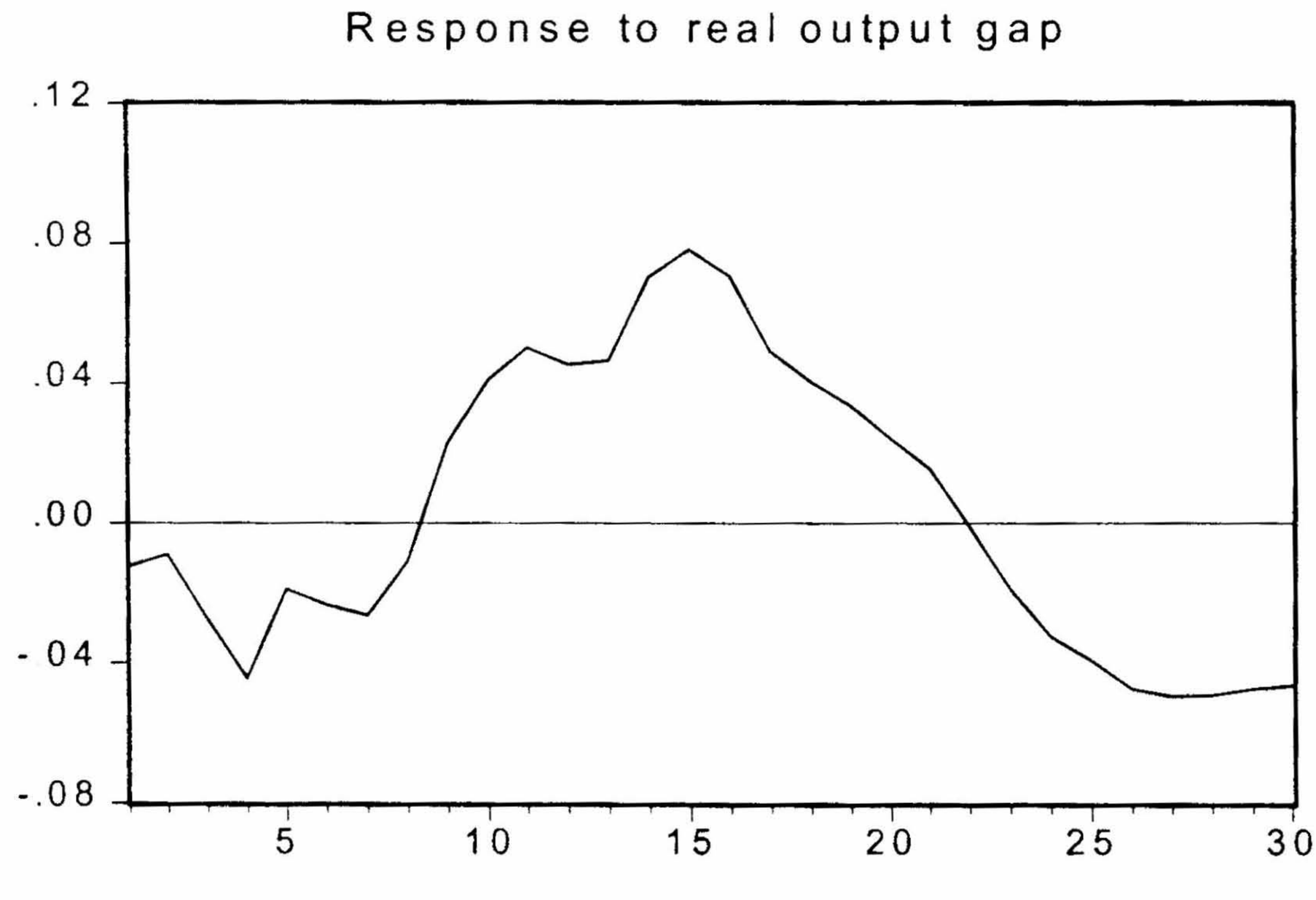
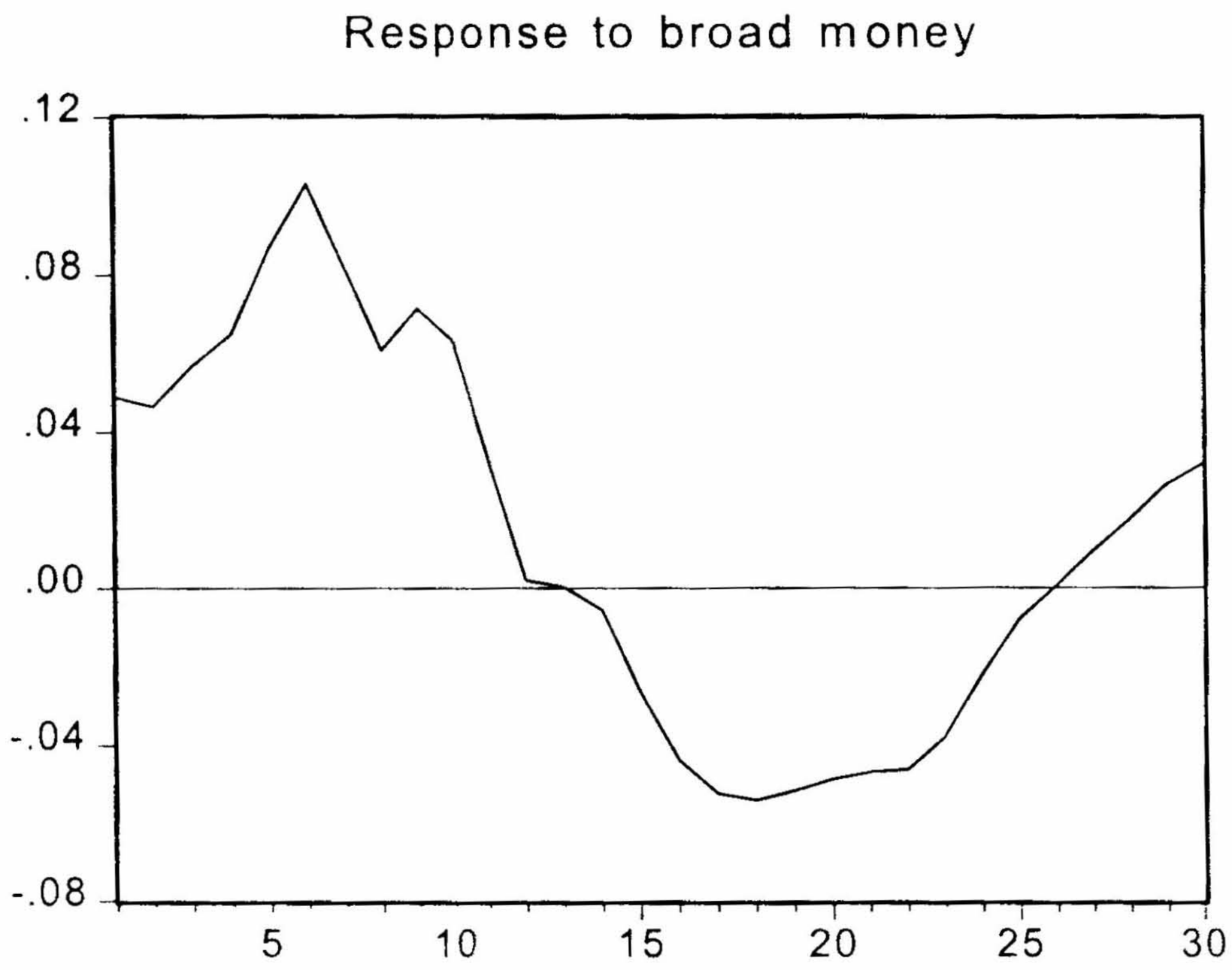
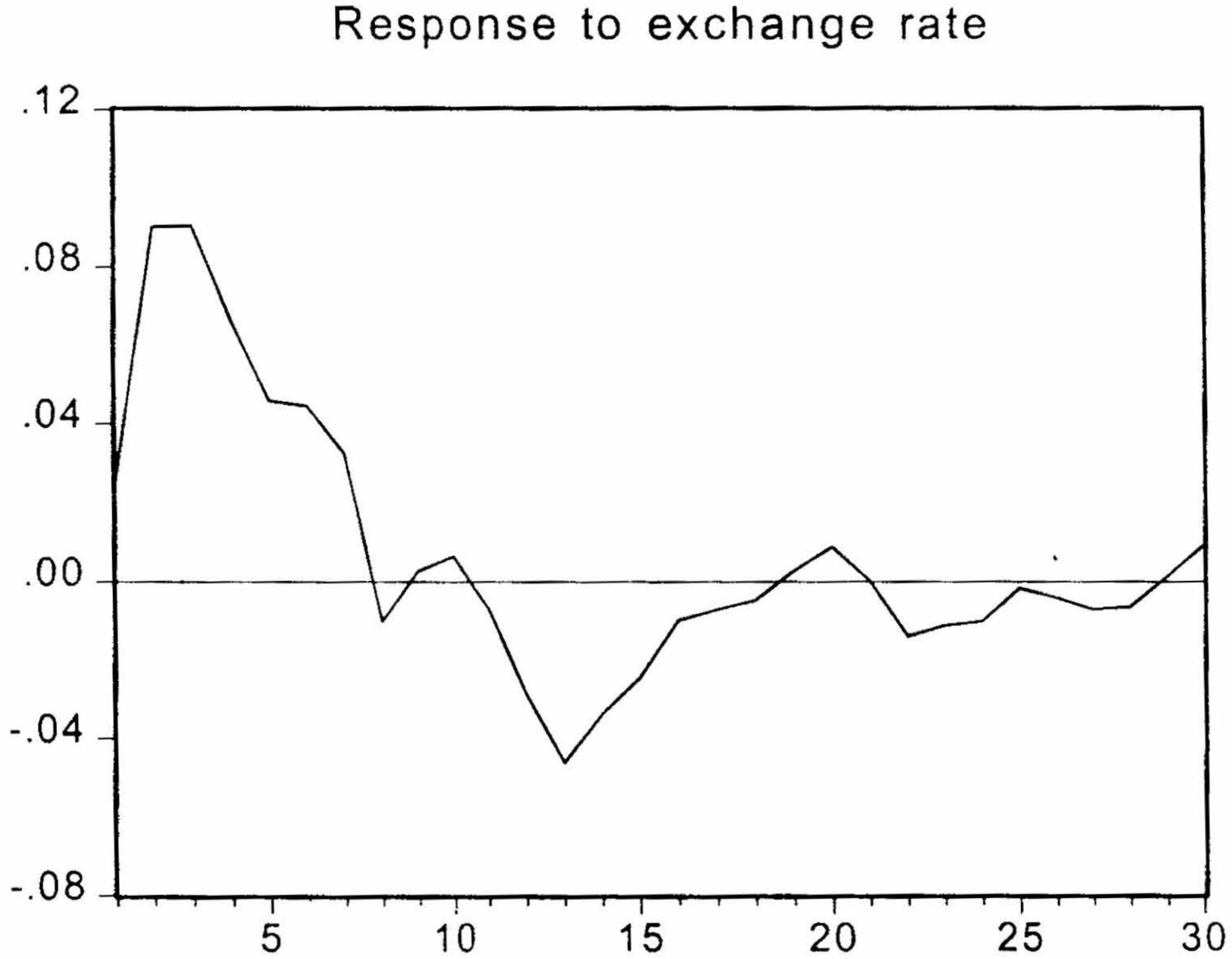
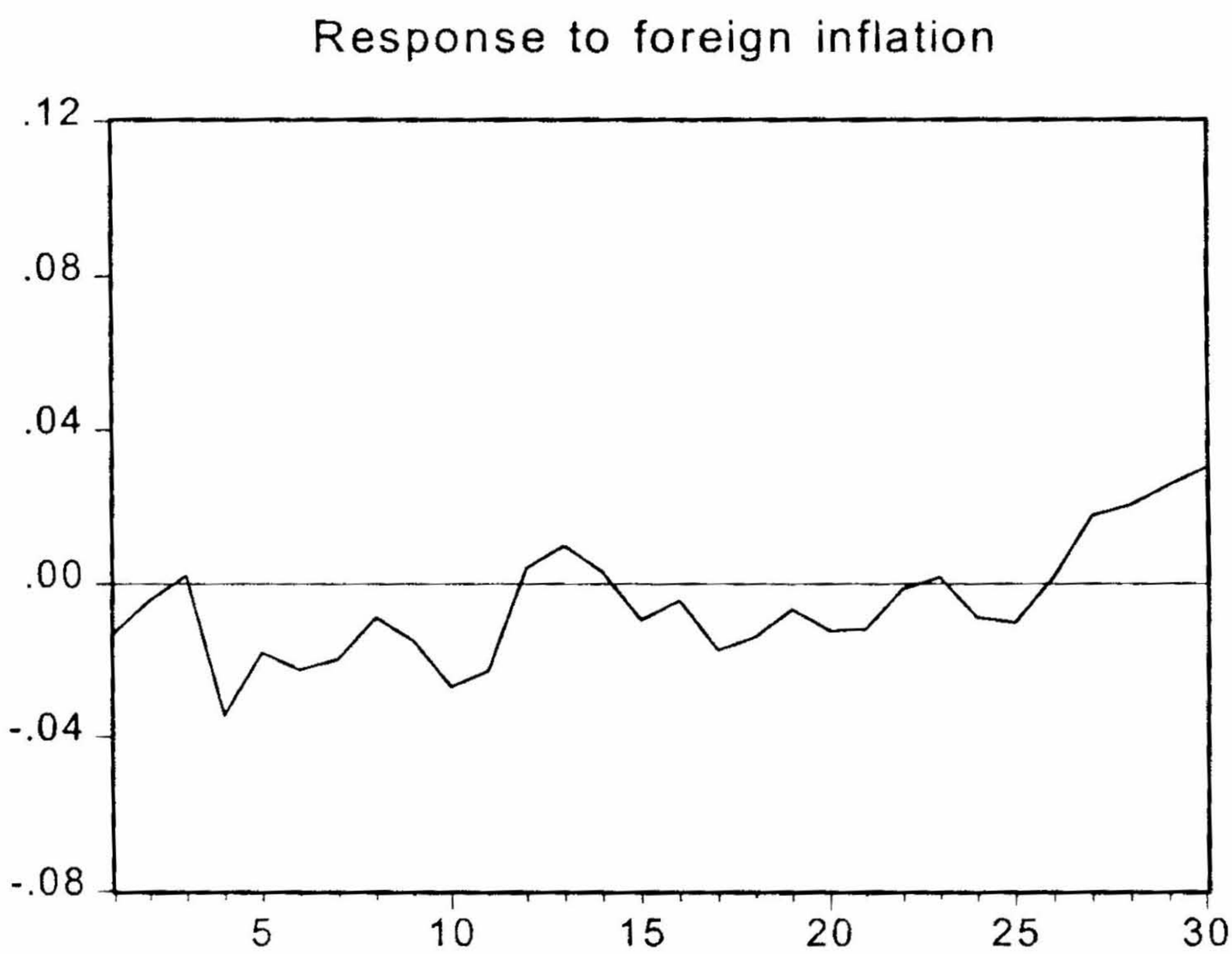


Figure 4.2 Response of inflation to one standard deviation shock in indicator variables (Monthly Data)




Response to broad money
.12
.08
.04
.00
-.04
-.08
5
10
15
20
25
30


Response to exchange rate
.12
.08
.04
.00
-.04
-.08
5
10
15
20
25
30


Response to foreign inflation
.12
.08
.04
.00
-.04
-.08
5
10
15
20
25
30


Response to interest rate
.12
.08
.04
.00
-.04
-.08
5
10
15
20
25
30

Figure 4.3: Annual out-of-sample inflation forecast (1985-2001)

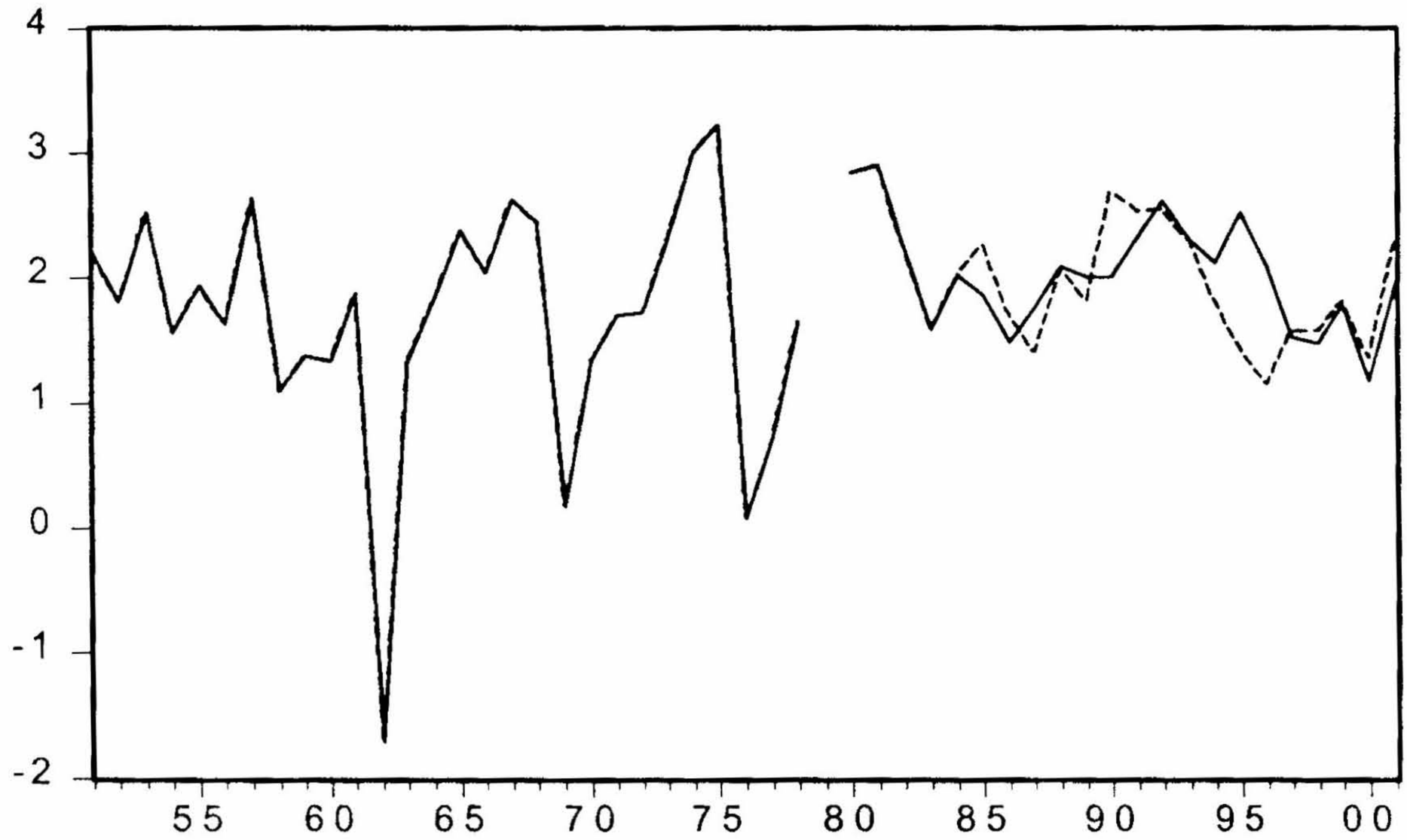
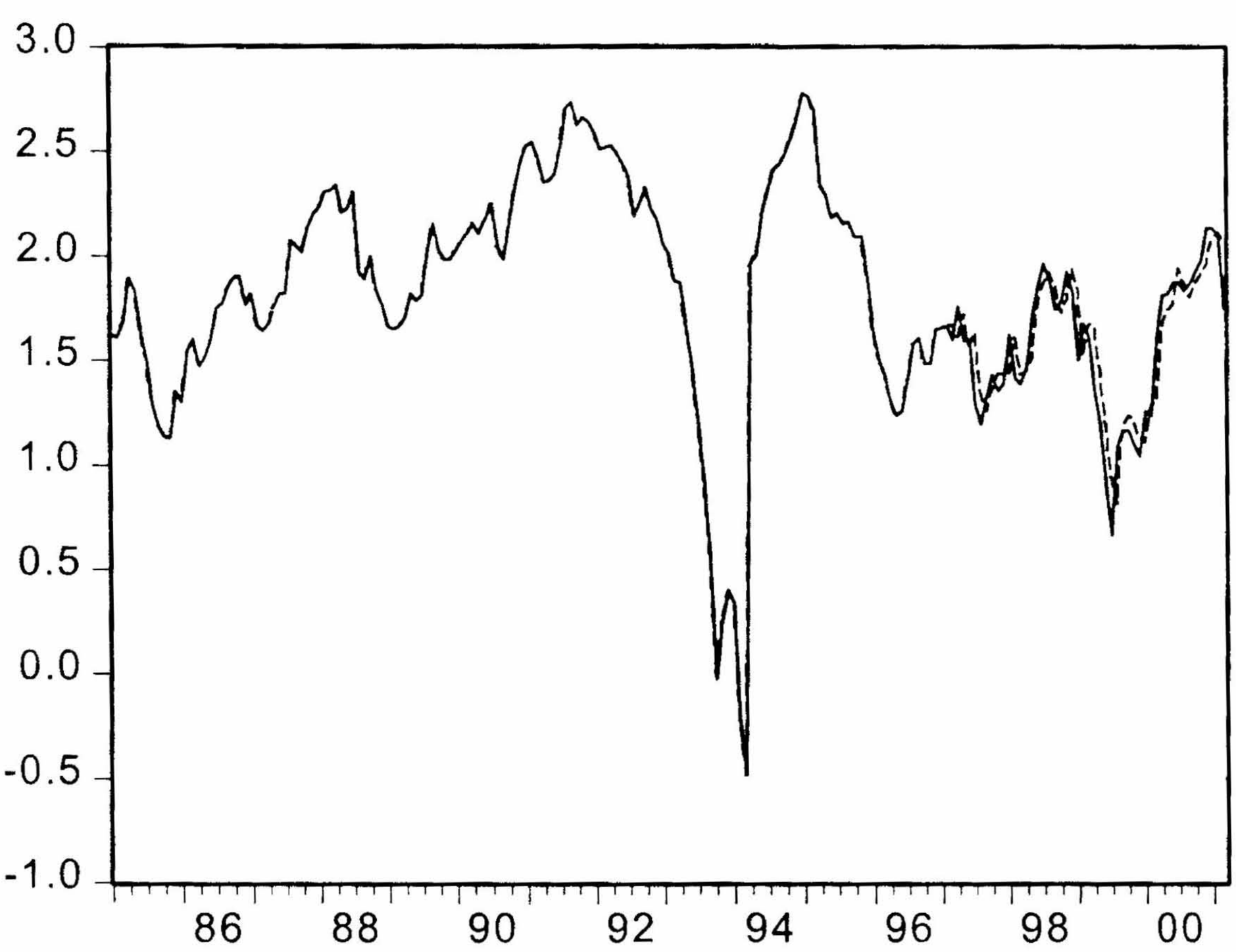


Figure 4.4: Monthly out-of-sample inflation forecast (March 1997 – March 2001)



Chapter V

Targeting Rules and Optimal Horizon for Inflation Targeting

5.0 Introduction

In the conduct of monetary policy during the past decade, the central issue has been what role forecast of future economic conditions play in policy making. Since it takes time for monetary policy to affect the economy, a central argument has been that policy should be forward looking. This strategy has been an integral part of the inflation targeting framework. In the literature this issue of inflation targeting is discussed in the context of monetary policy monetary policy rules, where it is considered from both an optimizing monetary policy approach (targeting rules) and an instrument modeling approach (instrument rules). A monetary policy rule for inflation targeting is to set the instrument such that the conditional inflation forecast hits the inflation target in some specified future period. In this context a crucial issue is to specify the exact time period or in other words the optimal horizon over which inflation target is to be achieved. In this chapter we have discussed the problem of selecting the optimal horizon in case of India.

The remainder of the chapter is as follows. In section 5.1 we go to discuss inflation targeting and transmission lags followed by a discussion on monetary policy rules in the context of inflation targeting in section 5.2. Section 5.3 goes to highlight on the tradeoff between inflation and output variability and in section 5.4 we discuss regarding inflation targeting horizon. This is followed by the case for India and finding the optimal horizon for inflation targeting in India. Section 5.6 concludes the chapter.

5.1 Inflation Targeting and Transmission Lags

The conduct of monetary policy under inflation targeting in practice involves targeting the conditional forecast of inflation that is the inflation rate expected to prevail in the future given presently available information rather that current

inflation. Hence the monetary policy rule under inflation targeting can be specified as

$$E_t\pi_{t+k} / i_t = \pi^* \qquad \ldots (5.1)$$

where $E_t\pi_{t+k}$ is the expectation based on information available at time t, of the inflation rate k periods ahead, conditional on some path for the instrument of their monetary policy $(/\ i_t)$ and π^* is the inflation target. So under inflation targeting, monetary policy aims to bring in the line the forecast of inflation k periods ahead with inflation target. In effect of practices inflation forecast targeting. The problem is to choose the horizon that is the value for k when the operational target is expected inflation k period ahead. Theoretically, the optimal forecast horizon under inflation targeting depends on the two factors. First one is the length of the monetary lags and secondly the policy makers preferences for output and inflation stabilization. Haldane (2002) calls the first one as the technology constraint and the second one a taste constrain

The analysis of the control lags depends on the transmission mechanism of monetary policy. In a closed economy, the standard transmission channels include an aggregate demand channel and an expectations channel. With the aggregate demand channel, monetary policy affects aggregate demand with a lag via its effect on interest rates and on the availability of credit. Aggregate demand then affects inflation, with another lag via an aggregate supply equation, more generally represented by a Phillips curve. The expectations channel allows monetary policy to affect inflation expectations which in turn affect inflation with a lag through a wage and price setting behaviour. Svensson (1997 1999) gives an example of a very simple model of the transmission mechanism for a closed economy, where monetary policy affects aggregate demand with a one-year lag and inflation with a two year lag. The recognition of the existence of lags from changes in monetary policy to inflation and attempts to quantify these lags has a long history. Jevons (1863) using UK data found that monetary policy takes one or two years to have effect on inflation. Similarly Friedman (1972) by using postwar US data concluded that the lag between changes in monetary policy and

change inflation is varies between eleven and thirty one months. There is now also a wide recognition that prices reacted more slowly than output to changes in monetary policy. For instance Christian et al. (1996) using VAR analysis for US data found that a monetary policy shock affect the real GDP with two quarter lag and the GDP deflator with a four quarter lag.

In an open economy, there are additional channels for the transmission mechanism of monetary policy such as the exchange rate channel. The exchange rate is affected by the difference between domestic and foreign nominal interest rates and expected future exchange rates via an interest parity condition. With sticky prices, the nominal exchange rates, affects the real exchange rate, which in turn affects the relative price between domestic and foreign goods. This will hence affect both the domestic and foreign demand for domestic goods and contribute to the aggregate demand channel for the transmission mechanism of monetary policy. There is also a direct exchange rate channel which affects the domestic currency prices of imported final goods which enter the price index used to measure inflation. The lag of this direct exchange rate channel is considered to be shorter than of the conventional aggregate demand channel. However, the experience with exchange mechanism shows that the time it takes the monetary policy to have its impact on nominal demand may still be lengthy. For example in the United Kingdom the exchange rate appreciations in 1982 and 1992 failed to produce appreciable increases in the inflation rate. Svensson (1999) examining the transmission mechanism in a small open economy found that domestic inflation depends on expected future inflation, the expected future output gap and the expected future real exchange rate. Aggregate demand depends on an expected future long run interest rate and the expected future real interest rate. Monetary policy affects the exchange rate and the CPI in the current period, aggregate demand in one period and domestic inflation in two periods. The relative lags are consistent with findings from VAR studies conducted by Christiano et al. (1996), Bernanke and Mihov (1997) and Cushman and Zha (1997). In this view of the transmission lags the policy maker only can affect the future values of the inflation rate and should act accordingly to bring the forecast inflation to the targeted level. Also from the above discussion it is apparent that money only plays

a minor role i.e. as one of the determinants of inflation. Thus in the transmission mechanisms, the focus is not in money supply growth but on the interest rate and the exchange rate and the effects on expectations, aggregate demand and inflation.

5.2 Monetary Policy Rules

As we have already mentioned the role of forecast inflation is based on monetary policy rules, this section goes to discuss monetary policy rules for understanding inflation targets and ultimately selecting the optimal horizon. Under the rules vs. discretion debate policy rules were interpreted narrowly as involving fixed settings for policy instruments such as the constant growth rate rule for money supply. However there is now considerable agreement among economists that feedback rules in which foe example the money supply responds to changes in unemployment or inflation are also policy rules. Taylor (1993) argues that a policy rule need not be a mechanical formula. Further he says, a policy rule can be implemented and adopted more informally by policy makers who recognize the general instrument responses that underlie the policy rule, but who also recognizes that operating the rule requires judgments and can not be implemented with a mechanical algebraic formulas. Svensson (1999) interprets rule as prescribed guide for the conduct of monetary policy. Also he distinguishes between two kinds of monetary policy rules, namely instrument rules and targeting rules. The inflation forecast targeting can be discussed by both the rules.

Instrument Rules

Instrument rules are the monetary policy rules most frequently referred to in the literature and they are what is frequently meant by rules. The well known instrument rules are the Taylor rule for the interest rate in Taylor (1993, 1998) and the McCallum rule for the monetary base proposed by McCallum in several papers, for instance MacCallum (1990). Svensson (1999) defines an instrument rule as it expresses the instruments as a prescribed function of predetermined or foreword looking variables or both. If the instruments are a prescribed function of predetermined variables only then the rule is an explicit instrument rule where as if the instruments are a prescribed function of foreword looking variables then the

rule is called an implicit instrument rule. Hence the instrument rule directly specifies the reaction function for the instrument in terms of current information.

An example of an implicit reaction function is the one used in Resave Bank of New Zealand forecasting and policy system, Black et al. (1997) i.e.

$$i_t = i_t^L + \gamma(\pi_{t+T\ t} - \pi^*) \qquad \ldots (5.2)$$

where i_t is a short nominal interest rate, i_t^L is a long nominal interest rate, $\pi_{t+T\ t}$ is a T quarter ahead inflation forecast, π^* is the inflation target and $\gamma > 0$. That is the instrument i_t is adjusted such that the forecast inflation is in line with the inflation target over the target horizon. This is an example of an implicit reaction function since both the long interest rate and the inflation forecast are forward looking and depend on the reaction function itself. Haldane (1997) used such an implicit reaction function to see the foreword looking nature of inflation targeting. His forward looking feedback monetary policy rule is given as

$$i_t = \gamma(E_t\pi_{t+j} - \pi^*) \qquad \ldots (5.3)$$

where E_t is the expectations operator conditional on information at time t and earlier. In this context the instrument responds directly to deviations of the inflation forecast from the inflation target. This implicit reaction function is further examined by Batini and Haldane (1998) and Rudebusch and Svensson (1998) where they try to find out the optimal horizon for inflation targeting. The implicit reaction functions are simple in the sense that few forward looking variables enter on the right hand side of the equations. The corresponding explicit reactions are however very complex as they depend on all the predetermined variables determining the inflation forecast. When private sector expectations enter such models explicitly, recent research has, however, emphasized the possibility that certain policy rules may be associated with indeterminacy of rational expectations equilibrium and might be viewed as undesirable. This issue has been discussed in Bernanke and Woodford (1997), Carlstorm and Furest (1998) and Clarida et al (2000). The idea is that if the monetary authorities

actually followed such a rule the system might get unexpectedly volatile, as agents are unable to coordinate on a particular equilibrium among the many that exist. The danger of indeterminacy rises with more aggressive response either to inflation or output deviations.

Also from Svensson (1998), and Rudebusch and Svensson (1998) it is apparent that implicit reaction functions are not optimal since other variables for instance output contain additional useful information beyond what is contained in the inflation forecast. Also this is the case for strict inflation targeting when only inflation enters the loss function. But the real world inflation targeting is flexible inflation targeting where some weight is also given to the stabilization of real variability represented by output gap variability. It is also numerically demonstrated in Batini and Haldane (1998) and Rudebusch and Svensson (1998) that the implicit reaction function of Haldane (1997) is generally not optimal. Again the appropriate policy for the instruments is to respond to the determinants of the target variables rather than to respond to the target variables themselves Svensson (1999) shows that if the central bank wants to stabilize nominal GDP growth around a target growth rate, it is better to respond separately to the determinants of the nominal GDP growth than to respond to the deviation between nominal GDP growth and the target growth rate only

Although a commitment to a simple instrument rule is feasible such a commitment is never practiced by the central bank neither in the form of implicit or explicit instrument rule. In particular no central bank responds in a prescribed mechanical way to a prescribed information set. Because committing the policy makers to reacting in a prescribed manner to prescribe information would make the monetary policy completely static, mechanical and not foreword looking. Therefore Svensson (1999) argues that simple or complex instrument rules do not make the central bank to give commitment to any policy decision, rather they serve as reference points for comparisons and elevation of actual policy. Under a commitment to a simple instrument rule the central bank is not foreword looking. It needs to be foreword looking only once while deciding to which simple reaction functions it will commit. After that it can just set the instrument mechanically according to the simple rule. Svensson (1999) points out that a commitment to a

simple instrument rule can be interpreted as an inertest rate targeting rule where the central bank's loss function is given by $L_t = (i_t - i_t^*)^2 / 2$ where i_t^* is the interest rate prescribed by the simple instrument rule. There are also considerable practical difficulties in deciding once and for all which instrument to follow. Currie and Levine (1993) have shown that the optimal reaction function does not only depend on the model and the loss function but also on the stochastic properties of the shocks and the initial state of the economy. This is a major problem because the model and the stochastic properties of the shocks are not exactly known. Again a commitment to an instrument rule does not leave any room for judgmental adjustment and extra model information. In practice, Svensson (1999) emphasized that monetary policy does not rely on models only. The use of judgmental adjustment and extra model information is both desirable in principle and unavoidable in practice. Furthermore, under an instrument rule, the scope for revisions of it due to new information and revision of the models is ruled out. A commitment to an explicit instrument rule either requires more confidence in the structural model and its stability or frequent revision that may be difficult to motivate and hence less transparent.

In real world monetary policy, decision-making under considerable discretion is more or less unavoidable. Blinder (1998) puts it as "rarely does society solve a time consistency problem by rigid pre commitment. Enlightened discretion is the rule" (Pp. 49). King (1999) stated that mechanical policy rules are not credible. No rule could be written down that describes as to how policy would be set in all possible situations. Some discretion, hence is inevitable but that must be constrained by a clear objective to which policy is directed. Hence a commitment should be prescribed by the objective of monetary policy. For these reasons the commitment to an instrument rule would be inefficient.

Targeting Rule

Svensson (1999) defined the targeting rule as the assignment of a particular loss function to be minimized. Setting the instrument to make the inflation forecast equal to the inflation target is an example of a target rule which, if applied by the monetary authority results in an endogenous optimal reaction function expressing

the instrument as function of available information. Further more Svensson expressed that a targeting rule can be expressed as an equation or a system of equations that the target variables must fulfill. In case if the central bank has perfect control over the target variable then there is a trivial first order condition for a minimum of the loss function i.e. $y_t = y_t^*$, where y_t is target variable and y_t^* is the level of the target variable. However, when the central bank has imperfect control over the target variable the trivial first order condition would be

$$y_{t+j/t} = y^* \qquad \ldots (5.4)$$

for $j \geq 1$ where $y_{t+j/t}$ denotes a conditional forecast of y_{t+j} based on information available in period t and $T \geq 0$ is the shortest horizon at which the instrument has an effect on the goal variables. In an important contribution to the optimizing targeting rule approach Svensson (1997) considers an inflation targeting central bank with an objective to minimize the expected loss given by

$$Min \quad E_t \sum_{t=0}^{\infty} \delta^t L_{t+t} \qquad \ldots (5.5)$$

where E_t denotes expectations conditional on the central bank's information in period t, δ $(0 < \delta < 1)$ is a discount factor and L_t is the period loss function which involves both stabilizing inflation around an inflation target and stabilizing the real economy represented by the output gap. Hence the loss function is given as

$$L_t = \frac{1}{2}\left[\left(\pi_t - \pi^*\right)^2 + \lambda\left(y_t - y_t^*\right)^2\right] \qquad \ldots (5.6)$$

He pointed out that the optimal inflation targeting horizon, that is, the time it is expected to take for inflation to return to its target level is positively dependent on the value of λ. A central bank that places a higher relative weight on the output gap in the loss function should conduct an instrument setting policy that brings forecast of future inflation in line with the inflation target over a longer period of time. Also he suggested that since disinflation process involves costs in terms of output loss, the target horizon selected should be larger than the minimum control

lag, i.e., the shortest horizon at which inflation can be affected. This implies that hitting the inflation target should be a gradual process as monetary policy has lagged impact on inflation due to reaction lags on the part of the private agents. This shows that the policy maker only has an impact on future values beyond the control lag and should act accordingly. Hence in case of a targeting rule by being able to commit to future policies the central bank influences the private sector forecasts, which lead private agents to behave in a way, that is consistent with policy objectives. The first order condition for the minimization of the loss function, given the policy lags can be written as

$$\pi_{t+2/t} - \pi^* = c(\lambda)(\pi_{t+1/t} - \pi^*) \qquad \ldots (5.7)$$

where the coefficient $c(\lambda) \geq 0$ is increasing in λ. The one period ahead conditional inflation forecast $\pi_{t+1\ t}$ is predetermined and the two periods ahead conditional forecast $\pi_{t+2/t}$ depends on the predetermined variables and the instrument in period *t*. Thus the targeting rule can be formulated as to adjust the instrument such that the deviation of the two year ahead conditional inflation forecast from the inflation target is a fraction of $c(\lambda)$ of the same deviation of the one year ahead forecast. Given the targeting rules dependent only on the loss function, the target rules are less complex. It also reflects a comprehensive approach to policy as it implements a 'look at everything' strategy. The target rule focuses on the achievement of the goal and allows more flexibility in finding the corresponding reaction function. More specifically, with new information about structural relationships, changes in the exogenous variables a target rule implies automatic revision of reaction function. In general target rules are inherently more stable than the instrument rules and easier to identify, motivate and verify.

5.3 Tradeoff between Inflation and Output Variability

The instruments in inflation targeting are set as to neutralize the effect of the shocks and achieve the target. However, given the existence of short run trade off between the output growth and the inflation, there are costs of disinflation. These costs arise from a change of monetary policy due to reaction lags on the part of private agents. The speed at which expectations adjust during the transition period

will influence the output loss Given the presence of this trade off there is now a consensus that the inflation targeting approach to price stability should be gradual process.

Svensson (1996) pointed out that when there is a positive weight an output stabilization, then instead of adjusting the inflation forecast all the way to inflation target the central bank should let it return gradually to the long run inflation target. This way the output fluctuations could be minimized. In case of this type of flexible inflation targeting the horizon will be longer. Bernanke et al. (1999) suggested that horizon for the inflation target would reflect the lag between the setting of monetary policy and the effects of policy on the economy. Specifically the target for inflation would be set not for the immediately following year but for a year farther in the future. They pointed out that the determination of the horizon for inflation targets should be based on research. If for the example the research indicates that lags is on the order of two years than the inflation target should be set for the annual inflation rate two years. This kind of investigation of the effect of monetary policy on inflation helped Bank of England to fix the forecast horizon of around two years, In Canada also the inflation targets were set to apply to a period beginning 22 months after the initial announcements. Setting the inflation targets for a short horizon, which does not reflect the lag between the policy actions and their effects on the target variable results in problems of control and instrument instability. Instrument instability arises because to meet the target arte in short horizon would require excessively large and frequent changes in the instruments as the economic outlook changes.

In case of inflation targeting the inflation forecast of the central banks becomes an intermediate target. The monetary authorities try to minimize the deviation between inflation target and inflation forecast so as to make the forecast target align with the inflation target. However, due to the occurrence of shocks deviations of actual inflation from the targeted horizon are inevitable. Hence the horizon should be at which the effect of the shocks could be dissipated. Again due to the costs involved in the disinflation process the choice of the horizon will depend on the rate of inflation at the time of the adoption of the inflation targeting and the targeted rate. The lower the inflation rate, the shorter will be the horizon

taking into account the lags. Again the small the deviation between actual and targeted inflation, the shorter will also be the horizon because in this case large manipulations in inflation will not be required to bring inflation back to the targeted level. This implies that the targeted rate should be an optimal rate inflation i.e. defined as where output growth is maximized and also consistent with the definition of price stability. Though it is now widely accepted that there is no long run trade off between inflation and output, the zero inflation rates not considered on a practical plane, given the presence of measurement bias in the price indexes and the danger of disinflation. Another factor that constrains the central banks from aiming at zero inflation is the difficulty in engineering negative real interest rate which may be needed during recessions. The argument here is that a bit of inflation greases wheels of monetary policy made by Tobin. The inflation targeting central banks have adopted the optimal target in a range of 1 to 3 percent. Again in the short run there is a cost of disinflation. Hence to try to bring down inflation from a very high level to such a low level will result in more output fluctuation and instrument instability. Hence this optimal target rate should be determined for each country may differ from the other inflation targeting countries. The optimal inflation target rate while introducing the inflation targeting framework will depend on the prevailing inflation rate and its correlation with the output growth so that the risk of either having to announce a very drastic reduction of inflation with high output costs and large margins of error or loss of credibility of the monetary policy. These considerations have guided the choice of medium term inflation target in those countries that have adopted an inflation targeting framework and more generally the concepts that underlies the debate on the merits of price stability in advanced countries. However, determination of such an inflation rate is not an easy task as it is essentially an empirical proposition cannot be settled on a theoretical basis.

5.4 Inflation Targeting Horizon

The above consideration suggests that in either case inflation targeting central banks need to decide how foreword looking they should be in order to bypass the transmission lags, that is when setting policy they must choose an optimal horizon over which to pursue the goal of price stability. Since the concept of horizon has

different meanings under the targeting rule and the feedback rule, Batini and Nelson (2000) provide two operational definitions of optimal horizon. They defined the optimal policy horizon under the targeting rule as the number of periods it takes for the inflation to settle on target after the occurrence of a shock. This is consistent with Rudebusch and Svensson (1998) interpretation of inflation targeting where they argues that real world inflation targeting can be approximated by viewing the central bank as carrying out an optimal exercise where the welfare function penalizes inflation departures from a target given certain weight on output stabilization. This definition corresponds to, what Svensson (1997) calls flexible inflation targeting. The underlying optimization exercise undertaken by the central bank is subject to limited discretion. But Woodford (1999) demonstrates that discretion has drawbacks when the models contain foreword looking components. However, more recently Svensson and Woodford (1999) have proposed several modification to standard discretionary optimization which by connecting past and current policy actions reduce the problems associated with discretionary behaviour.

They name the second concept of horizon as optimal feedback horizon defined as the period in future for which the authorities should form the inflation forecasts that enters their policy rule. The optimal feedback horizon is an optimal response horizon, that is the best horizon to focus on when designing a simple inflation forecast rule. The optimal feedback horizon is therefore is the j associated with the minimization of the loss function, when policy follows a simple rule such as of Haldane (1997).

The experience of the inflation targeting countries shows that the real world targeting can be interpreted as a targeting rule with a relatively explicit loss function to be minimized, where as previously there had been some doubt about whether inflation targeting framework will have any concern for stabilizing output, this happens to be an uncontroversial issue by now. The central banks explicit loss function contains concerns about the stability of the real economy. Hence the second definition of Batini and Nelson (2000) of optimal feedback horizon does not fit into the practice of inflation targeting framework.The inflation targeting framework based on a target rule ensures that the first order conditions

for a minimum of the loss function are fulfilled. Also the high degree of transparency and accountability associated with inflation targeting allows outsiders to monitor that the first order conditions are fulfilled and creates strong incentives for the central bank not to deviate. Given that the loss function contains concern for output stabilization the choice of optimal horizon depends on the trade off between output variability and inflation variability.

5.5 Case for India

As we have already proposed for the feasibility of inflation targeting in India, the adoption of inflation targeting would require announcing an explicit inflation target. This inflation target should be feasible to achieve and be consistent with price stability taking maximization of output into consideration. However in developing countries many argued (Masson et al 2000) that there does not exist consensus on the definition of price stability as well as on the rate of inflation at which growth is maximized. The benefits of low and stable inflation in these economies have rarely been quantified or related to a precise numerical value. Also there is no consensus on speed at which the inflation target ought to be attained. Some argue that once developing countries have reached a rate of inflation in the moderate to low range e.g. lower than 15% per year, they should adopt a cautious and general approach to further disinflation (Dornbusch and Fischer (1993), Dornbusch et al. (1995)) but many others disagree. In this context Vasudevan et al. (1999) found that threshold rate of inflation in the Indian context could be about 6 percent. At 4 percent the output is reduced to the inflation rate. The output effects are positive but marginally different from one another for 5, 6 and 7 percent inflation regimes. They also found that double digit inflation has negative effect on output.

The inflation targeting framework is discussed as to be based on the targeting rule which involves the minimization of an explicit loss function. Following Svensson we assume that policy makers wish to minimize deviation of inflation from the target and departures of output from potential. In line with the discussion on optimal horizon we follow the definition in accordance with the targeting rule, that is, optimal policy horizon is defined as the time at which it is least costly for a

given loss function, to bring inflation back to target after a shock. More intuitively, the optimal policy horizon is the horizon of the optimal speed of disinflation, that is, the optimal time required for the dissipation of the shock. Again the optimal policy horizon is taken as the number of periods ahead when a large fraction of the shock's effect, the policy has succeeded in eliminating.

To explore the optimal horizon issue, we use the VAR model which is estimated by using both annual data over the period 1951-2001 and for monthly data for the period 1985:1 –2001:3. There are four endogenous variables in the VAR such as real output gap, the deviation of annual forecasted headline inflation[1] from the inflation target, the bi lateral nominal exchange rate (dollar vs. rupee) and the call money rate. All the variables are expressed in logarithms except the call money rate. The inflation gap is calculated by taking the inflation at 5%. The rationale behind the choice of the level of this inflation rate was the finding of Vasudevan et al (1999). However, the current level of low inflation and on the basis of the expectation that it will continue to be the low in the future, we have settled down at 5 % of the inflation rate to be the target. The ordering of the VARs is chosen by the means of Choleski Decomposition where the equation disturbances are assumed to follow the causal ordering of real output gap innovation, exchange rate innovation, interest rate innovation and inflation innovation. The ADF and PP test have been used to check for the order of integration. The results from the unit root tests for both annual and monthly data are presented in table 5.1 and 5.2 respectively. The results indicate that except exchange rate all other variables are found to be stationary for both annual as well as monthly case. So VAR is estimated on the level of all the variables and on the first difference of exchange rate. The lag length is selected by using the likelihood ratio (LR) test, which indicated a lag length of 2 for annual data and 12 for monthly data.

The strategy for choosing the optimal horizon adopted is as follows. The tests involve the forecast error variance decomposition which measures the proportion of the variance of the inflation gap, that is explained by the variance of the indicator variable and the impulse response functions to assess the impact of the

[1] The forecasted inflation is calculated on the basis of the inflation forecaster model estimated in the last chapter

indicator variables on the inflation gap in the future. The results of the forecast error variance decomposition for annual data reported in table 5.3 indicate that the variance of changes in output gap explains a significant proportion of the variance of the inflation gap rising quickly from 25% in the first year to 35% in the second year and to more than 50% in the third year. The changes in exchange rate also happen to affect inflation gap significantly and more quickly by explaining 32% of the variance in inflation gap in the second year. However, the interest rate does not have any predictive power for the inflation gap over any horizon and takes around 6 years to explain one percent of the changes in inflation gap. Figure 5.1 shows the impulse response functions of the inflation gap. The impulse response function for the output gap shows that it has the maximum effect on the inflation gap in the third year where as impulse response for the exchange rate shows that it quickly affects the inflation gap as the maximum impact can be seen on the second year. The impulse response for the call money rate shows that it has low impact on the inflation gap. Even the low level of effect happens in the 6^{th} year which is a too long a period for the policy makers to gain credibility.

The forecast error variance decomposition results for the monthly data are presented in table 5.4. The results reinforce the findings of the annual data in case of output gap. The output gap explains 13 percent of the change in inflation gap in the 30^{th} month. However, in contrast with the findings of the annual results, in case of monthly data the call money rate explains a major portion of the inflation gap. rinsing very quickly from 14% in 10^{th} month to 22% in the 16^{th} month. Also the exchange rate in contrast with the annual findings is a poor predictor of the change in inflation gap over the entire horizon. The impulse response functions for monthly data given in figure 5.2 shows that in case of the output gap returns to zero in 24^{th} month. The same for exchange rate indicates that the inflation rate returns to the target in the 8^{th} month, which is too short a period to have any policy implication and will results in instrument instability. For the call money rate the impulse response shows that the optimal period should be two years. In case of the monthly analysis, we have defined the horizon as the number of periods ahead the inflation gap turns out to be zero, since in general inflation

targets are not set for months but for periods in terms of years. Hence the maximum impact on some short periods will have no concrete policy implications.

The above analysis indicates that for the policy horizon, it is optimal to remove the effects of various shocks over a period of 2 to 3 years. This happens to be consistent with the inflation targeting countries where inflation forecast is to be returned to the targeted level in more than two years.

5.6 Concluding Remarks

In this chapter we analyzed the problem of selecting an optimal horizon for inflation targeting. The issue of optimal horizon is discussed in the context of monetary policy rules where we defined optimal horizon in line with the targeting rules in a flexible inflation targeting framework as advocated by Svensson (1999). The results obtained from the VAR analysis of the optimal horizon conclude that the optimal horizon for inflation targeting in India would be of two to three years which is also found in the inflation targeting developed countries.

Table 5.1: Unit root test results for annual data (1951-2001)

Variables	On Levels		On 1st difference	
	ADF	PP	ADF	PP
Real output gap	-4.2001(4)	-3.5850(4)		
Exchange Rate	-1.3200(4)	-1.4390(4)	-3.6105(3)	-4.8520(5)
Call money rate	-3.7865(4)	-3.7063(5)		
Inflation gap	-3.6226(40	-3.492(5)		

Table 5.2: Unit root test results for monthly data (1951-2001)

Variables	On Levels		On 1st difference	
	ADF	PP	ADF	PP
Real output gap	-4 6041(4)	-8 4227(4)		
Exchange Rate	-1 8635(3)	-1 7534(5)	-5.6834(4)	-13.2918(5)
Call money rate	-3.2199(4)	-3.6475(4)		
Inflation gap	-4.218(4)	-4.610(5)		

Note

1 The unit root test regressions include the intercept and trend.
2. The values in the bracket refer to lag augmentation on the basis of AIC.
3. The critical values for ADF and PP tests at 1%, 5% and 10% are –3 51, -2 89, -2 58 (for annual data) and –3.46, -2.88, -2.57 (monthly data) respectively.

Table: 5.3 Forecast Error Variance Decomposition test results

Steps	Annual Data		
Period	ROGAP	DLERATE	CMR
1	25.27951	0.599029	1 007704
2	35 82228	32.42669	0 431943
4	53.69700	24.90376	0 460010
8	54.08162	23.27695	3.616019

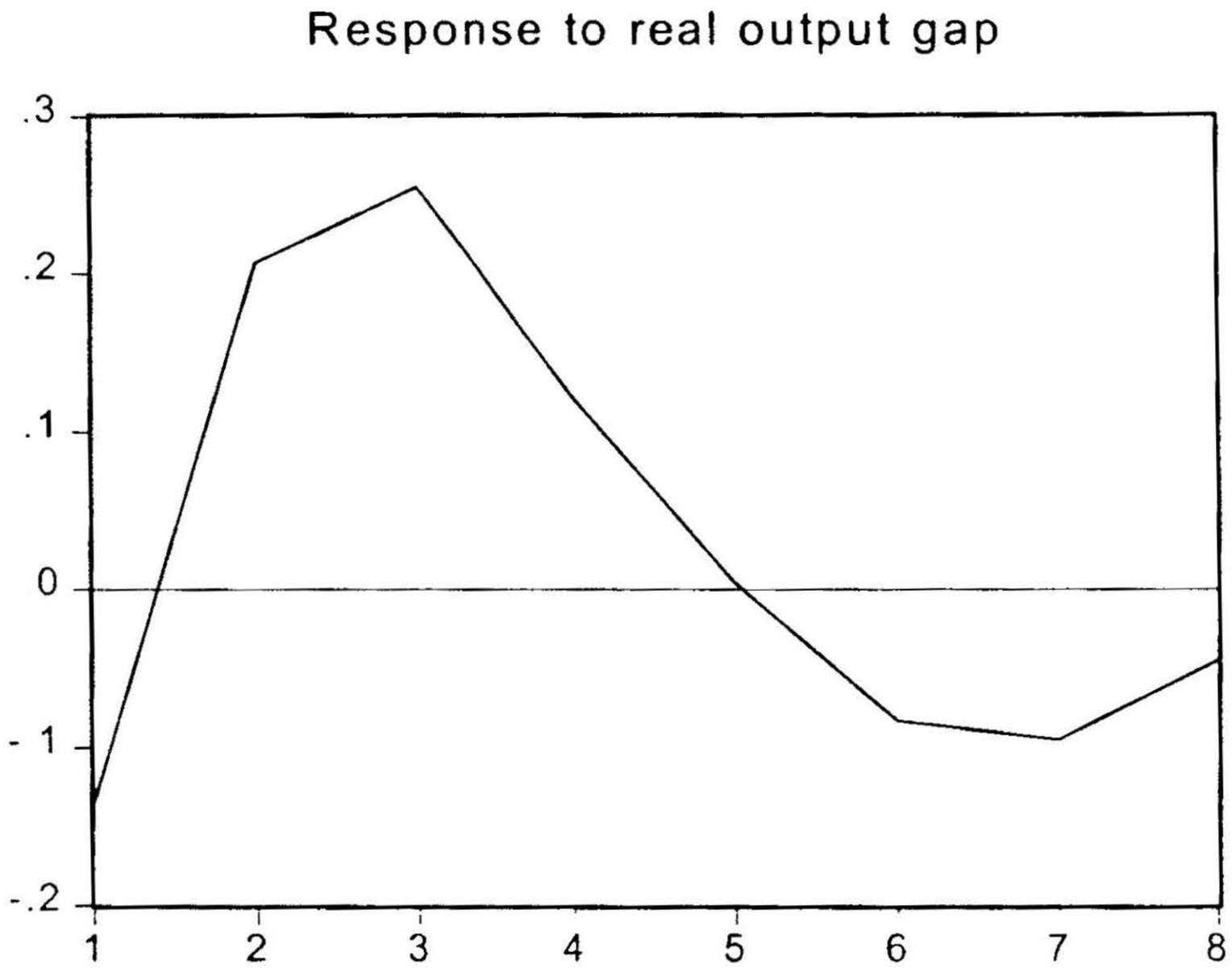
Note ROGAP, DLERATE and CMR refer to real output gap, first difference of logarithm of exchange rate and call money rate respectively.

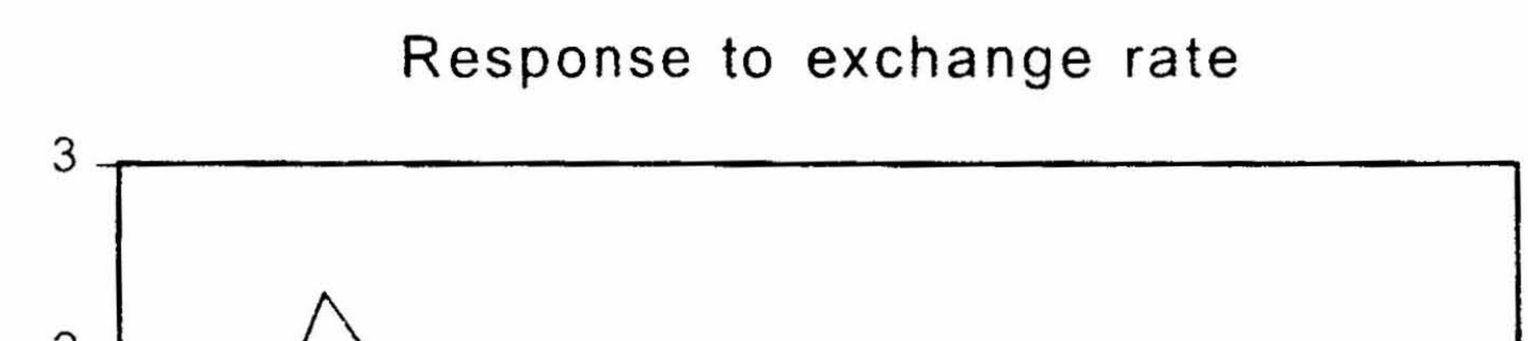
Table: 5.4 Forecast Error Variance Decomposition test results

Steps	Monthly Data		
Period	OUTGAP	DLERATE	CMR
1	1 958641	0.040099	0.568849
2	2 001414	2.283368	1.338950
4	5.423471	3.940544	4.136610
8	4.291072	2.846917	11.70044
12	5.851347	2.390128	18.59467
16	9 706366	2.505615	22.04017
20	10.28145	2.676380	22.93091
24	10.60782	3.097207	22.80256
30	13.08269	3.182663	23.13099

Note ROGAP, DLERATE and CMR refer to real output gap, first difference of logarithm of exchange rate and call money rate respectively

Figure 5.1: Response of inflation gap to indicator variables (Annual Data)





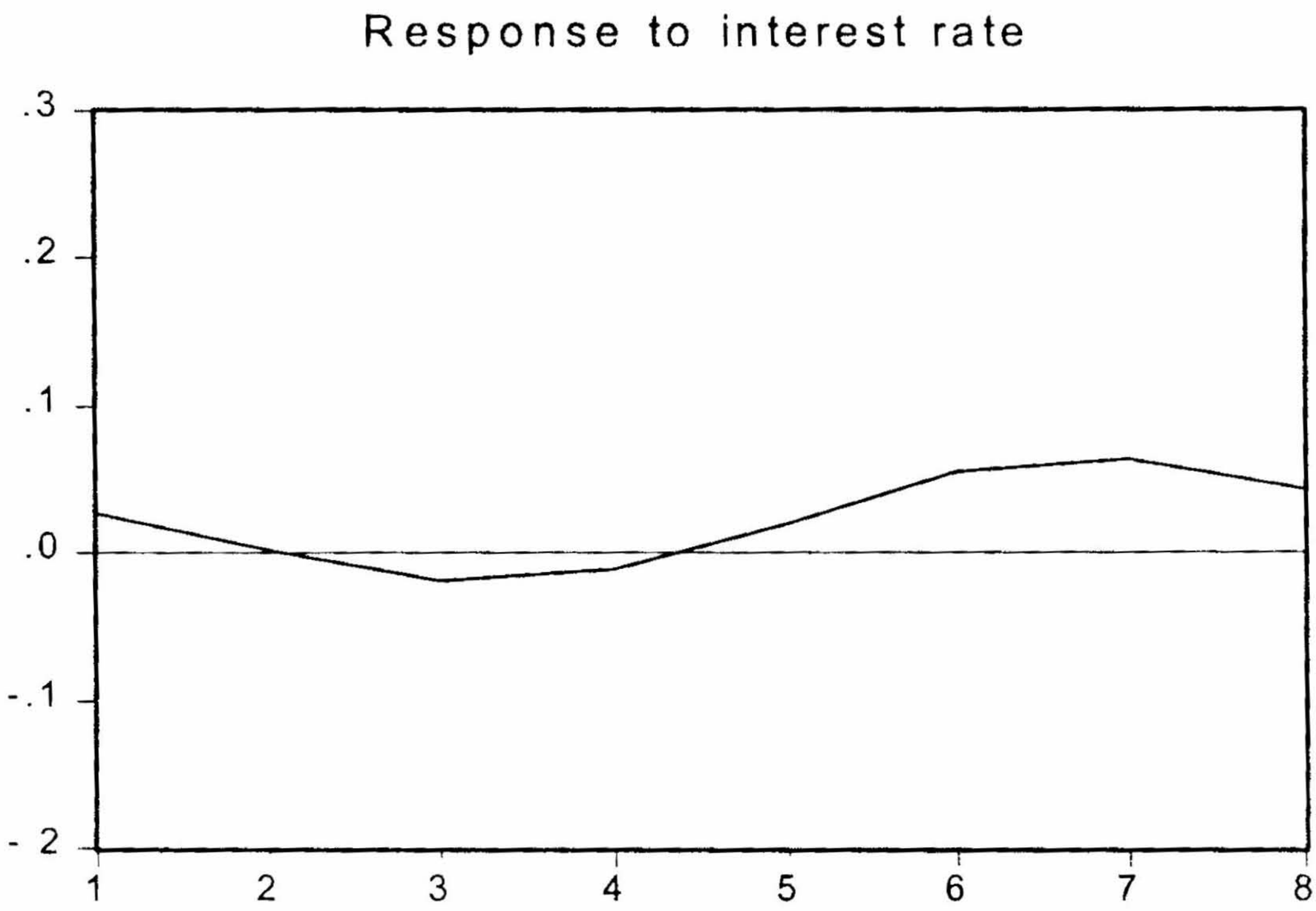
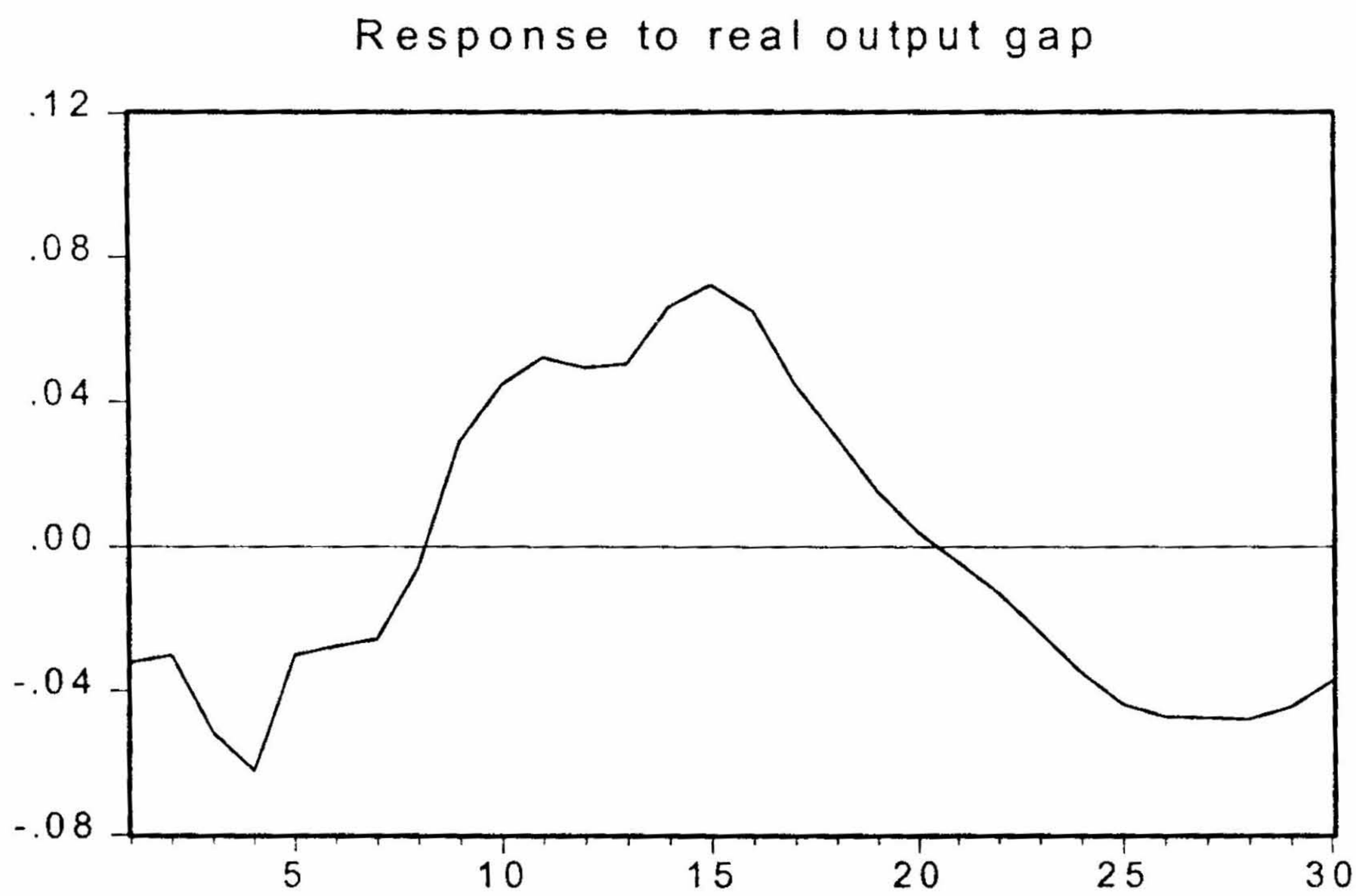
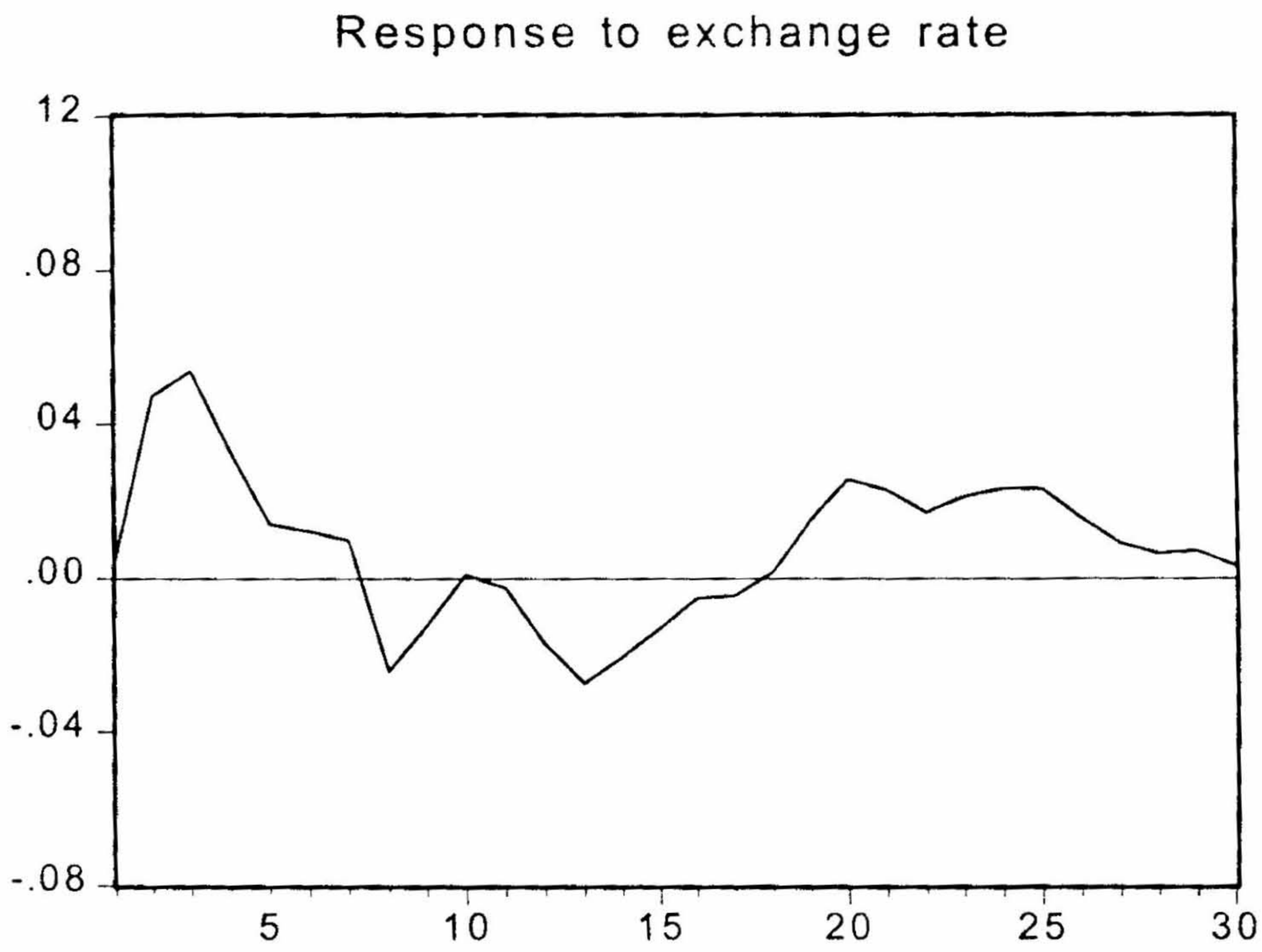
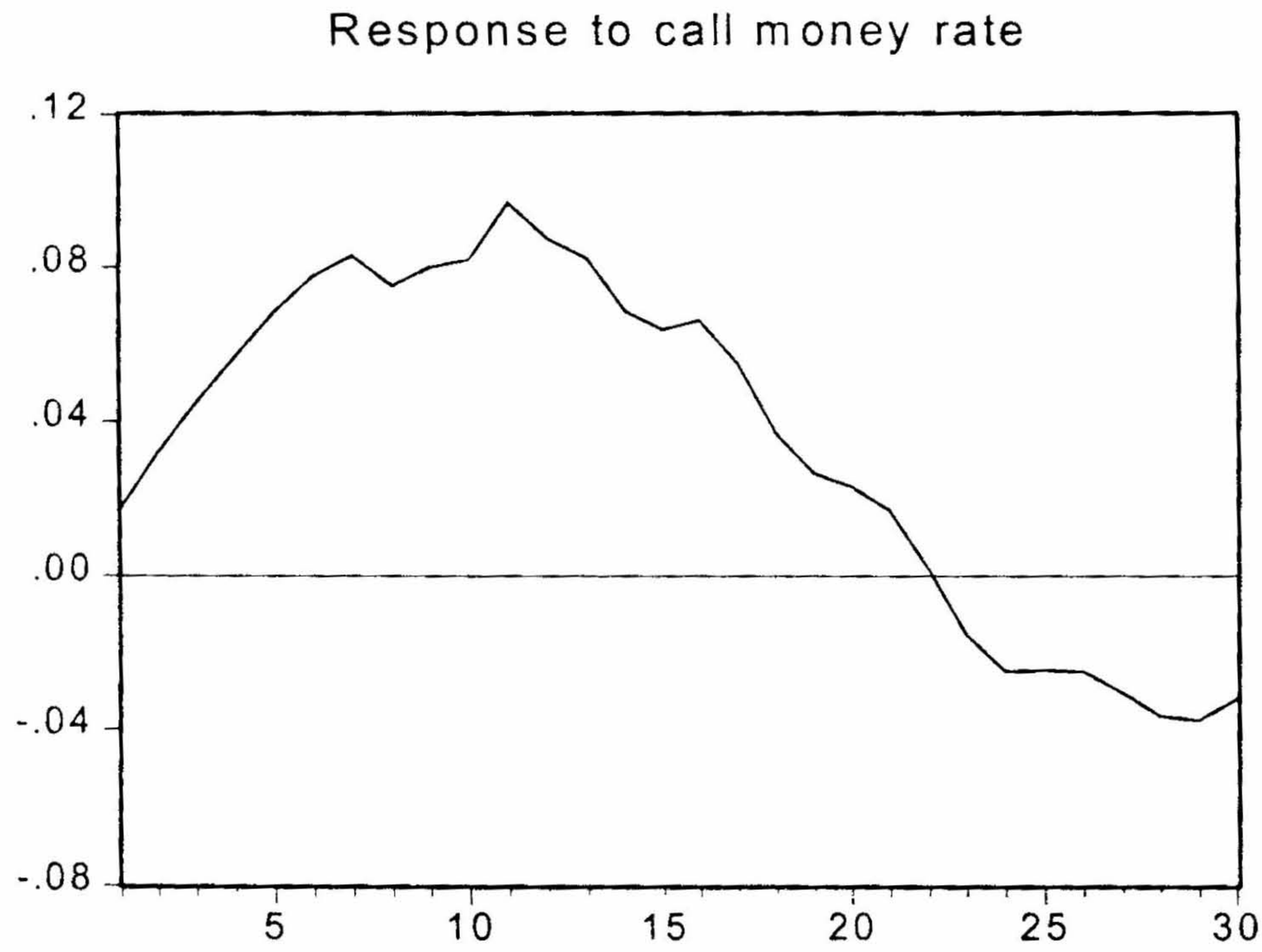


Figure 5.2: Response of inflation gap to indicator variables (Monthly Data)




Response to exchange rate
12
.08
04
.00
-.04
-.08
5
10
15
20
25
30


Response to call money rate
.12
.08
.04
.00
-.04
-.08
5
10
15
20
25
30

Summary of Major Findings and Scope for Further Research

Over the past twenty years there has been an emerging consensus among policy makers and economists that achieving and maintaining price stability should be the primary goal of monetary policy. While central bankers differ in the ways they seek to attain price stability, they all strive towards the same goal of price stability. In this context in the nineties inflation targeting which was adopted due to the problems of implementing monetary targeting in the light of the money demand instability, is getting popular. The experience so far shows that inflation targeting has been successful in achieving price stability. However, the experience also shows that the adoption of inflation targeting in any country would require the fulfillment of a number of operational issues rather than any theoretical prescriptions. In India, since 1985 monetary policy was conducted by using monetary targeting approach to achieve the dual objective of price stability and economic growth. However, though there is no evidence of money demand instability in the recent years the policy makers are conducting monetary policy with a multiple indicator approach and there is no reference to the monetary targeting any more. But this type of policy strategy does not happen to be transparent and does not give clear signals to the market about the stance of monetary policy. On the other hand, the experience of inflation targeting shows that this approach provides a quite transparent and credible framework for conducting monetary policy. In this context, the present study goes to take up the issue relating to the possibilities of India to adopt inflation targeting.

A key principle for monetary policy is that price stability promotes sustainable economic growth whereas a rising price level even at moderate rates imposes substantial economic costs on the economy. However, to achieve price stability certain nominal constraints on the central bank are to be placed so as to remove the inflation bias problem which arises due to the presence of short run tradeoff between inflation and output. Taking note of this, at the outset of the study, in the first chapter

the desirability of the price stability is discussed. Again to be operationally useful the price stability should be defined in numerical terms. This issue is briefly discussed by taking into account the costs of inflation as well as the risks at low level of inflation. The transition to price stability from a high inflation rate involves some costs in terms of output loss and employment loss. Hence the speed of the transition is also discussed in this chapter. The chapter also highlights the flexibility and credibility of inflation targeting to accommodate unforeseen contingencies and at the same time prevent overshooting of inflationary expectations and thus sets the ground for the present study.

In considering the desirability of an inflation target, an important question that arises is whether adherence to inflation targeting scheme is the best possible way for conducting monetary policy. Also a second important question that arises is whether inflation targeting is more desirable than the typical manner in which policy is currently conducted by the central bank. In the second chapter a detailed analysis of these issues are presented. There are basically two arguments to justify the adoption of inflation targeting One of these builds on the academic literature concerning dynamic inconsistency in monetary policy while the second one is derived from the disadvantages of monetary policy. The second argument for inflation targeting is based on the proposition that from a long run perspective monetary policy has a dominating influence on an economy's inflation rate and a negligible influence on its rate of unemployment or output relative to capacity. Hence it has been argued that monetary policy can only affect inflation, and manipulation of monetary policy to achieve short run goals can be counterproductive. The other argument is in line with the time inconsistency or policy credibility problem which shows that the presence of short run tradeoff between inflation and unemployment gives an incentive to the policy makers to pursue expansionary monetary policies to stimulate economic growth at least temporarily. However the proponents of time inconsistency problem argues that if this type of discretionary procedure is repeated period after period then public agents would come to understand the central banks incentives leading them to adjust their inflation expectations. This will results in an inflation bias problem where

there is an inflation rate which is greater than desired inflation without any benefit in terms of output growth or employment. It was argued that inflation targeting can remove the inflation bias problem by placing some external constraint on the policy makers.

However, there are other monetary policy regimes that in principle could provide similar advantages. In this chapter we have also discussed briefly the advantages and disadvantages of the alternatives to inflation targeting and conclude that unlike the intermediate target, inflation targeting is not vulnerable to the instability of interrelationship between intermediate target and the goal variable.

The realization of potential benefits of inflation targeting, however, depends on the effective design and implementation of the strategy. Again since the adoption of inflation targeting was not much influenced by the academic literature, the experience of the targeting countries provides valuable information on the practical implementation of inflation targeting. On the basis of this we try to address the first objective of our study in the third chapter. In this chapter we discuss the experience and arrangement of inflation targeting of the adopting countries. More specifically, the operational issues that central bankers have faced when they adopted inflation targeting are discussed in detail. On the basis of this discussion some generalizations are made for India. We found that many of the operational issues, though currently nonexistent, will not be a problem in adoring inflation targeting as they can very much be fulfilled by the authorities. And the current situation of low inflation rate will provide a better timing for adapting inflation targeting as much variability in the instruments are not required to achieve the targeted rate. The early achievement of inflation targets will also enhance the credibility of the central bank.

Notwithstanding the advantages of inflation targeting, it also faces some serious problems with regard to both its implementations and monitoring. The central bank has imperfect control over inflation due to the lags in transmission mechanism and uncertainty about it. Also inflation is affected by many other factors than monetary

policy and shocks to the economy also influence to a greater extent This problem makes the inflation targeting foreword looking in nature and requires the authorities to form a conditional inflation forecast before policy choices are decided. In chapter IV, we address the issue of inflation forecast targeting in the context of India in case it goes to adopt inflation targeting. We begin the analysis with the *P–Star (P*)* model of inflation forecast proposed by Hallman et al (1989), which is based on the quantity theory of money where *(P*)* refers to the price level that the current money supply will support given the long run equilibrium velocity and the potential output. It shows that any deviation in the current price level and the equilibrium price level is the main cause of inflation. The forecasting by this model is made on the basis of the notion that the current price will converge, over time, to the equilibrium price level and hence any positive (negative) deviation will indicate that price will rise (fall) in future. However, it is based on presence of the measure of potential output and long run equilibrium velocity, which are unobservable. To circumvent this problem, we have used the widely used HP filter to measure these two variables. The validity of the model requires that Price and the *P–Star* share a long run equilibrium relationship With this backdrop, taking into account annual as well as monthly data, we have estimated the P* model for India, the validity of which is established via cointegration test

However, the P* model is based on the quantity theory of money, which implies money as the sole determinant of inflation. But with the increasing skepticism about the money as the sole determinant of inflation has led the researchers to a quest for alternative forecasters of inflation that draw upon a number of indicator variables – financial as well as non financial. Taking note of this we have invoked VAR analysis to identify a number of such variables that may influence change in inflation. The major indicators comprise of real output gap, nominal broad money and bilateral nominal exchange rate which are crucial to construct an inflation forecaster model. In line with the work due to Debelle and Lim (1998), we have estimated an inflation forecaster model and tried to forecast out of sample inflation for both annual as well as monthly case. The results indicate that, barring the turmoil period of 1991 to 1995,

the model is able to render good annual forecasts of inflation whereas monthly forecast are found to be far more accurate

Inflation targeting in practice usually involves targeting the conditional forecast of inflation rather than the current inflation. A crucial issue in this context is how to choose the optimal horizon. Theoretically, there are two ways of thinking about an optimal horizon for inflation targeting depending on the way inflation targeting is modeled This issue has been discussed under monetary policy rules in chapter V. Technically, the optimal forecast horizon under inflation targeting depends on two factors: the length of monetary transmission lags and policymakers' output and inflation preferences. This has been discussed in analytical as well as empirical context. Taking targeted inflation at five percent level we have tried to measure the optimal horizon for inflation targeting in India The results indicate that the optimal horizon should be of two to three years in India, which is consistent with the findings of other countries.

Policy Implications

The study considered the option of an inflation target as the centerpiece of new monetary policy framework in India In addition to providing an effective framework for monetary policy where transparency and flexibility are properly balanced, which in turn helps in achieving output stability in the short run and price stability in the long run, the study shows that inflation target has the benefit of serving as an nominal anchor for wage and price setters. It also shows that use of an inflation target circumvents the uncertainties that arise in the monetary targeting framework due to instability in the money demand function as it does not pre necessitate the existence of a stable money demand function. Hence inflation targeting can well be pursued in India in light of the apprehension regarding the instability in money demand function due to ongoing financial liberalization. The study also highlights the important prerequisites to be fulfilled for adoption of inflation targeting in India. In particular, inflation target must take precedence over other policy considerations including the exchange rate or monetary aggregate However, the study finds that the exchange rate

or monetary aggregates should be seen as an important part of the transmission mechanism rather than final goals.

Besides, since inflation targeting must be pro active rather than reactive, the central bank must focus on the forecast of inflation at the policy horizon. The study, in this regard has constructed an inflation forecaster model that may serve the purpose. Along with this, the validity of *P–Star* model implies that, this can be used to measure the inflationary potential of the economy. Since monetary policy affects the economy with long lags, the determination of horizon for the inflation target must base on the period it takes for monetary policy to affect inflation. The study has estimated the optimal horizon as 2 to 3 years that may be essential for the practice of inflation targeting.

Scope for Further Research

The goal of the study has been to analyze the feasibility of inflation targeting in India and the relevant issues associated with it. The study makes an attempt to discuss two of the operational issues. However, this does not exhaust the scope for further research. The most crucial factor to adoption of inflation target is the appropriate choice of price index as the headline inflation is improper for the purpose as this includes volatile items that may convey misleading information. Hence construction of a suitable index is always there in the agenda. Again the proper instruments and the channels to achieve the inflation target must be identified. Apart from the above, the development of alternative inflation forecaster models having better predictive content is still at its infancy and hence calls for vigorous research. Besides, the most important aspect that demands an in depth research relates to determining the optimal rate of inflation to be targeted.

Appendix

A1 Cointegration Analysis

The method of cointgration applies to a wide variety of economic models Any equilibrium relationship among a set of nonsatationary variables implies that their stochastic trends must be linked After all, the equilibrium relationship means that the variables cannot move independently of each other. This linkage among the stochastic trends necessitates that the variables be cointegrated. Since the trends of cointegrated variables are linked, the dynamic paths of such variables must bear some relation to the current deviation from the equilibrium relationship Thus, the conventional wisdom of differencing all nonstationary variables used in a regression analysis was- incorrect After all, if the linear relationship is already stationary, differencing the relationship entails a misspecification error.

The concept of cointgration was introduces by Engle and Granger (1987). The formal analysis of cointegration initiates by considering a set of economic variables in long run equilibrium when

$$\beta_1 x_{1t} + \beta_2 x_{2t} + \ldots + \beta_n x_{nt} = 0 \quad \ldots(A1\ 1)$$

If we let β and x_t denote the vectors $(\beta_1, \beta_2, \ldots, \beta_n)$ and $(x_{1t}, x_{2t}, \ldots, x_{nt})'$, the system is in long run equilibrium when $\beta x = 0$ The deviation from long run equilibrium – called the equilibrium error – is e_t, so that

$$e_t = \beta x_t \quad \ldots(A1.2)$$

If the equilibrium is meaningful then it must be the case that the equilibrium error process is stationary The Engle and Granger (1987) provide the following definition of cointegration

The components of the vector $x_t = (x_{1t}, x_{2t}, \ldots, x_{nt})'$ are said to be cointegrated of order d,b, denoted by $x_t \approx CI(d,b)$ if

1. All components of x_t are integrated of order d.
2. There exists a vector $\beta = (\beta_1, \beta_2, \ldots, \beta_n)$ such that linear combination $\beta x_t = \beta_1 x_{1t} + \beta_2 x_{2t} + \ldots + \beta_n x_{nt}$ is integrated of order $(d\text{-}b)$, where $b>0$

The vector β called the cointegrating vector.

Although the Engle-Granger (1987) cointegration procedure is easy to implement, it has several limitations The estimation of the long run equilibrium regression requires that the researcher place one variable on the left hand side and use the others as regressors. In practice, it is possible

to find that one regression indicates the variables are cointegrated whereas reversing the order indicates no cointegration. This is a very undesirable feature of the procedure since the test for cointegration should be invariant to the choice of the variable selected for normalization Moreover, in tests using three or more variables, we know that there may be more than one cointegrating vector The method has no systematic procedure for the separate estimation of the multiple cointegrating vectors. Another limitation of the Engle-Granger procedure is that it relies on a two-step estimator. Hence, if any error introduced by the researcher in first step is carried into second step. Fortunately, Johansen and Juselius (1992) maximum likelihood estimators avoid the use of two-step estimators and can estimate and test for the presence of multiple cointegrating vectors Moreover, the test allows the researcher to test restricted versions of the cointegrating vector(s) and the speed of adjustment parameters.

Consider the n-variable first order VAR given by

$$x_t = A_1 x_{t-1} + \varepsilon_t.$$

Subtract x_{t-1} from each side to obtain.

$$\begin{aligned}\Delta x_t &= A_1 x_{t-1} - x_{t-1} + \varepsilon_t \\ &= (A_1 - I)x_{t-1} + \varepsilon_t \\ &= \pi x_{t-1} + \varepsilon_t\end{aligned}$$

where x_t and ε_t are $(n \times 1)$ vectors; A_1 is an $(n \times n)$ identity matrix; and π is defined to be $(A_1 - I)$.

The rank of π equals the number of cointegrating vectors. There are several ways to generalize the model

1 The equation is easily modified to allow for the presence of a drift term:

$$\Delta x_t = A_0 + \pi_1 x_{t-1} + \varepsilon_t$$

where A_0 is a $(n \times 1)$ vector of constants $(a_{01}, a_{02}, \ldots, a_{0n})$.

The effect of including the various a_{0i} is to allow for a linear time trend in the data generating process. One would want to include the drift term if the variables exhibited a tendency to increase or decrease. Here, the rank of π can be viewed as the number of cointegrating relationships existing in the detrended data. Suppose that the rank of $\pi = 1$ so there is exactly one cointegrating vector In this case, each $\{\Delta x_{it}\}$ sequence has an expected value of a_{i0} if

$$\pi_{11} x_{1t-1} + \pi_{12} x_{2t-1} + \ldots + \pi_{1n} x_{nt-1} = 0.$$

2 An intercept can be included in the cointegrating vector. Consider an $n+1$ variable system but let all values of x_{n+1} equal unity so that.

$$\Delta x_t = \pi^{*} x^{*}_{t-1} + \varepsilon_t$$

Here the cointegrating vectors have the form

$$\pi_{11} x_{1t} + \pi_{12} x_{2t} + \ldots + \pi_{1n} x_{nt} + \pi_{10} = 0$$
$$\pi_{21} x_{1t} + \pi_{22} x_{2t} + \ldots + \pi_{2n} x_{nt} + \pi_{20} = 0$$
$$\ldots\ldots$$

3 The multivariate model can also be generalized to allow for a higher order autoregressive process Consider.

$$\Delta x_t = \sum_{i=1}^{p-1} \pi_i \Delta x_{t-i} + \pi x_{t-p} + \varepsilon$$

where

$$\pi = -\left(I - \sum_{i=1}^{p} A_i \right)$$

$$\pi_i = -\left(I - \sum_{j=1}^{i} A_j \right).$$

Again the key feature is rank of the matrix π. the rank of π is equal to the number of independent cointegrating vectors

The number of distinct cointegrating vectors can be obtained by checking the significance of the characteristic roots of π. We know that the rank of a matrix is equal to the number of its characteristics roots that differ from zero. Suppose we obtained a matrix π and ordered the n characteristics roots such that $\lambda_1 > \lambda_2 > \ldots > \lambda_n$ If the variables in x_t are not cointegrated, the rank of π is zero and all of these characteristic roots will equal unit Since $ln(1) = 0$, each of the expressions $ln\ (1-\lambda_1)$ will equal to zero if the variables are not cointegrated Similarly, if the rank of π is unity, the first expression $ln\ (1-\lambda_1)$ will be negative and all the other expressions are such that $ln\ (1-\lambda_2) = ln\ (1-\lambda_3) = \ldots = ln\ (1-\lambda_n) = 0$.

In practice, we can obtain only estimates of π and its characteristic roots. The test for the number of characteristic roots that are insignificantly different from unity can be conducted using the following two test statistics:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{n}\ln(1-\hat{\lambda}$$

$$\lambda_{\max}(r, r+1) = -T\ln(1-\hat{\lambda}_{r+1})$$

where $\hat{\lambda}_i$ are the estimated values of the characteristic roots (also called eigenvalues) obtained) obtained from the estimated π matrix, and T is the number of usable observations When the appropriate values of r are clear, these statistics are simply referred to as λ_{trace} *and* λ_{max}

The first statistic tests the null hypothesis that the number of distinct cointegrating vectors is less than or equal to r against a general alternative From the previous discussion, it is clear that λ_{trace} equals zero when all $\lambda_i = 0$. The further the estimated characteristic roots are from zero, the larger the λ_{trace} statistic The second statistic tests the null that the number of cointegrating vectors is r against the alternative of $r+1$ cointegrating vectors. Again, if the estimated value of the characteristic root is close to zero, λ_{max} will be small.

A2 Vector Autoregression Analysis

A natural starting place for multivariate models is to treat each variable symmetrically In the two variable case we can let the time path of the y_t be affected by current and past realizations of the z_t sequence and let the time path of the z_t sequence be affected by current and past realizations of the y_t sequence. Consider the simple bivariate system

$$y_t = b_{10} - b_{12}z_t + \gamma_{11}y_{t-1} + \gamma_{12}z_{t-1} + \varepsilon_{yt} \quad .. \qquad (A2.1)$$

$$z_t = b_{20} - b_{21}y_t + \gamma_{21}y_{t-1} + \gamma_{22}z_{t-1} + \varepsilon_{zt} \quad \ldots \quad (A2.2)$$

Where it is assumed (i) that both y_t and z_t are stationary, (ii) ε_{yt} and ε_{zt} are white-noise disturbances, and (iii) ε_{yt} and ε_{zt} are uncorrelated

Equations (5.1) and (5.2) constitute a first order VAR since the longest lag length is unity. The structure of the system incorporates feedback since y_t and z_t are allowed to affect each other

Using matrix algebra, we can write the system in compact form

$$Bx_t = \Gamma_0 + \Gamma_1 x_{t-1} + \varepsilon_t \quad \ldots (A2.3)$$

where

$$B = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}, \quad x_t = \begin{bmatrix} y_t \\ z_t \end{bmatrix}, \quad \Gamma_0 = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix},$$

$$\Gamma_1 = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix}, \text{ and } \varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}.$$

Equation (5 3) represents a VAR in primitive form Premultiplication by B^{-1} allows us to obtain the VAR model in standard form

$$x_t = A_0 + A_1 x_{t-1} + e_t$$

where $A_0 = B^{-1}\Gamma_0$, $A_1 = B^{-1}\Gamma_1$, *and* $e_t = B^{-1}\varepsilon_t$.

For notational purposes, we define a_{i0} as element I of the vector A_0, a_{ij} as the element in row I and column j of the matrix A_1; and e_{it} as the element I *of the vector* e_t Using this new notation, we can rewrite (5 3) in the equivalent form

$$y_t = a_{10} + a_{11}y_{t-1} + a_{12}z_{t-1} + e_{1t} \quad \ldots \text{(A2.4a)}$$

$$z_t = a_{20} + a_{21}y_{t-1} + a_{22}z_{t-1} + e_{2t} \quad . \text{(A2.4b)}$$

It is important to note that the error terms are composites of the two shocks ε_{1t} *and* ε_{2t} Since $e_t = B^{-1}\varepsilon_t$ we can compute e_{1t} *and* e_{2t} as.

$$e_{1t} = (\varepsilon_{1t} - b_{12}\varepsilon_{2t})/(1-b_{12}b_{21}) \quad \ldots \text{(A2.5)}$$

$$e_{2t} = (\varepsilon_{2t} - b_{21}\varepsilon_{1t})/(1-b_{12}b_{21}) \quad \ldots \text{(A2.6)}$$

Since ε_{1t} *and* ε_{2t} are white-noise processes, it follows that both e_{1t} *and* e_{2t} have zero means, constant variances, and are individually serially uncorrelated.

Innovation Accounting

An essential tool to analyze the dynamic interrelationships among the variables in a VAR is the Vector Moving Average (VMA) representation The VMA representation (5 3) expresses the variables y_t and z_t in terms of the current and past values of the two shocks ε_{1t} *and* ε_{2t} We can write equations (5.4a) and (5 4b) in matrix form

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}$$

Let μ_1 *and* μ_2 be the mean values of be the mean values of y_t *and* z_t , respectively. If we iterate backwards, it is possible to form:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix} + \frac{1}{1-b_{12}b_{21}} \sum_{i=0}^{\infty} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}^i \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \quad \ldots (A2\ 7)$$

Now define the 2 × 2 matrix ϕ_i with elements of $\phi_{jk}(i)$ such that

$$\phi_i = \frac{A_1}{1-b_{12}b_{21}} \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix}$$

If we let $\mu = [\mu_1 \quad \mu_2]$ the moving average representation of (5.7) can be written as:

The moving average representation is an especially useful tool to examine the interaction between the y and z sequences The coefficients of ϕ_i can be used to generate the effects of ε_{1t} *and* ε_{2t} shocks on the entire time paths of the y_t and z_t sequences. If you understand the notation, it should be clear that the four elements $\phi_{jk}(0)$ are impact multipliers. The four sets coefficients of coefficients $\phi_{11}(i)$, $\phi_{12}(i)$, $\phi_{21}(i)$, and $\phi_{22}(i)$ are called the impulse response functions.

The VAR in standard form is written as follows.

$$x_t = A_0 + A_1 x_{t-1} + e_t$$

Now suppose the coefficient A_0 and A_1 is known and we want to forecast the various values of x_{t+1} conditional on the observed value of x_t. Updating the above equation by one period (i.e. $x_{t+1} = A_0 + A_1 x_t + e_{t+1}$) the conditional expectation of x_{t+1} is:

$$Ex_{t+1} = A_0 + A_1 x_t$$

Here one-step ahead forecast error is $x_{t+1} - Ex_{t+1} = e_{t+1}$. Similarly the two step ahead forecast of x_{t+2} is $Ex_{t+1} = (1+A_1)A_0 + A_1^2 x_t$.

The two-step ahead forecast error is $e_{t+2} + A_1 e_{t+1}$. More generally the n-step ahead forecast is:

$$E_n x_{t+n} = (1+A_1+A_1^2+\ldots+A_1^{n-1})A_0 + A_1^n x_t$$

And the associated forecast error is:

$$E_{t+n} + A_1 e_{t+n-1} + A_1^2 e_{t+n-2} + \ldots + A_1^{n-1} e_{t+1}$$

It is possible to write the forecast errors in term of the ε_{yt} and ε_{zt} shocks The forecast error variance decomposition tells the proportion of their movements in a sequence due to its own shock versus shocks to the other variables. If ε_{zt} shocks explain none of the forecast error variance of ε_{yt} at all forecast horizons, it can be said that $\{y_t\}$ sequence is exogenous In such a circumstance, the $\{y_t\}$ sequence would evolve independently of the ε_{zt} shocks and of $\{z_t\}$ sequence On the other hand if ε_{zt} shocks explain all of the forecast error variance in $\{y_t\}$ sequence at all forecast horizons then $\{y_t\}$ would be entirely endogenous

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