ESTIMATING IMPLICIT INFLATION TARGET FOR PAKISTAN: STATE SPACE APPROACH

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Dedicated to My Husband Arif Khaliq

The Source of My Happiness

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Abstract

This study has estimated implicit inflation target for Pakistan by using Kalman Filter and time varying parameter model relaxing the assumption of constant inflation target. We have considered both the specifications in state space representation, constant natural rate of interest and time varying natural interest rate, using quarterly data over the period 1981Q1 to 2012Q4. The estimated value of implicit target is 6.79 percent with constant rate. When we included time varying natural interest rate in the model, the trend is same but it shifts the path of inflation target upward. The estimated value of implicit target is 8.43 percent with time varying natural rate. The estimated inflation target is consistent with the intentions of policy makers reflected through the behavior of interest rate and SBP has been partially successful.

Chapter 1

Introduction

The ultimate objective of economic policy is to improve the economic well-being of the citizens, which could be achieved through higher economic growth, efficient resource utilization, price stability, regional balance, fair income distribution, wealth accumulation and good quality environment. Most vital of the aims of economic policies are growth and stability. Monetary policy besides other macroeconomic policies is used to help in guiding economic activity for optimal utilization of resources. Among fiscal and monetary policies, the latter is considered a better tool to stir the functions of the market (Sevensson, 2003).

During the last three decades central banks of many countries[1] have announced "price stability" as their primary responsibility owing to variety of reasons. High and variable inflation has negative effects such as inefficient resource allocation in the economy and jeopardizing the income distribution among economic agents. For achieving price stability monetary policy has three frameworks namely the monetary targeting, exchange rate targeting and inflation targeting. In first two frameworks monetary policy target intermediate variables to achieve price stability such as the growth rate of monetary aggregates or the exchange rate valuation. Contrary to this, in the

[1] For example, Australia (1993), Sweden (1993), Israel (1991), Brazil (1999), Canada (1991), New Zealand(1990), and UK (1992).

inflation targeting framework monetary policy directly targets inflation [Batini et. al. (2005)].

The inflation was tripled in many countries during 1960-1974 because of failure of Bretton wood system in 1971 and petroleum shocks in 1973. According to Schmidt-Hebbel and Werner (2002) average inflation rates were above 200 percent a year in few countries. The Governments and policy makers in those countries changed their minds and made price stability as the primary objective of monetary policy. During 1990's a number of countries adopted inflation targeting for controlling inflation. New Zealand was the first country to adopt this regime in 1989.So monetary policy was successful in controlling inflation.

Under inflation targeting the primary objective of monetary policy is low and stable inflation rate. Inflation targeting is more than simply announcing a target for inflation. There are some essential components of inflation targeting framework: central bank announces the target, which may be a point or a range; central bank's commitment about setting price stability as primary objective; better communication between central bank, government and markets about the objective of monetary policy; and increased accountability of the central bank for achieving its objectives of price stability [Bernanke et al. (1999)]

However, Pakistan is among those countries where explicit Inflation targeting does not take place, and quantitative inflation objectives are not announced; SBP's inflation target does exist implicitly. Although annual inflation targets are announced but

those are actually inflation projections and not the targets as inflation targets cannot achieved in one year. This is however, different from couple of other countries where inflation targeting is done in an explicit manner, for example The Bank of England (BOP) sets an explicit quantitative target of 2% of CPI for two years.

Inflation targets are normally set by the Government and the central banks utilize the monetary policy to achieve the targets. For policy effectiveness and further evaluation, keeping a target ahead is always a better option. The indisputable importance of implicit inflation targets and its observed significance makes this estimation important for countries like Pakistan where the trends of rising inflation are repetitive over time.

On an average, the inflation rate from 1957 to 2013 stood around 8 percent per year. In December 1973 Pakistan's economy experienced maximum hype in inflation i.e. 38 percent, because of political instability. On the other hand, the lowest ever inflation rate was -10.3 percent in 1959. Recently, the expansionary monetary policy has resulted in an upsurge of inflation rate from 3 percent in 2003 to 9.3 percent in June 2005. The inflation rate rose to 10 percent in 2008 even though SBP applied contractionary monetary policy, after decreasing to 7.8 percent in 2007 (Economic Survey, 2012-2013).

In Pakistan the opponents of inflation targeting argue that the main determinant of inflation is import prices and not the monetary policy, so Pakistan should not adopt inflation targeting framework to influence inflation rate [Choudhary and Chaudhry (2006)]. Contrary to this, a number of economists have investigated the level of preparedness of SBP to adopt inflation targeting and they have given the examples of

some developing economies for example Columbia has successfully adopted IT. Pakistan can also think about to revive its monetary policy [Arif (2011), Khalid (2005) and Akbari (2005)].

In Pakistan, (Malik, 2007) has estimated the policy reaction function of SBP for the period 1991–2005 and found the optimal inflation target to be 8%. Estimation in this analysis has been performed by assuming constant inflation. Observations of variation in inflation target have been made, and multiple reasons can be associated with this belief. Annual reports by The SBP reveal some facts regarding variation in inflation objectives. The effect of monetary policy on the stabilization of economy can be observed from the annual reports. There has been a transition over time in inflation target with numerical goals, and this study also attempts to prove that. This also suggests the supposition of a constant inflation target is too much bounding.

Analyzing the literature already existing in this field gives inspiration for a study ahead. The need of the time is to move forward in all dimensions and comply with the latest and most useful tools to achieve development in this field.

The prime objective of this study is to estimate the unobserved implicit inflation target using Kalman filter (Kalman, 1960) in state space representation for Pakistan. Kalman filter offers certain advantages that lay heavy on its minor disadvantages if found any. It can be accustomed to work in numerous specifications for example, Gaussian, Bayesian and likelihood etc. It is also helpful in the estimations of the frameworks which need to calculate multiple unknowns simultaneously. Considering the relevance and

significance of estimation of implicit inflation target, the present study aims to achieve two main objectives, first, to analyze implicit inflation target in the mind of policy makers while conducting monetary policy. For this purpose, two alternate estimations have been made. Initially, implicit inflation target is estimated with constant natural interest rate, and later, with time varying natural interest rate. Second, given the worldwide facts and studies on the variations in trends of implicit inflation target, this study intends to examine whether the estimated inflation target is constant or not?

The rest of the study is organized as follows. The next chapter presents an overview of the theoretical and empirical literature carried out in this area so far. Chapter 3 explains model and estimation procedure and also discusses the choice of variables and data issues. We include results, interpretations and discussion in chapter 4. Finally chapter 5 attempts to bring together the main findings for concluding remarks.

Chapter 2

Literature Review

This chapter presents an overview of the theoretical and empirical literature carried out in this area so far.

2.1 History

Initially money was a medium of exchange, now it is an asset. Money explains prices which is a neutral force between demand and supply. When equilibrium between demand and supply get out of order, it generates inflation. Inflation is "sustained rise in the general level of prices" by (Griffiths, 1976). In his definition of inflation two terms "general" and "sustained" are important. General increase in price level does not mean that there will be increase in prices by the same proportion. Prices of all the goods and services are affected according to their relative importance in the economy. By the word "sustained" means an increase in general price level continuously. Such increase in general price level is referred to as inflation which remains at high level for a long time period (Ederm and Kayhan, 2010). There are many definitions of inflation in the literature as Friedman (1980) states that the major reason of inflation is creation of money. Price level rises when the quantity of money increases and production of goods and services do not increase or there would be fall in velocity of money. Eder (1979) characterized inflation as demand pull inflation and cost push inflation. He states that cost push inflation is caused when wages are increasing more than labor productivity and

demand pull inflation is caused when increase in quantity of goods and services is less than increase in money.

According to classical economists money supply is the only source of inflation given the level of output. In classical models, money supply is exogenous. According to classical, money has no effects on real GDP. When money stock changes the prices will change, this is known as classical dichotomy. Cambridge economists considered rise in demand for money was the source of inflation in Neo Classical theory of inflation. Keynes stated in his book on inflation "How to Pay for the War" in 1940 that increase in aggregate demand is not just because of increase in money supply, it can be increase due to increase in real factors. If prices are rigid monetary policy can affect real sector. Increase in money supply can increase prices only when wages are sticky. Keynesians believed on discretionary monetary policy. In this framework central bank can change money supply by discretion in order to control inflation.

On the other hand, monetarists also believe that money supply is the only source of inflation. However the modern monetarists make some modifications in classical theory of inflation as they do not believe that money stock and price level are strictly proportional. Modern monetarists do not believe on the proposition of classicals that "the supply curve is vertical in short-run." Friedman stated that "a reduction in the money stock does in practice first reduce the level of output, and only later have an effect on prices". They differentiate the long run and short run effects of change in the money

stock. They argue that change in money stock effect output in short run but in long run the change in money is neutral to output.

The inflation was tripled in all the countries during 1960's and 70's; the main reasons of this increase were the failure of Bretton Wood system in 1971 and petroleum shocks in 1973. According to Schmidt-Hebbel and Werner (2002) average inflation rates were above 200 percent a year in four countries. As the increase in inflation had negative impact on the economy, Therefore governments and policy makers changed their minds and made price stability as the primary objective of monetary policy. According to the (Bernanke et al., 1999) and (Mishkin, 2000) the major cause of introducing inflation targeting in 1980's were the money demand instability and exchange rate crises that overwhelmed many economies of the world.

2.2 Alternative monetary policy strategies

There are two main alternatives of inflation targeting i.e. monetary targeting and exchange rate targeting. In the late 1970's and 1980's a number of countries adopted monetary targeting to fight against inflation. Exchange rate targeting was not good option for large economies like USA and Japan and not any currency can function as nominal anchor for these economies. In monetary targeting Central bank announce target for the growth of monetary aggregates every year. There are some benefits of monetary targeting such as data on money supply is easily available and money supply can be directly controllable. Like the exchange rate targeting the information about the stance of monetary policy is easily available because Central bank announces figures for monetary

aggregates immediately. In this strategy public and firms both become well aware of monetary policy stance and about the plan of policy makers to control inflation. They form inflation expectation accordingly which help to reduce inflation. It also promotes CB accountability to control inflation and help policy makers to avoid falling into time inconsistency problem. Time inconsistency problem defined by Kydland and Prescott (1977) and Barro and Gordon (1983). This problem is the result of expansionary monetary policy when the policy makers thought to get short run objectives of high growth and employment which result in poor long run outcomes (Mishkin, 1999).

A major advantage of monetary targeting against the exchange rate targeting is that Central bank is able to react according to its domestic considerations. CB can choose its own inflation goal which can be different from other countries and CB can also respond to output fluctuations.

All the advantages of monetary targeting depend on the strong relationship between the targeted variable and goal variable. If this relationship is weak then monetary targeting will not work properly means that when Central Bank hits the target the desired outcomes will not achieved. The collapse of this relationship has occurred in USA (Frieman and Kuttner, 1996).

Monetary targeting has successfully pursued in two countries Germany and Switzerland. The reason for the success is that the monetary targeting regime is very different from the monetary targeting rule presented by Friedman. In which a constant growth path is set for monetary aggregates. After the collapse of the relationship between

the targeted variable (money aggregates) and goal variable (inflation) many countries thought about for other better options [(IMF, 2005) and (Mishkin, 1998)]. Earlier the exchange rate targeting was fixing the domestic currency to gold standard but recently fixed exchange rate targeting is fixing the value of domestic currency to other country which has low inflation. Crawling target or peg in which currency depreciate slowly, so that inflation should be high in pegging country. There are some advantages of Exchange rate targeting such as inflation rate is fixed for internationally traded goods which helps to keep the inflation low. Secondly this strategy is simple and easily understood by the public. Exchange rate targeting is 'strong commitment mechanism' it offers automatic rule for monetary policy which constrain time inconsistency problem. When domestic currency depreciate it force to tight the monetary policy and when the domestic currency appreciate it force to lose the monetary policy which helps to avoid the discretionary time inconsistence monetary policy. Exchange rate targeting has been used in industrialized economies like United Kingdom and France to reduce inflation and in emerging economies this strategy has also been successfully used to lower inflation like Argentina which adopt fixed exchange rate in 1991.

There are some shortcomings of Exchange rate targeting. First Central bank loses the independence to use monetary policy to react to domestic shocks. Secondly the external shocks are directly transferred to the targeting country. Thirdly when the domestic prices are rigid the output has to adjust first to achieve the proper real exchange rate.

During 1990's countries forced to abandon this regime because of currency crises. Most of the countries adopted inflation targeting with floating exchange rate and some countries adopted hard pegs. The recent performance of the countries with hard pegs is good but not better than the countries those adopted inflation targeting. One main disadvantage of this regime in emerging economies as stated by Mishkin (1998a) that: this regime is very hazardous in emerging economies because it promotes financial instability, which leads to financial crises that is critical for the economy. A financial crisis evades the functioning of financial markets efficiently which can be highly dangerous to the economic activity [(Bernanke, 1983) and (Mishkin, 1991, 1996)].

The deep financial crises of Latin America and East Asian countries in 1990's have led the countries to explore the alternative monetary policy strategy. Industrialized countries were already successfully using inflation targeting as monetary policy strategy, so emerging and developing economies found this attractive alternative and a number of emerging economies including Brazil, Chile, South Africa, Poland and Czech Republic adopted IT as monetary policy framework (Mishkin, 2000).

2.3 Inflation Targeting

During 1990's many industrial countries adopted inflation targeting to conduct monetary policy for controlling inflation. New Zealand was the first country to adopt this regime in 1990 and the following countries are Canada, Sweden, UK, Australia, Finland, Spain, Israel and Chile……

There are almost 27 countries who formally adopted inflation targeting as MP regime. Inflation targeting is divided into two main groups strict and flexible IT. Central bank focus on controlling inflation in short horizon which leads to rapid changes in interest rate and exchange rate under strict Inflation Targeting. In small open economy the main reliance would be on exchange rate channel to inflation which would lead to volatility in exchange rate which increases the output volatility (Sevensson, 1997). In flexible inflation targeting with achieving the goal of price stability some weight is also given to business cycle stabilization, stability of interest rate, exchange rate, output and employment for decreasing inflation to its target in long horizon [(Sevensson, 1997) and (Ncube and Ndou, 2011)].

Pure inflation targeting is easy to understand, explain and monitor, so adopting IT there may be significant advantage because solution of difficult problems can be estimated by a simple rule (Cecchetti, 1998) and (Ball, 1997)]. (Bernanke, 2003) states that all the central banks that have adopted inflation targeting as policy regime have been pleased with their performance and none of the adopter of IT has abandoned this approach. Inflation targeting improved the overall economic performance of the IT countries (Bernanke et al., 1999), (Truman, 2003) and Mishkin, 2006). Contrary to it Ball and Sheridan (2005) argued that in industrialized countries inflation targeting does not make a difference. He has compared performance of IT and non IT countries (OECD) and he concluded that during 1990's performance of IT and non IT countries both have improved because of Inflation Targeting. (IMF, 2005) strongly disagree with the findings of (Ball and Sheridan, 2005) and presents evidence based on the data of emerging

economies that inflation volatility and persistence has reduced in inflation targeting countries. There is improvement in output volatility and sacrifice ratio after inflation targeting (corbo et al., 2002).

Inflation targeting has several advantages. Like Monetary targeting in this regime Central bank can focus domestic considerations and CB can respond to domestic shocks efficiently. In this regime Monetary Policy does not depend on the relationship of the money and inflation, so velocity shocks are inappropriate. In this framework the Central Bank uses all the available information and makes the best situations for monetary policy. Secondly like exchange rate targeting monetary policy is easily understood by the public and it is extremely transparent. Inflation targeting increases the accountability of Central Bank and also lessens the chance of falling CB into time inconsistency problem. The main reason of time inconsistency trap is political pressure on CB and in Inflation targeting framework CB is independent and the only focus of CB is to control inflation, so inflation targeting can reduce political pressure on the CB which would decrease the probability of time inconsistent policy making (Mishkin, 1998) and (Mishkin, 2000). The reason of success of this strategy in industrial countries is that their CB focuses on transparent monetary policy and communication with the public (Bernanke et al., 1999), (Mishkin and Possen, 1997). They publish the documents or reports about inflation they presents the details of the stance of monetary policy and performance of inflation. Because of transparent monetary policy the CBs are highly accountable to the public (Mishkin, 2000).

There are some disadvantages of this framework. Four main shortcomings are discussed in Bernanke et al. (1999) and (Mishkin, 1999); Inflation targeting permits "too much discretion", It is too rigid, it promotes "output instability" and It decreases output growth.

As (Mishkin, 2000) states that these are not serious objections if this strategy is properly designed according to Bernanke et al. (1999) characterized it as "constrained discretion". One other disadvantage is weak accountability of central bank; it is difficult to control inflation for central bank because there are substantial lags associated with the instruments to inflation outcome. This is a serious problem for emerging and developing economies because in these economies inflation has to bring down from a high level. So there will be great chance of target missed and credibility cannot be gained by inflation targeting but as Masson et al. (1997) states that *"Inflation targeting is likely to be a more effective strategy if it is phased in only after there has been some successful disinflation."*

Joe Stiglitz, stated that "*Today, inflation targeting is being put to the test – and it will almost certainly fail*" (Stiglitz, 2008). The opponents of Inflation targeting argued that IT is untested framework and not any severe shock put pressure on the stable inflation in IT countries but this objection is wrong. They have faced severe shocks as the result of Asian crises of 1997 such as New Zealand, Chile, Israel and Australia have to run to major exchange rate devaluation. They have little passed through from devaluation to inflation. They have faced this storm successfully (Corbo et al., 2000). Oil price shock of 1999-2000 was the test of oil importing IT countries such as Brazil, Poland, Czech Republic, Chile, New Zealand Israel and Australia. They have faced increased imported

inflation through exchange rate devaluation and energy prices. However the effect of this shock was minor on inflation.

2.4 Design or implementation issues

There are a number of issues related to design and implementation of inflation targeting. The basic issue is to balance flexibility and transparency during the operation. Price level target and inflation target sets the path for price level. In price level target, if the inflation is more than the target in one period then it should be less the target in next period. In inflation target the missed targets are not balance. Price level target has the advantage to offset the missed target but it can create price level volatility in short horizon (Mishkin and Posen, 1997). All the countries have chosen inflation rate to target rather than price level. Which of these two targets is better; this is still an open question in literature (Mishkin, 1998). Fisher (1994) argued that price level as target creates more output variability than an inflation rate as target. One other disadvantage of price level target is that it can lead to deflation which promotes financial instability (Mishkin, 2000). In his work on financial instability Mishkin (1978, 1991, and 1997) has stated that in industrialized economies the major reason of financial instability is deflation which leads to increase the debts of households and firms which decrease their net wealth and worsening their balance sheets.

What should be the long run target for inflation? Inflation targeting requires a numerical value for inflation target to achieve the objective of price stability. The target ranges between 0 to 3 satisfy the definition of price stability as presented by

Alan Greenspan. Some economists stated that '0' is a magic number as inflation target and he argued that inflation target greater than zero effects the central bank credibility and inflation expectation which could increase inflation (Poole, 1999). But Bernanke et al. (1999) stated that inflation target should be above zero but less than 3 percent and it will not affect the central bank credibility and inflation expectations. Here is one more argument against inflation target at zero in literature that it would leads to deflation in the economy and deflation is very dangerous and leads to financial instability. If the interest rate reaches at zero, it will create more problems in conducting monetary policy as in case of Japan (Leigh, 2004). So undershooting an inflation target from zero is more problematic than overshooting a zero target. Most of the countries have target ranges like Australia has a 'thick point' target (1 percent) and some countries have target without identifying a single point to target and some in their disinflation period stated only upper bound of the range not lower bound, usually countries have same width of the inflation target range which is mostly 2 percent points [(Roger and Stone, 2005), (Mishkin, 1998) and (Hammond, 2012)].

The inflation target horizon is the period in which **c**entral bank has to meet its target. One basic requirement of inflation targeting is that the horizon should consider the lag between the policy actions and their effects on inflation. For central bank flexibility long horizon is essential, in which central bank can focus other objectives without ignoring inflation. Annual inflation target horizon is suitable for disinflating countries and the countries with high inflation rates need long horizons at least more than 2 percent to bring inflation down. Korea, New Zealand, Canada and Sweden have long

horizons when they have adopted inflation targeting [(Mishkin, 2000), (Roger and Stone, 2005), (Hammond, 2012) and (Mishkin and Posen, 1997)]. Almost all the inflation targeting countries use CPI (consumer price index) as measures of inflation because its monthly data is easily available and data of other measure like GDP deflator is quarterly available. Some countries use core inflation and some use headline inflation. Headline inflation is more volatile than core inflation because core inflation excludes food. Headline inflation has the advantage that public is familiar with it and in some developing countries the food is 40 percent of CPI basket and excluding food from CPI will lack central bank credibility.

UK and Chile have chosen a point target and a number of countries have chosen target range. Target range provide flexibility and it also shows that there is uncertainty involve in inflation process. Wide target range can confuse the public about the plans of policy makers and Central bank and it can affect the credibility of Central bank. On the other hand with narrow target range, there is great chance of target missed. Narrow target range can also leads to instrument instability and controllability problems. New Zealand initially set a narrow target range (2 percent point) and in November 1996 New Zealand widen the target range up to 3 percent point. But with widening the target range the Central bank can lack credibility. So recently Central bank of New Zealand has chosen midpoint of the target range. Point target is a better option than a target range [(Mishkin, 1999), (Mihkin and Jonas, 2003) and (Mishkin and Posen, 1997)].

2.5 Role of Exchange rate

The movements in exchange rate can effect inflation. In small open economies, the domestic currency depreciation can increase inflation because of high import prices and Central bank has to change monetary policy as the result of public and political pressure. In emerging and developing countries the exchange rate movements are very important as the industries can be less competitive with the appreciation of domestic currency which results in current account deficit and currency crises. Depreciation of domestic currency is also very hazardous in emerging and developing countries because most of the countries have debt in foreign currency. With depreciation the debt burden of these economies will increase which can result in financial instability [Mishkin (1996b, 1999c)] like the currency crises of East Asia (1997) and Mexico (1994-95). The major problem of limiting exchange rate under inflation targeting is that exchange rate target can have first priority over the inflation target [(Mishkin, 1999) and (Jonas and Mishkin, 2003)].

2.6 Preconditions of Inflation targeting

There are some standard initial conditions identified by the earlier literature for adoption of IT [(Mishkin and Savastano, 2000) and (Mishkin and Hebbel, 2007)].

The pre-requisites are Financial system should be strong, Floating exchange rate, Independence of central bank, Low debt level, Sufficient foreign reserves, Fiscal

discipline and Transparency of information. (Batini and Laxon, 2007) states that for adopting and maintaining inflation targeting; initial institutional and economic conditions do not matter. After adopting IT the countries build up these conditions gradually. Most of the countries adopted IT without satisfying all the preconditions such as Chile and Israel targeted the exchange rate and some countries do not publish inflation forecast such as Israel, Mexico, South Africa, Columbia, Peru and Korea (Mishkin and Hebbel, 2001).

Although Pakistan does not fulfill most of the pre requisite conditions of inflation targeting as most of the countries did not satisfied all the pre requisites before adoption. Similarly, before 1999 Columbia was also not satisfying most of the pre-conditions. There was deepest recession because of macroeconomic mismanagement. In January 1998, Columbia's currency was depreciated by 22 percent and its central bank lost 18 percent of its foreign reserves to defend its currency. At that time its growth rate was -4.2 percent. Ultimately Columbia adopted inflation targeting with flexible exchange rate system. Inflation targeting is successful in Columbia as inflation has decreased GDP has improved and condition of foreign reserve is also adequate (Ahmad M. Khalid, 2005).

How well Pakistan is prepared for the adoption of Inflation targeting as monetary policy strategy. Initially Pakistan was using monetary aggregate targeting. Since 2005 Pakistan has adopted interest rate targeting implicitly till 2009. But after 2009, Pakistan is using interest rate targeting explicitly. There was fiscal dominance over monetary policy till the reforms. In 1993 SBP got independence for monetary policy implementation as

the result of changes in SBP act of 1993. But there is some escapes in this act as SBP still borrow from commercial banks. Pakistan need

Market based monetary policy which was guaranteed in 1990's financial sector reforms and in 1995 the initiate of Open Market Operation. Pakistan moved from fixed exchange rate to floating exchange rate from July, 2000. Now Pakistan has to focus on exchange rate movements because it can affect trade flows severely and it can create uncertainty. Pakistan should consider inflation targeting as monetary policy strategy as Pakistan is in the process of satisfying the preconditions for improving the monetary policy [(Zaidi, 2006), (Arif, 2004), (Janjua, 2004) and (Arif, 2011)].

Although the inflation targeting countries explicitly announce inflation targets, non IT (inflation targeting) countries implicitly announce a target for inflation, for example countries like USA have been analyzed for their implicit inflation targeting behavior. (Clarida et al., 1998) have estimated the Fed's policy reaction function assuming constant inflation target for the period 1979 -1994, and estimated it to be around 4 percent. Similarly, (Malik, 2007) studied the same policy reaction function for Pakistan for the time period 1991–2005 and found the optimal inflation target to be 8 percent. It has also been observed in the study that by assigning equal weight to the output stabilization and inflation, improved macroeconomic results can be reaped. His study shows the optimal level of inflation for Pakistan and his findings are consistent with the results of (Mubarik, 2005) threshold level of inflation being at 9 percent and of

(Khan and Senhadji, 2001) where threshold level of inflation is estimated to be 7-11 percent for growing countries like Pakistan.

(Leigh, 2007) has estimated the implicit inflation target by easing the assumption of constant inflation target applying Kalman filter and time varying parameter model for US economy. Same estimations with same methodology have been conducted for South Africa by (Klein, 2012). His findings revealed that the inflation target remained between the range 4.5 to 6 percent for the time frame 2001 -2011.

This study follows the same pattern of estimation performed by (Leigh, 2007) and (Klein, 2012). The assumption of constant inflation target is relaxed for the analysis; the models have been estimated alternatively using constant natural interest rate and time varying natural interest rate. Results indicated the range of implicit inflation target fluctuates between 6- 9 percent which is consistent with the previous literature with relevance to Pakistan.

Chapter 3

Econometric Methodology, Data and Variables

3.1 Introduction

This chapter describes the econometric methodology used for the analysis of the present research and also explains the estimation procedure. Section 3.2 contains analytical background of the implicit inflation target. Section 3.3 describes the model. Section 3.4 explains the model for constant natural interest rate. Section 3.5 contains the model for time varying natural interest rate. The estimation procedure of implicit inflation target at different stages of business cycle is discussed in section 3.6. Section 3.7 comprises discussion on selected variables used in this study. The constructed variables of the present study are described in section 3.8 and section 3.9 includes data description.

3.2 Analytical Background

This empirical study follows the methodology of Daniel Leigh (2007), Nir Klein (2012) and Laubach and William (2003). Daniel Leigh (2007) has estimated the implicit inflation target for US Central bank relaxing the assumption of constant inflation target and constant natural rate of interest. As Fed announces qualitative inflation target, studies conducted so far have estimated its quantitative inflation target under the assumption of constant inflation target and natural interest rate. He proved that inflation target vary over the time by using structural stability test and incorporate interest rate smoothing in Taylor rule.

3.3 Model

Taylor rule is monetary policy rule proposed by John Taylor in 1993 in order to adjust interest rate (policy instrument) in response to inflation and output. When the forecasted inflation upsurges the Taylor rule increases the nominal interest rate to raise real interest rate for output stabilization; when output falls below its potential level then Taylor rule prescribe decreasing interest rate. The central banks control the nominal interest rate according to the following rule:

$$i_t^* = r_t^n + \pi_t^e + (\beta - 1)(\pi_t^e - \pi_t^*) + \gamma y_t^{\sim} \qquad (1)$$

Where i_t^* is the target level of nominal interest rate in time period t, $y_t^{\sim}$ is the output gap,π_t^e is the forecasted inflation, r^n is the natural rate of interest and π^* is the inflation target.

There are two important conditions in Taylor rule; first is inflation stabilization that is $\beta > 1$ and second is output stabilization or 'leaning against the wind', that is, $\gamma > 0$. The real rate gap $r_t^* - r^n$ is positively related to inflation gap $\pi_t^e - \pi^*$ i.e. when the expected inflation increases above its target then policy makers increase the nominal interest rate which ultimately increases the real interest rate. When there is increase in inflation rate above its target then central bank will increase the target of real interest rate above its natural rate.

If we consider the earlier literature of Taylor rule with the assumption of constant inflation target and constant natural rate of interest such as Clarida et.al (1998) has

estimated inflation target π^* = 4% and he has assumed r^n=3.5%, then equation (1) can be rewritten as:

$$i_t^* = r^n + \pi_t^e + (\beta - 1)(\pi_t^e - \pi^*) + \gamma y_t^{\sim}$$

Where r^n and π^* are without the subscript t which shows these variables are constant. With manipulations we can write the above equation as follows:

$$i_t^* = \alpha + \beta\pi_t^e + \gamma y_t^{\sim} \qquad (2)$$

Where $\alpha = r^n - (\beta - 1)\ \pi^*$

By estimating the values of α and β, one can find the value of π^* by assuming a constant value for r^n using the following equation.

$$\pi^* = \frac{r^n - \alpha}{\beta - 1} \qquad (3)$$

This study relaxed the assumption of constant inflation target and estimates implicit inflation target for Pakistan by using both the approaches, constant natural rate of interest and time varying natural interest rate and use the following equation:

$$i_t^* = r_t^n + \pi_t^e + (\beta - 1)\ (\pi_t^e - \pi_t^*) + \gamma y_t^{\sim} \qquad (4)$$

Now the variables r_t^n and π_t^* have subscript t which shows that these variables vary over the time. This study uses the Wald test to find whether the inflation target is constant or not. So this study set the null hypothesis that the inflation target is constant as follows:

$$H_O: \quad \pi_t^* = \pi^* \qquad \forall \quad t$$

And alternative hypothesis that the inflation target vary at some time period T.

$$H_1 : \pi_t^* = \pi_O^* \qquad \forall \quad t \leq T$$

$$\pi_t^* = \pi_1^* \qquad \forall \quad t > T$$

There are some other studies in the literature such as Boivin (2006) that estimated the variation in slope parameters and has concluded that there is variation in slope parameters along with the inflation target. But Leigh (2007) has estimated this time variation in slope parameters by using likelihood ratio test and concluded that there is variation in inflation target but not in slope parameters.

For the estimation of Equation (4) this study also incorporates interest rate smoothing in Taylor rule because if there is sudden policy reversals, Central bank can loose its credibility [Clarida et al.(1998)], so this study also take this assumption that central bank change the nominal interest rate to target interest rate progressively:

$$i_t = (1 - \delta)\, i_t^* + \delta\, i_{t-1} + \varepsilon_t \qquad (5)$$

Where i_t^* is the target level of nominal interest rate, $\delta \in (0, 1)$ is the degree of interest rate inertia and ε_t is i.i.d. normal disturbance with zero mean.

This empirical study uses the Kalman Filter approach (Kalman, 1960) to estimate implicit inflation target for Pakistani data. There are many advantages related to Kalman Filter, including that no assumption is required about time variant inflation target. Kalman filter offers certain advantages that lay heavy on its minor disadvantages if found any. It can be accustomed to work in numerous specifications for example, Gaussian,

Bayesian and likelihood etc. It is also helpful in the estimations of the frameworks which need to calculate multiple unknowns simultaneously. This uniqueness can be criticized for restricting the degrees of freedom, considering the time series data being evaluated is spread over few years, but dispersion of the time series data into quarters and months can help to solve this problem.

By combining eq (4) and eq (5), we can write:

$$i_t = (1 - \delta)\ (r_t^n + \pi_t^e + (\beta - 1)\ (\pi_t^e - \pi_t^*) + \gamma y_t^{\sim}) + \delta i_{t-1} + \varepsilon_t \quad (6)$$

$$\pi_t^* = \pi_{t-1}^* + v_t$$

$$\text{var}\ (v_t) = \lambda\ \text{var}\ (\varepsilon_t)$$

We assume that inflation target follows the random walk process because random walk specification absorbs the time variation and this specification can be used to estimate unobserved variables. Staiger et al (1997) has estimated NAIRU assuming that it follows random walk process by using Kalman Filter and Haider and Javed (2011) has also estimated NAIRU for Pakistani data by using Kalman Filter. State space representation can be written as follows:

$$y_t = \text{Z}\ \alpha_t + \varepsilon_t$$

$$\alpha_t = \text{T}\ \alpha_{t-1} + v_t \quad (7)$$

Where y_t and α_t both are vectors, α_t contains unobservable state variables and y_t contains observable variables.

Where $y_t = (i_t - [(1- \delta) (r_t^n + \pi_t^e + (\beta - 1) \pi_t^e + \gamma \tilde{y_t}] - \delta i_{t-1})$,

$$\alpha_t = \pi_t^*,$$

$$Z_t = - (1 - \delta) (\beta - 1) \text{ and}$$

$$T = I \text{ (Identity matrix)}$$

ε_t and v_t are i.i.d. normal disturbances with zero mean. λ is signal to noise ratio parameter which determines the variability of inflation target relative to the variability of policy rate i.e.

λ = var (v_t) / var (ε_t), if λ = 0 this means the assumption of time varying inflation target collapse and this is called 'pile up problem'.

3.4 Model for Constant Natural Interest Rate

As mentioned earlier that this study has considered both the approaches, constant natural rate of interest and time varying natural rate. For constant natural rate we have estimated implicit inflation target by estimating eq. (6) in state space by assuming constant natural rate at 1.28 percent. This value is the average of real interest rate during the sample period.

$$i_t = (1 - \delta) (1.28 + \pi_t^e + (\beta - 1) (\pi_t^e - \pi_t^*) + \gamma \tilde{y_t}) + \delta i_{t-1} + \varepsilon_t \qquad (8)$$

$$\pi_t^* = \pi_{t-1}^* + v_t$$

$$\text{var}(v_t) = \lambda \ \text{var}(\varepsilon_t)$$

These equations are estimated in state space model for inflation target.

3.5 Model for Time Varying Natural Interest Rate

For the estimation of time varying natural interest rate this study has adopted the approach of (Laubach and William, 2003).They estimated natural rate, potential output and trend growth rate by using Kalman Filter because they defined natural interest rate in terms of output gap, so the estimation of r^* also contains the estimation of potential output. There is another method to estimate natural rate that is, univariate time series but this approach has some problems. During 1960s and 1970s when inflation was high, this univariate method has underestimated r^* and overestimated r^* in the period of disinflation during 1980s and 1990s in the United States. So they have estimated natural rate by using state space model which consist output, inflation and real interest rate.

$$\tilde{y_t} = A_y(\text{L})\, \tilde{y_{t-1}} + A_r(\text{L})\, (r_{t-1} - r^*_{t-1}) + \epsilon_{1t} \qquad (9)$$

Where $\tilde{y_t} = (y_t - y^*_t) * 100$ is the output gap, y_t is the real GDP, y^*_t is the unobserved potential GDP, r_t is the real interest rate and r^*_t is the natural rate of interest . Inflation rate π is determined by its own lags and output gap.

$$\pi_t = \boldsymbol{B}_\pi(\text{L})\, \pi_{t-1} + \boldsymbol{B}_y(\text{L})\, \tilde{y_{t-1}} + \epsilon_{2t} \qquad (10)$$

Equation (9) and (10) are the measurement equations of state space model. This state space model also constitutes some transition equations. According to economic theory the main determinant of r^* is trend growth rate, so we mentioned

$$r_t^* = c\ g_t + z_t \quad (11)$$

Where g_t is the trend growth rate and $z_t$constitutes the other determinants, like household's time preference and z is assumed to be autoregressive,

$$z_t = D_z(L)\ z_{t-1} + \epsilon_{3t} \quad (12)$$

ϵ_{3t} is serially uncorrelated normal disturbance. Potential output is evolved according to

$$y_t^* = y_{t-1}^* + g_{t-1} + \in_{4t} \quad (13)$$

$$g_t = g_{t-1} + \epsilon_{5t} \quad (14)$$

Where ϵ_{4t} and $\epsilon_{5t}$are serially uncorrelated normal disturbances. Equations from (11) to (14) are transition equations of state space model. From this model we got the values for natural rate of interest and we have re estimated equation (6) by using these values in state space form for the estimates of implicit inflation target with time varying inflation target and time varying natural interest rate.

3.6 Estimation of implicit inflation target at different stages of business cycle

Inflation rates prevail variant at different stages of business cycle in the history of Pakistan and here we are interested to estimate the implicit inflation target in recession and as well in expansionary situation of the economy. We want to check "Is inflation target stays different in recessionary and expansionary phase of the economy in case of

Pakistan?" For this purpose, this study has generated two distinct series separating the periods of boom and recession. We have parted the high and low growth periods by computing output gap from the output series; the positive values of output gap means the periods of boom or high growth and the negative values of output gap means the periods of recession or low growth (Zakir and Malik, 2013). Accordingly data series of all the variables i.e. call money rate, inflation rate, expected inflation and natural interest rate are also separated. We have re-estimated the model (eq.8) of implicit inflation target with constant natural interest rate for both the periods exclusively taking the values of all the variables in boom or recession in consonance with the positive or negative values of output gap otherwise equal to zero.

3.7 Description of variables

This section comprises discussion on selected variables used in this study guided by empirical literature.

Call Money Rate (CMR) or Money Market Rate (MMR)

Call money rate is used as a proxy for nominal interest rate; it is short-term lending rate between financial or banking institutions for sustaining the margin account. Its maturity period is very short; i.e. 1 to 15 days and has to be paid back on demand. So we have used call money rate (CMR) or interbank offered rate as short term interest rate.

For the estimation of implicit inflation target; US consider federal fund rate as interest rate and federal fund rate is comparable to call money rate or interbank rate in Pakistan.

Malik (2007) has explained call money rate as "*CMR can be used instead of the discount rate as Discount rate is only a policy tool to achieve operational target for the instrument that can also be achieved by other policy tools like open market operations and changes in the reserve ratio*". So according to empirical literature on monetary policy in Pakistan, we can use call money rate as interest rate.

Consumer Price Index (CPI)

The most frequently used measure of inflation of consumer goods in monetary stance is consumer price index (CPI). It reveals changes in the cost of getting a fixed basket of goods and services at retail level by the normal consumer. CPI is the price of an identified basket of goods and services (Economic survey, 2012-2013).

Gross Domestic Product (GDP)

GDP is described as the over-all market cost of all final goods and services created inside a given country in a given time period. We have used real GDP as the measure of aggregate economic activity as guided by empirical literature to make our results comparable to other studies in case of Pakistan.

3.8 Construction of Variables

The constructed variables of the present study are as follows.

Output gap ($y_t^{\sim}$)

The output gap is measure of the difference between potential (natural) and actual output of the economy. Output gap is referred to as transitory component of output, whereas potential output is mentioned as permanent component of output. Output gap is an unobserved variable, which is measured by using HP filter from observable data in this study for Pakistani data.

Inflation Rate (π)

The inflation rate (π) is measured as the percentage change in Consumer Price Index (CPI). We have calculated Annualized inflation rate.

$$\boldsymbol{\pi = (CPI_t - CPI_{t-4})/CPI_{t-4} * 100}$$

Expected Inflation (π_t^e)

Data of expected inflation is generated following the study of Laubach and William (2003); in which forecasts are based on univariate AR (4) by a 40 quarter rolling regression window. Like the variable (p_{t+4} /p_{t-1}) is estimated by using (p_t/ p_{t-1}-1), (p_{t-1}/ p_{t-2}-1) and (p_{t-2}/ p_{t-3}-1). Where p_t is the price level in quarter t.

Natural interest rate (r^n)

The natural interest rate is also an unobserved variable. Equilibrium" or "neutral" rate of interest is the rate which confirms price stability. One approach in this regard is to consider natural rate of interest constant at average rate as Clarida et al. (1998) used this

approach and the second approach is to assume natural rate of interest time variant [Daniel Leigh (2004); Nir Klein (2012); and Laubach and William (2003)]. Laubach and William (2003) have found significant variation in natural interest rate for US economy. Nir Klein (2012) has estimated implicit inflation target using both approaches, constant and time varying natural interest rate and we will also consider both approaches to estimate inflation target.

3.9 Data Description

This empirical analysis has been performed using quarterly time series data from 1981Q1 to 2012Q4. We have selected quarterly data series because of its high frequency, as it increases the number of observations and also, this is the general trend found in empirical literature. All the needed data for this research is attained from International Monetary Fund's International Financial Statistics Database and various issues of Economic Survey. Data on the variables; Money market rate or Call Money Rate (CMR), Consumer Price index (CPI) is taken from IFS and annual data of GDP at constant factor cost (2005) is attained from several issues of Economic Survey of Pakistan. These annual data series is converted into quarterly data using quarterly shares of GDP from Arby (2008). Arby (2008) has quaterized the annual data series of GDP and his data series ends at 2005Q2 and shares ahead this period are generated with the help of moving average of five quarters. However this transformation is done to obtain consistent and smooth data series.

Chapter 4

Results and discussion

4.1 Introduction

This chapter explains the comprehensive analysis of the findings of this study. Section 4.2 contains the unit root analysis of all data series. Section 4.3 includes the results of expected inflation. The results of output gap are discussed in section4.4. Section 4.5 explains the results of the model with constant natural interest rate and its first sub section contains the result of Wald coefficient test to check whether the estimated inflation target is constant or not and second sub section explains the results of Wald coefficient test to check whether the estimated inflation target follows random walk or it is a stationary process. Section 4.6 gives a check of the robustness of the results by taking alternative values for λ. Section 4.7 includes the results of the model with time varying natural interest rate. In section 4.8 we have discussed the impact of time varying natural interest rate on estimated inflation target. Section 4.9 contains the comparison of estimated inflation target with both the approaches and discussion. Section4.10 explains empirical results of the Estimation of implicit inflation target at different stages of business cycle

4.2 Stationarity Test

Stationarity properties of all the data series are tested at first step by using Augmented Dickey fuller test and estimated test statistics and p-values are reported in Table.1. The first two columns of Table 1 contains ADF test statistics of all the variables at level and at first difference and last two columns report the p values at both level and at first difference of all the variables.

Table.1: Stationarity Test

Variables	ADF Test – Statistics		P values	
	Level	First difference	Level	First difference
INF	-4.0730	-8.8764	0.0014	0.0000
RATE	-1.8434	-10.6227	0.3581	0.0000
RGDP	2.4867	-3.7276	1.0000	0.004

Table.1: table shows the results of Augmented Dickey-Fuller test. ADF test statistics and P-values are reported at level and at first difference. P values are MacKinnon (1996) one sided.

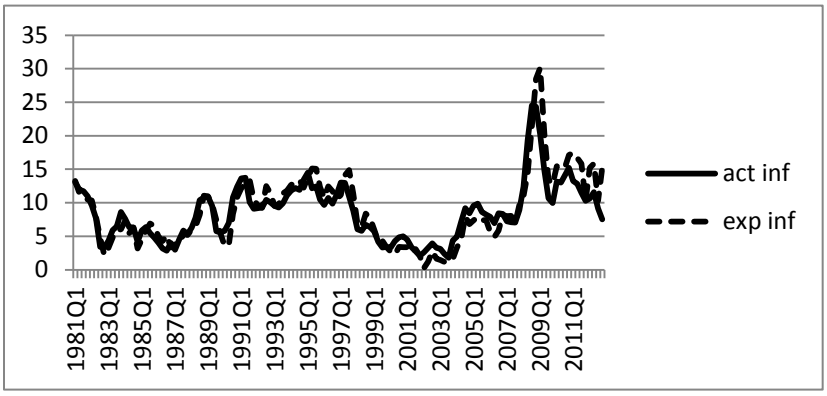
The result shows that the series of call money rate (RATE) and real gross domestic product (RGDP) are non-stationary at level but stationary at first difference; both the series are integrated of order one i.e. I (1). The null hypothesis of having a unit root is accepted for both the series at level and rejected at first difference. On the other hand the series of inflation rate is stationary at level i.e. I (0); integrated of order zero.

4.3 Expected Inflation

In literature inflation is also used as an alternative of inflation expectation but the main advantage of inflation expectation is a forward looking element which is also injected in the estimations. Data of expected inflation is generated following the study of Laubach and William (2003), in which forecasts are based on an univariate AR (4) by a 40 quarter rolling regression window. Like the variable (p_{t+4} /p_{t-1}) is estimated by using (p_t/ p_{t-1}-1), (p_{t-1}/ p_{t-2}-1) and (p_{t-2}/ p_{t-3}-1). Where p_t is the price level in quarter t.

In figure 1 we have compared the data series of actual inflation and estimated expected inflation, the trends of the series are identical and a sharp spike has been observed between 2009 and 2010 because of upsurge in global commodity prices particularly related to energy and food sectors, and increase in international oil prices which was about 70 percent y-o-y (Pakistan Economic Survey, 2009-2010). This persisted increase has put an upward pressure on local prices. Both actual and forecasted inflation are high during stated period but expected inflation is higher than actual inflation which means this sharp increase in prices was anticipated.

Figure.1.Actual Inflation and Expected Inflation Rate

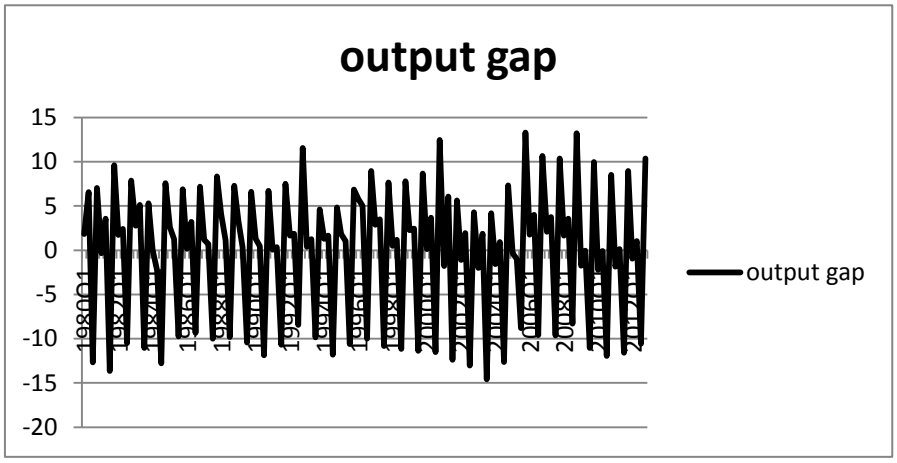


4.4 Output Gap

As stated earlier that the output gap is measure of the difference between potential (natural) and actual output of the economy Output gap is another unobserved variable, which is measured by using HP filter from observable data in this study. The estimated series of output is expressed in figure .2.

The estimated output gap values reflect that it fluctuated between 13.3 percent (2005Q4) and -14.6 percent (2003Q3). The positive values of output gap show high growth period (boom) i.e. 2005Q4 while negative values of output gap show low growth periods (recession) i.e. 2003Q3.

Figure .2: Estimated Outputs Gap



4.5 Results of the Model with constant natural interest rate.

After confirming the stationarity of all the data series, we have estimated the model with the assumption of constant natural interest but we have relaxed the supposition of constant inflation target for the period of analysis. In this section we have assumed that natural rate of interest is constant over time at 1.28 percent while estimating the specification in eq. (6). Here the constant natural rate is the average of real natural rate during the sample period.

While estimating Taylor rule, it should put emphasis on the two important conditions to achieve macroeconomic stability. β is the coefficient of inflation deviation (the difference between expected inflation and inflation target) and its value should be greater than one as claimed by Taylor to achieve inflation stabilization. Less than one

value of β means interest rate cut as a result of upsurge in inflation which will increase the spending, aggregate demand and end result would be an unstable solution (inflation will further increase). So according to the results of the model under study, the estimated value of β is positive but not greater than one (0.36) which is not consistent with the Taylor rule principles and it shows that SBP (SBP) has not been following the Taylor rule. Malik and Ahmed (2010) also found similar results.

The coefficient of the output gap is γ; it should be positive to attain output stabilization according to Taylor rule. According to the results of this model, the estimated value of γ is also positive and different from zero (0.19) suggesting that Pakistan has been following the output stabilization objective. In other words SBP increased interest rate or contracted money whenever our economy accelerated or when the value of output gap was positive (output above the potential level); these results are consistent with the theory and comparable with the findings of (Tahir, 2013) for quarterly data (1971:Q1–2011:Q4).

The coefficient of lagged interest rate is denoted by δ; the estimated value of δ is 0.64 which indicates high degree of interest rate inertia in the underlying results. The estimated degree of interest rate inertia is highly significant and indicates that there are not various variations in interest rate and predominantly interest rate depends on its own lagged values. (Clarida et al., 1998), (Woodford, 1999), (Leigh, 2007) and (Klein, 2012) have reported similar results.

Table.2 Estimated Response Function with Constant Natural Interest Rate

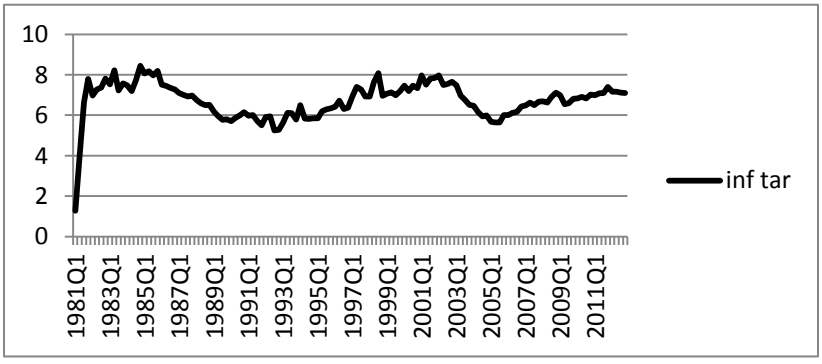
Parameters	Coefficients	P – values
δ	0.64(0.0690)	0.0000
γ	0.19(0.0818)	0.0215
β	0.36(0.0805)	0.0000
Var(ε_t)	2.725(0.320)	0.0000
Var(v_t)	0.068	-------
λ	0.025	-------

Notes: the parameters β, γ, δ and var (ε_t) are estimated with maximum likelihood and p-values are consistent with the null hypothesis, λ = 0. The estimates of standard errors are in parenthesis.

In this model the estimated value of λ (signal to noise ratio) is 0.025 i.e λ = $\sigma_v^2 / \sigma_\varepsilon^2$

which is a precise value according to empirical literature (Leigh, 2007). He has stated that the value of signal to noise ratio span from 0.03 to 0.38 with 90 percent confidence interval and with 95 percent confidence interval it ranges from 0.02 to 0.50.

Figure.3 the Estimated Implicit Inflation Target



Estimation results indicate that there are substantial variations in implicit inflation target for the sample period under concern in Pakistan (Figure 3) and its average value is approximately 6.79 percent. We can observe the variation in inflation target in figure 2 as we have relaxed the assumption of constant inflation target. In the next first sub section Wald coefficient test is employed to check whether the estimated inflation target is constant or not which would display the precision of our supposition and in second sub section we have used Wald coefficient test to check whether the estimated inflation target follows random walk or it is a stationary process.

4.5.1 Wald Coefficient Test

We have applied Wald coefficient test to check that inflation target is constant or not, so we set the null hypothesis; inflation target is constant (H_o: var (v_t) = 0). The results of Wald coefficient test reject the null hypothesis with 99 percent confidence interval, so results fulfilled our assumption.

Test statistics	value	df	Probability
Chi square	72.48114	1	0.0000

4.5.2 Random walk or Stationary Process?

In the estimation of implicit inflation target we have assumed that inflation target is a random walk process. At the moment we can relax this assumption by adding a coefficient φ.

$$\pi_t^* = \varphi\pi_{t-1}^* + v_t \quad (15)$$

Now we have substituted eq. (15) into eq. (8) and re estimate this equation for two purposes,

(i) To check whether inflation target is a stationary process or it follows random walk and

(ii) To assess whether these changes will affect the path of inflation target.

We have used Wald coefficient test to check that the coefficient of π_{t-1}^* is equal to one or not. Wald test cannot reject the null hypothesis that φ is equal to one, so results confirm that inflation target follows random walk.

Test statistics	value	df	Probability
Chi square	0.216260	1	0.6419

The values of estimated parameters are not altered considerably and the path of implicit inflation target is also very comparable.

Table 3 Estimated Response Function with Relaxed Assumption of Random Walk.

Parameters	Baseline $\pi_t^* = \pi_{t-1}^* + v_t$		Alternative $\pi_t^* = \varphi\pi_{t-1}^* + v_t$	
	coefficients	p-value	coefficients	p-value
δ	0.636(0.0690)	0.0000	0.638(0.0737)	0.0000
γ	0.188(0.0818)	0.0215	0.189(0.0848)	0.0258
β	0.355(0.0805)	0.0000	0.362(0.0818)	0.0000
Var(ε_t)	2.725(0.3201)	0.0000	2.748(0.03245)	0.0000
Var(v_t)	0.068	-------	0.0687	-------
λ	0.025	-------	0.025	-------
φ	------	------	0.998(0.0022)	-------

Notes: the parameters β, γ, δ and var (ε_t) are estimated with maximum likelihood and p-values consistent with the null hypothesis, λ = 0. The estimates of standard errors are in parenthesis.

We can conclude the same results as we have mentioned earlier with a model that inflation target follows random walk. The estimates of all the parameters β, γ, δ, var (ε_t) are very similar that indicates the same interpretation as we have stated earlier. P – Values and standard errors with both the models are very comparable and estimates of signal to noise ratio (λ) are also very appropriate in both the models. Determined value of the coefficient of lagged inflation target (π_{t-1}^*) is 0.998 which is approximately one which shows that the assumption about inflation target is appropriately used.

4.6 Robustness Analysis; Alternative values for λ

This section describes the results for different values of signal to noise ratio parameter. The baseline value of λ is 0.025 and we have assumed two different values for signal to noise ratio parameter to evaluate how this change affects the path of implicit inflation target. The high value of λ indicates the rapid change in implicit inflation target during the sample period and low value of λ implies slow change. We have assumed λ is equal to 0.2 as high value of λ and 0.0125 as low value of λ and their results are reported in table 3.

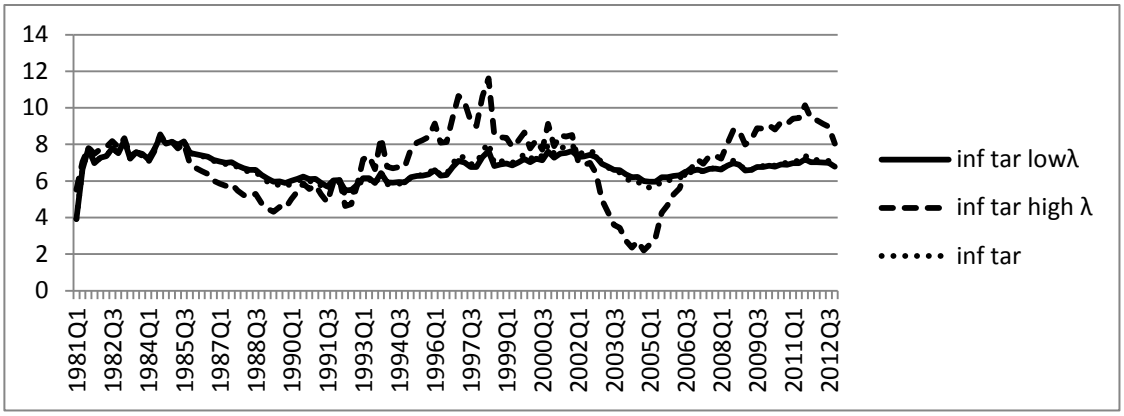
Table.4 The Estimated Response function under Alternative Values of λ

Parameters	Baseline (λ=1/40)		(λ=1/80)		(λ=1/5)	
	coefficients	p -values	coefficients	p- values	coefficients	p – values
δ	0.637(0.07)	0.0000	0.638(0.06)	0.0000	0.454(0.12)	0.001
γ	0.188(0.08)	0.0215	0.189(0.08)	0.0189	0.115(0.05)	0.036
β	0.355(0.08)	0.0000	0.357(0.07)	0.0000	0.195(0.09)	0.029
Var(ε_t)	2.725(0.32)	0.0000	2.735(0.32)	0.0000	2.382(0.30)	0.000
Var(v_t)	0.068	-------	0.034	-------	0.476	--------
β/γ	0.1888	-------	0.1889	-------	1.695	--------

Notes: the parameters β, γ, δ and var (ε_t) are estimated with maximum likelihood and p-values consistent with the null hypothesis, λ = 0. The estimates of standard errors are in parenthesis.

Table 4 describes that the estimated value of the parameters of Taylor rule in case of low λ are almost similar with the baseline estimations and the interpretation of the results will be similar as stated earlier. The estimates of second case is slightly different (high λ) and the estimation results show that the value of coefficient δ of lagged interest rate is less as compared to other alternative value as the value of δ is 0.45; which shows low interest rate smoothing means CB is not consistent and there can be various variations in interest rate. Mainly interest rate does not depend on its own lagged values. The coefficient of inflation stabilization is β and this low value of β (0.195) is not consistent with the Taylor rule principles and it shows that SBP (SBP) has not been following the Taylor rule.

Figure 4 The Estimated Implicit Inflation Target with Different signal-to-noise Ratios



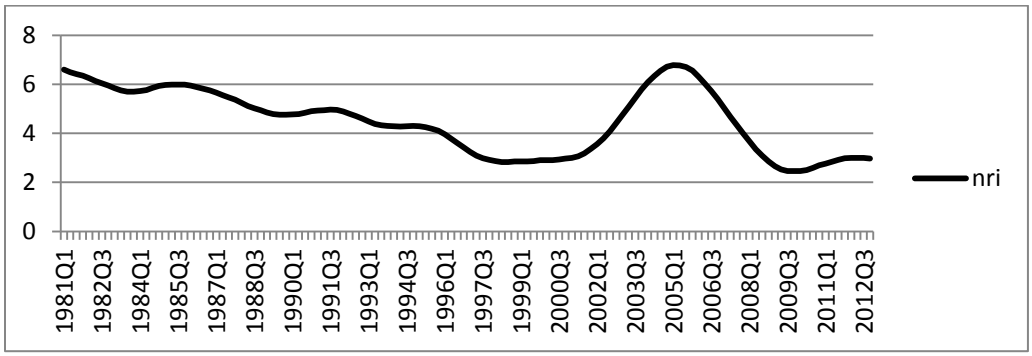
The estimated values of implicit inflation target with different signal-to-noise ratios reveal that the change affects the path of estimated implicit inflation target in a non-linear manner. The results display that high value of signal-to-noise ratio (λ) creates rapid

changes in implicit inflation target during the sample period. In the beginning of the sample period estimated inflation target with high λ has the trend as baseline and estimated inflation target with low λ. The baseline and estimated target with low λ have smooth trend throughout the sample period but great variability is seen in inflation target with high λ. Inflation target reached at its peak almost 12 percent in 1998Q2 under high value of signal-to-noise ratio. After this it starts declining and reached at 2 percent in 2004Q2. Overall the average of estimated inflation target with low λ is 5.4 percent which is significantly low as compared to the average value of inflation target with high λ (6.8 percent).

4.7 Time Varying Natural Interest Rate

In the earlier section we have estimated the response function by taking the assumption of constant natural interest rate but according to economic theory, this assumption is excessively restrictive and natural rate of interest vary with the changes in output's growth rate (Laubach and William, 2001). We have estimated the values for time varying natural rate of interest following the methodology of Laubach and William (2003).

Figure.5 Time Varying Natural Rate of Interest

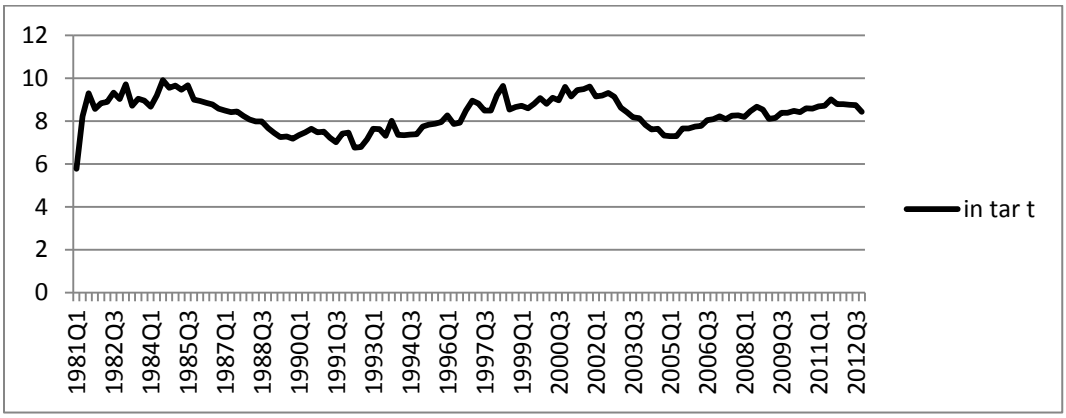


The estimated value of r^*implies that it has two peak values, one at the beginning 6.5 percent (1981Q1) of the sample period under study and second peak is 6.8 percent (2005Q1). It reached its minimum 2.4 percent in 2009's. The average value is 4.8 percent during the sample period.

4.8 Impact of time varying natural interest rate on inflation target

Now we will examine the impact of time varying natural interest rate on implicit inflation target.so we have used the value of time varying natural interest rate in the earlier model to estimate implicit inflation target. Figure 6 shows the path of implicit inflation target with time variant natural interest rate.

Figure.6. Estimated Response Function with Time Varying Natural Interest Rate



The figure shows that the path of implicit inflation target shifts slightly upward but the trend is almost similar; maximum and minimum values of inflation target have increased but the trend of increase and decrease is almost similar.

The values of all the parameters i.e. β, γ, δ and var (ϵ_t) are significantly different from zero and almost comparable with the earlier model as shown in table 5. So the interpretation of all the values of the parameter is similar as we mentioned earlier.

Table.5. Estimated Response Function with Time Varying Natural Rate of Interest

Parameters	Baseline r = 1.28 percent		Time Varying r^n	
	coefficient	p – values	coefficient	p – values
δ	0.637(0.069)	0.0000	0.635(0.068)	0.0000
γ	0.188(0.082)	0.0215	0.189(0.081)	0.0196
β	0.355(0.081)	0.0000	0.355(0.079)	0.0000
Var(ϵ_t)	2.725(0.320)	0.0000	0.2720(0.319)	0.0000
Var(v_t)	0.068	-------	0.068	--------

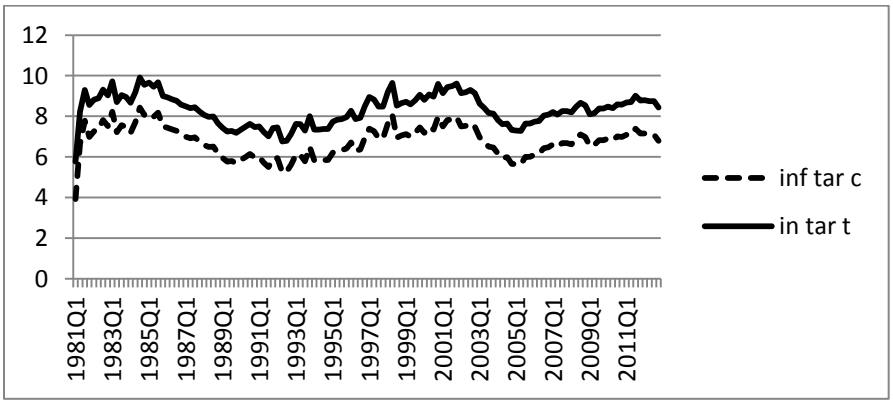
β/γ	0.1888	-------	0.1878	--------

Notes: the parameters β, γ, δ and var (ε_t) are estimated with maximum likelihood and p-values consistent with the null hypothesis, λ = 0. The estimates of standard errors are in parenthesis.

Under both the specifications the value of β/γ is almost same which shows that inflation stabilization and output stabilization have the same importance in both the specifications.

If we compare the path of implicit inflation target estimated from both the models then we can conclude that including the time varying natural interest rate in the model the trend is the same but it shifts the path of inflation target upward as shown in figure 7.

Figure.7. Estimated Implicit Inflation Target under both approaches.

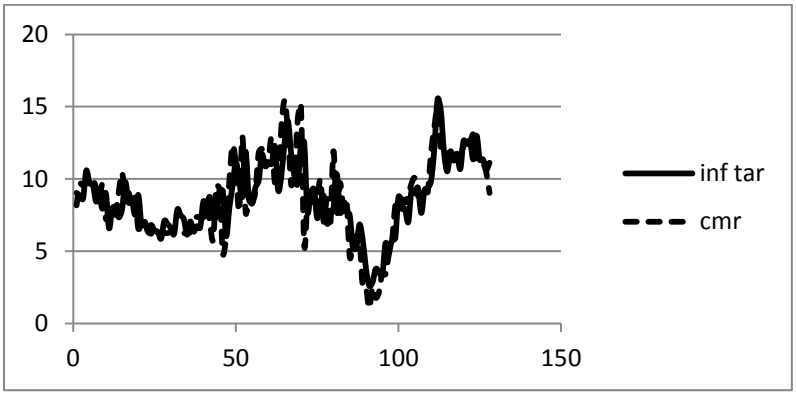


4.9 Discussion

We found implicit inflation target which is around 6 to 8 percent but unless we have optimal inflation rate for Pakistan economy, it is difficult to evaluate the desirability of this targeted inflation rate. To check the reliability of the estimated inflation target, inflation target is compared with interest rate in the figure (8). The comparison shows that SBP has indeed targeted the same rate as estimated by the model since the policy

instrument is set in line with this rate. Looking at the path of interest rate, it is consistent with the estimated implicit inflation target providing support for our results.

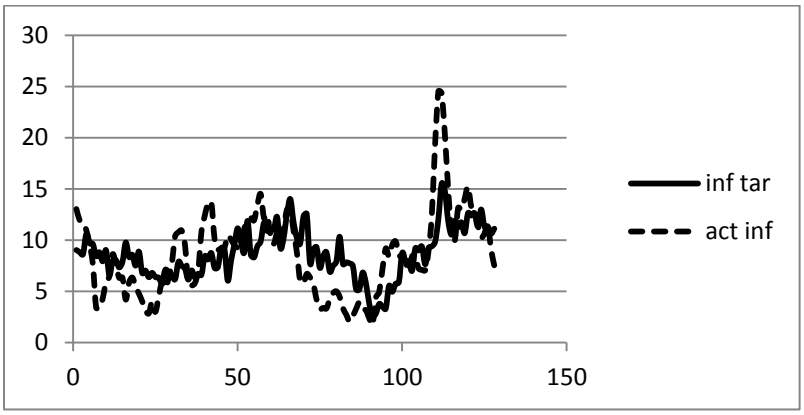
Figure 8 The Relationship Between Estimated Inflation Target and Interest Rate.



In Pakistan growth and inflation targets are set by the government and SBP sets the monetary instrument to achieve that target. Since SBP does not announce its inflation target explicitly but it may have some target in view while setting the interest rate for the economy, this implicit inflation target is consistent with the target. In the figure, the plotted values indicate that estimated inflation target and interest rate indeed are consistent.

Now in order to evaluate that how far this implicit target has been achieved in the past, the target and actual rate of inflation are compared in figure (9). This shows how far policy makers have been successful in achieving the implicit target rate of inflation and the figure shows that for most of the times in the history, the two figures diverged. Thus target inflation rate could not be realized for most of the periods and actual inflation behavior has not been consistent with expectations and target of the policy makers.

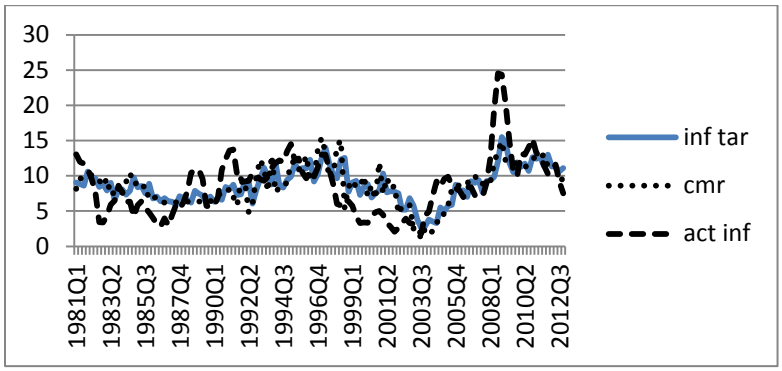
Figure 9. The Estimated Inflation Target and Actual Inflation



Monetary policy has not been effective in pursuing its inflation target and in recent decade, actual inflation is above the target rate and SBP is somehow unsuccessful in containing the inflation in the economy. One point of sharp distinction is 2008-09 where actual inflation jumped while there is no such movement in the target inflation for this period. Thus economy behaves in the way as making the monetary policy less effective for inflation rate in this period particularly.

To get further insight into the relationship of actual and targeted inflation, interest rate is plotted with these two series in the figure to get a complete picture of the intention of SBP regarding the inflation rate in the economy.

Figure.9. The Relationship between interest rate, actual inflation and estimated Inflation target



The comparison supports the above analysis since the jump in actual inflation is not consistent with both inflation target and interest rate. This provides support to the fact that SBP has set the policy instrument in line with inflation target and thus actual inflation in this period may have been caused by phenomenon other than monetary policy since policy maker did not intend or target this sharp rise of prices.

4.10 Empirical results of the Estimation of implicit inflation target at different stages of business cycle

In this section we have discussed the results of the estimation of implicit inflation target at different stages of business cycle in case of Pakistan using the estimation procedure explained in last chapter. We want to check "Is inflation target stays different in recessionary and expansionary phase of the economy in case of Pakistan?" We have re-estimated the model (eq.8) of implicit inflation target with constant natural interest rate for both the periods exclusively taking the values of all the variables in boom or recession

in consonance with the positive or negative values of output gap otherwise equal to zero. The estimated value of implicit inflation target is about 21.85 percent in low growth period or recession and about 5.25 percent in period of high growth or boom. The estimation results show that high (low) inflation rate has been observed during the period of low (high) economic growth or in recessionary (expansionary) phase in the case of Pakistan for the sample period under analysis. The estimation results are consistent with the findings of empirical literature in the case of Pakistan.

The evidence related to growth history of Pakistan reveals that high inflation is adverse to economic growth. Low inflation periods correspond to high growth spell and high periods of inflation are associated with the phases of low growth or in recession [(Khan and Schimmelpfennig, 2006) and (Afzal et al. (2013)].

Chapter 5

Conclusion

During the last three decades Central banks of many countries have announced "price stability" as their primary responsibility owing to variety of reasons. High and variable inflation has always negative effects. Many industrial economies adopted Inflation Targeting to control increasing inflation in 1990's. So Monetary Policy was successful in controlling inflation, even the non-IT has some implicit inflation target while conducting Monetary Policy. Pakistan is a non-IT country; Pakistan does not explicitly announce inflation target but SBP's unobserved implicit inflation target exists. Amazingly, research on this topic has not been given much attention. This study has estimated implicit inflation target for Pakistan in state space approach by relaxing the assumption of constant inflation target.

We have considered both the specifications, constant natural rate of interest and time varying natural interest rate. Using Quarterly data from 1981Q1 to 2012Q4, the study used Kalman Filter and time varying parameter model.

While estimating implicit inflation target with constant natural rate (average of real rate 1.28 percent during the sample period) we can conclude that SBP has not been following the Taylor rule. The estimated value of implicit target is around 6 to 7 percent with constant natural rate. The estimated implicit inflation target shows significant time variation over the sample period. Estimation results imply that estimated inflation target and interest rate move together and when we include time varying natural interest rate in

the model the trend is the same but it shifts the path of inflation target upward. The estimated value of implicit target is around 8 to 9 percent with time varying natural rate.

This study has also used Wald coefficient test to check that inflation target is constant or not and it can be concluded that inflation target is time variant. We also have tested whether inflation target is a stationary process or it follows random walk by using Wald coefficient test and evaluate whether these changes will affect the path of inflation target. So we have found that inflation target follows random walk in case of Pakistan and the values of estimated parameters are not changed much.

To check the reliability of the estimated inflation target, inflation target is compared with interest rate. Since SBP does not announce its inflation target explicitly but it may have some target in view while setting the interest rate for the economy, this implicit inflation target is consistent with the interest rate. Monetary policy has not been effective in pursuing its inflation target and in recent decade, actual inflation is above the target rate and SBP is somehow unsuccessful in containing the inflation in the economy. One sharp spike has been observed during 2008-09 where actual inflation jumped while there is no such movement in the target inflation for this period. Thus economy behaves in the way as making the monetary policy less effective for inflation rate in this period particularly.

This study has also estimated implicit inflation target for the periods of high growth (boom) and similarly for the low growth periods (recessionary phase). The estimation results are coinciding with the findings of empirical literature in case of Pakistan. Low inflation periods are corresponding to high growth spell and high periods of inflation are associated with the phases of low growth or in recession. In light of estimation results we

can conclude that high and persistent inflation is adverse for financial development and economic growth; so primary objective of SBP should be price stability. Pakistan should set a suitable inflation target and make appropriate policies to retain inflation rate nearest to its target. Price stability will be the appropriate policy role to achieve sustained economic growth and trade-off between growth and inflation does not exist in short run rather it be existent in medium to long run.

Future research on this topic can be interesting with research questions like: Is time varying inflation target better than a constant inflation target? The performance of inflation targeting and non-targeting countries can also be compared.

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