Response of Monetary Policy to Big and Small Shocks of Inflation and Output

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15/ MPhil- ECO/ PIDE/ 2014

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ISLAMABAD.

2016

Pakistan Institute of Development Economics

CERTIFICATE

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ACKNOWLEDGMENT

All praise for the Almighty who has always helped me throughout my life and blessed me with the best.

I would like to express my sincere gratitude to my supervisor Dr. Wasim Shahid Malik for the continuous support of my MPhil study and related research, for his patience, motivation, and immense knowledge. His teachings really broadened my concepts of Macroeconomics and boosted my interest in Monetary Economics. It has been a privilege to know him since he first taught me in my Bachelors. Moreover, I am also thankful to Dr. Ahsan Satti for his help in earlier draft and valuable comments in the internal review of thesis. His teachings of Econometrics helped me in doing thesis research.

I am really thankful to my colleague Massam Javed for assisting me throughout my research. His valuable input is highly weighted. It was a wonderful journey at PIDE and I learned a lot here. Having the company of my close friends during thesis facilitated me to enjoy a friendly environment. Especially, I am thankful to Syed Hamza Ali, Muhammad Ali, Rao Bilal and Tayyab Ayaz for their support and encouragement. I always enjoy spending time with them. I am also grateful to my class fellow Romina Maryum and my senior Muhsin Ali for helping me in compiling the final thesis.

My parents and siblings have been exceptionally generous and always supported me throughout my life.

On a lighter note, one must possess high level of patience and a good walking habit if he wants to do research with Dr. Wasim Shahid.

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LIST OF ACRONYMS

Acronym	Description
GDP	Gross Domestic Product
GNP	Gross National Product
VAR	Vector Autoregressive
SBP	State Bank of Pakistan
CPI	Consumer Price Index
PTA	Policy Target Agreement
FED	Federal Reserve System
FOMC	Federal Open Market Committee
OPEC	Organization of Petroleum Exporting Countries
MCI	Monetary Condition Index
SLR	Statutory Liquidity Ratio
OMO	Open Market Operation
RR	Required Reserves
OLS	Ordinary Least Square
GMM	Generalized Method of Moment
IFS	International Financial Statistics
NAIRU	Non-Acceleration Rate of Unemployment
D-W	Durbin Watson
T-bill	Treasury Bill

ABSTRACT

The core objective of policy makers is to stabilize vital macroeconomic variables and promote economic growth. The business cycle fluctuations require optimal response of monetary authorities. Distortions in inflation and output negatively affect the economy. Our main objective of the study is to estimate the response of State Bank of Pakistan to big and small shocks of inflation and output. Higher levels of inflation could be responded offensively by general public whereas distortions in output may directly affect the employment level in the economy. Moreover we also estimated the optimal response of State Bank of Pakistan to inflationary and output shocks. We used Ordinary Least Square (OLS) technique to estimate the monetary policy response using quarterly data over the period 1990 Q1 to 2015 Q3. The results indicate that SBP responds more aggressively to small shocks of inflation because past studies indicate that SBP finds it more convenient to change policy instrument by small margin. The response coefficient of output gap confirms the significance of real stabilization motive of SBP. SBP also make gradual changes in interest rate to stabilize the financial markets. Estimation of optimal monetary policy indicates that SBP should put more weight on stabilizing the small shocks of inflation and output.

Chapter 1

INTRODUCTION

Monetary authority's prime objective is to stabilize inflation and minimize the output distortions. The inflation rate persisting in the economy is largely driven by the existence of output gap which is the difference between economy's actual and potential production level. When there is positive output gap, means actual level is above potential level. This case general price level lifts upwards because economy is facing higher levels of aggregate demand.

The advancement of monetary analysis in the past decades has intensified the debate regarding the role of money and monetary policy. An important issue is the identification of target variable. Real GDP and output gap serve as the measure of economic activity. Sims (1980) practiced VAR model to elucidate the effect of monetary policy on macroeconomic variables. Similarly McCullum (1983), Bernanke and Blinder (1992) opted for interest rate as main policy tool.

There has been a great resurgence of interest in the matter of how to conduct the monetary policy. The framework of policy making is broadly characterized as rules or discretion. The rules are defined as frameworks in which the policy response must follow a pre-specified course. This course could be activist or non-activist. The non-activist course calls policy makers to apply same settings in all sort of circumstances. Contrary to this, the activist course directs policy makers to respond to different scenarios in a different, pre-specified ways. On the other hand, discretionary framework allows the policy makers to apply the best policy response according to the given circumstances. The conduct of monetary policy has remained the greatest concern for the monetary policy makers since Simons (1936).

The discretionary policy was termed as time-inconsistent by Kydland and Prescott (1977) as the decisions of individuals are not only based on past and present information but they also incorporate rational future expectations. So what the authorities say today, they can deviate from it tomorrow. Such policies can make general public satisfied in short run but its opportunity cost is very high as it produces long run consequences.

Even though the most of the economists put more weightage to rules rather than discretion, to find a simple, robust, and efficient rule remains a challenge for the policy makers. In case of developing countries like Pakistan, a simple rule may perform well as compared to a complex one due to weak institutions. Taylor rule and McCallum rule are the two basic examples. So it is clear that rules produce time-consistent outcomes because they make monetary authorities pronouncements credible.

Either rule being followed or discretion, economies sometimes have to cope with undesirable circumstances. There may be uninvited fluctuations in key macroeconomic variables termed as shocks. Broadly, we can identify shocks in to ways- small and big. Small shocks represent minor deviations of a macroeconomic variable from its trend trajectory path, having a transient impact on the system. On the other hand, big shocks will change the trajectory of system for long time.

It is important to identify the actual and optimal response of monetary authorities against such shocks in case of Pakistan. The core targets of SBP include formulation and conduct of monetary policy that is consistent with government's target of growth and inflation. In addition to price and output stability, the targets also include the soundness of financial system and exchange rate management. The past experience indicates that there had been a lot of inflationary variations and output fluctuations. The main components of inflationary processes were 1970's oil shock and 1990's monetary expansion. These shocks have ranged inflation in Pakistan from 3-27 percent. On average, it's estimated to be 8.8 percent with 5.3 percent of standard deviation. Moreover, real output growth varied between 8.7 percent in 1980 and -0.1 percent in 1997. Studies have shown that macro management of Pakistan's economy does not appear to ensure the consistency of the interventions. So, there is a dire need to check if the monetary policy has remained optimal in the presence of output shocks. We will check how rule based policy reacts when inflation and output disturbances are incorporated.

Our main concerns of this study revolve around how SBP responds to the inflation and output shocks. We have divided these shocks as small and big. As SBP is the core institution of monetary sector, its actions are very crucial under certain circumstances. Price volatility creates uncertainty in the financial market and inclines central bank to react. The degree of this impulsiveness drives the central bank to react accordingly. If the inflationary shock is small, then the general public may not react and markets remain at equilibrium. This shock under tolerance level drives SBP to remain neutral. If the inflation takes a big jump then there could be a colossal response from public as it could cause massive depreciation of currency, reduction in real wage and uncertainty in the market. Moreover, uncertainty about future rates would drive firms away from investing in long-term projects. Now SBP has to react accordingly to compensate the inflationary effects by increasing the policy rates. The conventional Taylor rule proposed that if inflation goes up by 1%, then target interest rate goes up by 1.5%. But the heaps of pressure from government politicians, industry, media and academia influence the independent behavior of SBP. On the other hand, if the SBP decides to cut its policy rate because inflation has come down (but is likely to rise once again), the critics could view it as SBP succumbing to governmental pressure and comprising its autonomy. As one of the primary objectives of SBP is to keep unemployment at natural rate, negative output shocks might disturb the employment balance requiring the reaction of central bank to curb these market distortions.

1.1 Motivation

The response of State Bank of Pakistan to such shocks is very influential and critical. Small deviations of inflation and output might be tolerated but the big shocks need the proper treatment. The backward looking modified Taylor rule will tell us what has been the response of SBP to small and big shocks of inflation and output. We hardly find any such study in case of Pakistan, so we target to check the response of SBP under various economic circumstances.

1.2 Objective

- Our main objective is to estimate the response of monetary authorities of Pakistan in case of small and big deviations of Inflation and output from their trend.
- Does SBP differentiates the small and big shocks of inflation and output? What is the optimal response of SBP to these shocks?

Remainder of the study proceeds as follows. Chapter 2 discuss literature review. Chapter 3 is about the monetary policy of Pakistan. Chapter 4 relates to methodology of the study. The estimation results are explained in chapter 5. Moreover the last chapter 6 provides the conclusion of the study.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

The main objective of policy makers is to design best response policies to current economic conditions. The effectiveness of monetary policy to drag the vital macroeconomic variables of the economy to positive direction was initially described by Friedman and Schwartz (1963). Monetary policy's central target is to stabilize prices as distortions in price level dampens economic activity. Moreover, inflationary atmosphere reduces the investments and causes financial system instability. There is always an opportunity cost of the course of action taken by authorities. If they misinterpret the economic conditions then their policies might result into further stagnation. Another prime objective of monetary authorities is the output stabilization. The policy makers have to play very wise because when they try to stabilize output, inflation suffers and vice versa for alternative. So, it is basically the art of balancing between various policy goals. In reality, price and output doesn't remain on a constant growth path. There occurs minor and major deviations in these variables due to which monetary reaction changes. The literature provides us with various monetary responses.

The economic history is full of various debates about which monetary policy proves to be feasible and optimal and what course of action should be opted. Taylor (2015) described that forward guidance should be part of monetary policy for future, only if it is consistence with rule based strategy of the central bank. The earlier findings regarding the monetary economics include Wicksell (1907), Fisher (1920; 1926) and Simon (1936). Friedman

(1968) described that monetary authorities should guide it by magnitudes that it can control and it should avoid sharp swings in the policy. Because sharp swings could move monetary authorities in wrong direction. He described monetary authorities to opt constant money growth. Furthermore, Friedman and Schwartz (1968) concluded that monetary authorities should manage the money supply at a persistent growth rate. Opposing to Friedman and Schwartz stance, Tobin (1970) described the reverse causation between money and output. He defended his theory by elaborating that output cause's money. Similarly, King and Plosser (1984) resulted to the fact that money doesn't result into output growth rate. It is the commercial banks reacting to the output variabilities. Friedman and Meiselman (1963) found a significant relationship between money supply and nominal income while examining the effect of monetary and fiscal policy on nominal income. Coleman (1996) concluded the fact that money is reasonably correlated with output lags.

With the passage of time, different schools of thoughts strike the conventional behaviour of economics. The introduction of the time-inconsistency problem (Kydland and Prescott 1977; Barro and Gordon 1983), theories of rational expectations (Muth 1961; Lucas 1972) and the inability to forecast the effects of change in economic policy entirely based on historical data; described as Lucas critique (1976) revolutionized the approach towards monetary policy making. Before the arrival of millennium, there was a great deal of advancement of literature on monetary policy rules not only in developed countries but also in developing countries. Mostly the literature was based on Taylor rule (1993; 1999a) and McCullum rule (1988) at that time. Taylor rule is concerned with how central bank could maintain low and stable level of inflation and maintains the output under tolerance level by avoiding large distortions. The instrument used is the short term interest rate against the deviations of inflation and output from their potential level. On the other hand, McCullum rule is a money base nominal GDP targeting rule. It is also an adaptive policy formula but with a different policy instrument. Meltzer (1987), Gordon (1985), Hall and Mankiw (1994), and Feldstein and Stock (1994) recommended a nominal GDP targeting rule for monetary policy. But the question under consideration is that what policy methodology the policy makers can use to regulate the vital macro variables of the economy. And in the presence of an undesirable external shock, what is the best policy response. Monetary policy makers have different approaches to cope with different scenarios.

2.2 Long Run and Short Run Effects of Monetary Policy

It is the general consensus of all schools of thought of macroeconomics that money is neutral in the long run. Monetary policy will not cause a permanent change in the macroeconomic variables. Monetary economists agree on the fact that government injections of money into the macro economy have no long run consequences (Lucas, 1995). The background behind this is linked to element that changes in the monetary level results into the changes in nominal variables, ultimately leaving the essential macroeconomic variables unaffected e.g. real wages, real output, real interest rate, real consumption expenditure because the power influencing the nominal and real variables is different. As the decision making of both individuals and policy makers depends on the real variables of the economy, the effect of changes in monetary injection in the long run is described as neutral. Expansionary monetary policy can help economy to get out of recession and return to its long run trend projection but it cannot ensure high growth rate forever. The classical hypothesis describes that permanent change in inflation rate has no long run effect on unemployment which is described by long run vertical Phillips curve. Similarly according to

Fischer relation, permanent change in inflation rate has no long run effect on interest rate. The concept of super money neutrality describes that the effect of changes in monetary growth rate is zero and only inflation occurred. Friedman and Schwartz (1982) described neutrality in long run correlation between money and prices. McCandless and Weber (1995) found the correlation of one between money growth and inflation covering 110 countries. There have been many studies attempted to oppose the long run neutrality of money. Fischer and Seater (1993) found proof against long run neutrality of money in case of United States. Boschen and Otrok (1994) concluded that such results were only due to the inclusion of great depression years in the sample. King and Watson (1997) could result into little evidence opposed to the money neutrality searching various identification schemes. Haug and Lucas (1997) were unable to reject the concept of long run neutrality of money in case of Canadian data. The concept of long run money neutrality couldn't be much opposed by the researchers and policy makers. King and Watson (1997) used 40 years of quarterly data in order to investigate the long run neutrality concept. Their study resulted into conclusion that opposed the rejection of long run money neutrality and suggested steeper long run Phillips curve. Stefan Collignon (2007) concluded that the robustness of long run neutrality of money requires the stationary of interest rate. This could be the case over very long time spans. Abrams and Settle (2005) resulted to the fact that inclusion of credit channel into standard neoclassical open economy model offers variety of angles of study regarding the money neutrality. They concluded that when money supply shocks are originated with money multiplier then standard money neutrality thesis is rejected.

The first proposition of IS-LM model was done by Hicks (1937) prior to which the original introduction was composed in the book of Keynes (1936)[1]. Various economists modified and developed the ISLM framework, distinguished of them include Hansen (1949, 1951, 1953). Moreover, Mundell (1960, 1963) and Fleming (1962) modified the ISLM model to cope with the open economy. Initially the ISLM model was used to deal short run analysis. Today, Dornbusch and Fischer (1978) IS-LM model is considered as core of macroeconomics. Keynes described that money is neutral even in short run under liquidity trap. Philips (1958) found the negative relation between inflation rate and rate of unemployment- termed as Philips curve. Additional to that, Tobin (1965) evaluated the long run effects of monetary policy and found that increase in money supply results in higher level of inflation. The Keynesian consider that money is neutral in long run that it affects only nominal variables but real variables remain unchanged.

The era of 1960s laid the foundation of monetarists of which the major contribution was by Milton Friedman who presented the quantity theory of money- opposing the Keynesian school of thought. Friedman (1968) concluded that the monetary policy shock was major factor of nominal GDP. He concluded that the demand for money depends on permanent income and it is insensitive to interest rate- opposing the Keynesian stance. Friedman (1968) modified the ISLM framework and opted for constant money growth approach. Monetarists agree to the short run effects of monetary policy but disagree to the long run effectiveness.

New classical school of thought also supported that the money is neutral in long run. Lucas (1972) proposed that the unanticipated change in the money supply would have implications

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[1] Keynes, J. M. (1936). The general theory of interest, employment and money. *Macmillan Cambridge University Press.*

on the real economic activity. Barro (1977, 1978) supported Lucas stance concluding that relationship between money and prices is stable.

The real business cycle (RBC) theory developed in 1980's postulates that only factor boosting the economy is the technological shocks, there is no room for monetary and fiscal policy. In context to real business cycle theory, output always remain at its natural rate and only factors to which economy responds is the technological modernizations.

2.3 Response of Monetary Policy to Shocks

When the economy is hit by inflationary shock, should the monetary policy turn extinguishing, that is decrease the money supply to combat inflation or turn accommodative to support high prices? Positive analysis shows that what will be the effect of selected course of action on inflation and output while normative analysis shows that which variable should be given more weightage? These issues have engaged the attention of macroeconomists for quite some time; see, e.g., Gordon (1975, 1984), Phelps (1978), Blinder (1981), Fischer (1985). Aizenman and Frenkel (1986) analyzed the framework of wage indexation and monetary policy while using labor and imported energy as variable input in a Cobb-Douglas production function. They called for policy accommodation and concluded that if demand for labor is more elastic than supply then policy rules that stabilize employment are preferred to policy that stabilize real wage. Supporting the same, Gamber, Sinclair and Tie (2013) used simple 3-variables VAR (vector autoregressive) model and constructed monetary policy shocks by interpreting the policy shocks as forecast error. The difference between Federal funds rate constructed with real time data and fund rate constructed with actual realization of inflation and real output is termed as monetary policy shock. Following Romer and Romer (2004) they concluded that output reacts negatively to contractionary monetary policy shock. Accommodative policy calls for decrease in interest rate so that funds can be made available to public and effective demand retains its previous level. Gordon (1975) argued for monetary accommodation in response to adverse supply shock. Contrary to easy monetary stance, Alan S. Blinder (1981) conducted optimal monetary response to inflationary shocks under rational expectations by introducing an imported intermediate good, oil, (neither produced domestically nor consumed directly) in the model which extended the analysis of well-known papers by Lucas (1973) and Fischer (1977). The oil market is considered as strict monopoly in which OPEC sets the price and US decides how much to buy at this price. He concluded that transitory unanticipated shocks should be accommodated while if shocks nature is permanent then inflation stabilization should be targeted. Similarly, Fry and Lilien (1986) supported the remarks that using monetary policy to accommodate exogenous shocks undoubtedly works but the more such policy is used, the less effective it becomes.

The correct nature of the shock is very crucial to identify. If the policy makers underestimate the effects of shock (e.g. Price shock), then they might engineer a wrong policy response function. Which would further catalyze the shocks effect. Fischer (1985) analyzed the optimal response to a supply shock in a one-sector real model under the light of 1973 oil price shock. The main result of the study was that supply shocks by themselves are unlikely lead to unemployment if monetary policy remains passive and as long as there is no wage resilience by the workers. Supporting the neutral stance of monetary policy, Kahn and Hampton (1990) used the triangle model of inflation (Robert Gordon, 1988 and 1990) to study the effects of 1990 oil price shock on US economy. They argued that the likely effects of Iraqi oil price shock will be small providing monetary policy does not over react and concluded that if the economy is hit by small shocks then best monetary stance is to follow constant GNP approach (given the shock is anticipated correctly).

Separating the effects of aggregate demand and aggregate supply shocks, Peery and Olson (2013) examined exogenous federal fund rate shocks on US economy (for period 1969-1996) using Romer and Romer's (R and R) new measure. Using Blanchard and quah (1989) they concluded that if Romer and Romer have constructed reasonable set of monetary policy shocks then including them in small VAR should help to identify other structural shocks that effect the US economy. They supported Taylor's contention that monetary policy was too tight in 1981-1982 recession.

The general consensus from literature can be derived that neutral policy stance is the best response to small deviations of output and prices while large shocks require monetary response. Moreover, the reaction of monetary policy could be different for developed and developing countries. Developed countries put more weightage to real stabilization while developing countries targets inflation stability.

2.4 Monetary Response in case of Pakistan

Pakistan is a developing country facing various fluctuations in output and inflation since the beginning. Monetary policy has not been very effective in the past. The advantages of rule based policy are very dominant on discretion. Despite the long history of dispute, choices do not have to be made between rules and discretion but between the rules that are less rather than complicated, and more rather than less open to scrutiny and evaluation. Malik and Ahmed (2010) estimated whether Taylor rule is being followed in Pakistan. For the period (1991-2006) they concluded that monetary policy has generally been conducted through discretionary measures and rule based policy may have improved the macroeconomic conditions. Supporting the same stance, Tahir (2013) compared the pre and post reforms period (1989) by using forward and backward looking Taylor rules to investigate the conduct of monetary policy in Pakistan for period (1971-2011). Explaining the inability of that State Bank of Pakistan (SBP) to control inflation and minimize output gap, she concluded that rule based policy should be followed so that fiscal dominance could be avoided. Another problem for SBP is the correct identification of output gap. Satti (2013) found that in case of Pakistan, output gap estimates from final or revised data is a poor proxy of output gap estimates that were available to policy makers at the time of policy decision. SBP should rely on methods of estimating output gap which are less sensitive to end sample estimates. Arby (2001) decomposed statistically the real GDP of Pakistan into long run trend, business cycles and short run shocks. It found that trend growth of real GDP, though positive, is declining since early 1980s. It further postulated that after 1990s, Pakistan economy faced a recessionary phase. Moreover, Arby and Hanif (2010) explored how the monetary and fiscal policies have coordinated with each other in Pakistan. The sample period of 1964-65 to 2008-09 postulates that both the monetary and fiscal policy have been conducted independently throughout the period. And there have been very few instances of coordination between the two policies.

Ahmed and Malik (2011) estimated the monetary policy reaction function for Pakistan over the period 1992; Q4-2010; Q2. They calculated threshold level of inflation 6.4 percent and concluded that SBP gives more weightage to price stability when economy falls under high inflationary regime. Policy remained consistent for most sample period except for last two years when economy was hit by price hike and massive currency depreciation. Moreover, short lived price hike does not call for change in policy instrument. Mubarik (2005) estimated the threshold level of inflation in case of Pakistan using annual data set from 1973-2000. The estimated model suggests 9 percent threshold inflation level above which inflation is inimical for economic growth. Akmal (2011) found the nature of relationship between inflation and relative price variability (RPV) for Pakistan. For the sample period 1986-2011, the inflation threshold (annualized) with respect to RPV is 4.7 percent. In this case the inflation threshold is lower than 6 to 9 percent found by Mubarak (2005) and Iqbal and Nawaz (2010) while studying relationship between inflation and growth. Similarly, Nasir and Malik (2011) used modified version of Structural VAR developed by Enders and Hurn (2001) and found weak response of policy to supply side shocks as correlation coefficient between demand and supply shocks is only 0.041. Moreover, demand shocks have no significant contribution to output variability. Qayyum (2002) estimated monetary condition index (MCI) for Pakistan using monthly data from June 1990 to June 2001. The weights of interest rate and exchange rate have been estimated by unit root analysis and Johanson (1988) maximum likelihood method based on VAR technology. The analysis indicates overall tight monetary policy during the decade. However, there were some easing spells during 1977 to 1999. The easing of monetary policy in that era is generally associated with 1989 reforms. Munir (2012) estimated the dynamic effects of monetary policy on macroeconomic variables in Pakistan. The effects of monetary policy at aggregate level were measured by VAR and FAVAR models. They found that the exchange rate channel worked efficiently in case of Pakistan. Moreover, it was evident that monetary policy affects output in short run. Ahmad (2013) used three broad categories of monetary policy rules i.e. Taylor rule, McCullum rule and Friedman rule in order to estimate optimal monetary policy rule in case of Pakistan. He measured the loss function using stochastic and historical simulation and concluded that strict inflation targeting rule is optimal monetary policy rule. Neelum (2014) used LSTVAR approach to check the asymmetric effects of monetary policy in Pakistan. She investigated the effect of monetary policy shock on output and prices and concluded that the effect may vary depending on the situation of the economy i.e. high growth period or low growth period. Or if the economy is in high inflation regime or low inflation regime. Expansionary monetary policy affects prices by greater margin while contractionary monetary policy affects output aggressively. Khan (2008) analyzed the short-run impact of unanticipated change in monetary policy on macroeconomic variables in Pakistan. Using monthly time series data from 1991-2006 and VAR methodology, he concluded that positive nominal shock will increase output growth in short-run and this positive effect will die out between 23 to 32 months horizon. It explains the long-run money neutrality phenomenon in case of Pakistan. Shah (2012) applied co-integration, impulse response and variance decomposition analysis in VAR framework in order to check the effects of exchange rate channel of monetary policy on inflation and output using data from 1991 to 2009. He concluded that output and prices rise to the positive shock to real exchange rate in short run. The long run relationship implicates that output is negatively related to interest rate and domestic prices in Pakistan. Siraj (2013) carried a study on monetary policy shocks in case of Pakistan using VAR technique over a period of about 25 years. He concluded that the movement of economic variables is better explained by interest rate shocks as compared to exchange rate and monetary aggregate shocks. Khan and Qayyum (2007) measured the stance of monetary policy in case of Pakistan. They used monetary condition index (MCI) as policy indicator. MCI is the weighted sum of variations in short term interest rate and exchange rate relative to their base year values. Their model constituted of backward looking IS-curve and backward looking Phillips curve. For the period of 21- years from 1981-2004, they concluded that supply shocks are dominant in case of Pakistan. Moreover, contractionary monetary policy in response to negative supply shock will further inflate the prices level rather than reducing it. Hanif et al. (2016) estimated monetary policy stances measures like Monetary Conditions Index (MCI), Financial Conditions Index (FCI), and Bernanke and Mihov Index (BMI) for Pakistan. Despite the fact that supply shocks are found to be dominant in Pakistan which gives little room to monetary policy to play an effective role as stabilizing tool, they found that movements in exchange rate and monetary aggregates turned out to be more important than the interest rate in policy transmission mechanism. The comparison of different estimated measures depicted that MCI performs better as measure of monetary policy stance (compared to FCI and BMI) in the case of Pakistan.

Monetary policy has confronted a lot of challenges in the past. The independence of monetary sector is the key condition for its effectiveness. Fiscal dominance has remained a big problem in Pakistan's case. Moreover, in context to the inflation and output variations in the past, literature concludes that rule based policy would improve the economic conditions. Correct identification of shock is very essential, as policy makers could damage the conditions further by choosing wrong policy stance. Neutral policy response could be the best option against small shocks while big shocks require accommodative or extinguishing monetary response

Chapter 3

MONETARY POLICY OF PAKISTAN

After the establishment of State Bank of Pakistan on 1st September 1948, the central bank took charge of financial sector of the country. In the early days, SBP targeted the primary objective of price stability via opting the monetarists approach. The SBP 1956 act clearly points out price stability and economic growth as the core objectives of SBP. The early weak financial system inclined reluctant behavior of banks to lend. So SBP's initial goals included the development of various aspects of banking system thus exceeding the conventional functions of central banks. The major task was the distribution of credit and money to the private and public sector. At that stage, bank credit was in very small percentage of GDP so interest rate was not used as policy instrument because of many constraints. Instead, rate of deposits were used as policy instrument. 1960s was entitled as the liberalization phase as flow of resources from abroad took place. SBP regulated its policies to keep pace with higher rates of growth and investment at that time. In August 1963, SBP introduced the quota system. This introduction highlighted the constrained borrowing of scheduled banks from SBP against government securities. Above constrained level borrowing was subject to higher level of interest rates. All types of borrowing in 1965 were covered by quota system. Before 1972, monetary policy was conducted through indirect method of credit control. Establishment of National Credit Consultative Council (NCCC) and Annual Credit Plan in 1972 shifted the controlling of cost and volume of credit to more direct methods. In context to that, regime of credit ceiling was introduced in October 1973. The main instrument of credit management was credit ceiling itself. Moreover SBP revised its pre 1972 policy and raised the bank rate from 5 to 6 percent and ultimately to 10 percent. The Statutory Liquidity Ratio (SLR) was also elevated from 25 to 30 percent in 1973 but this elevation in SLR failed to control the volume of credit. Although credit budgeting was an effective instrument of monetary policy but with the passage of time, various flaws in credit ceiling approach were highlighted. Commercial banks were affected in terms that they were unable to mobilize deposits. Credit ceiling adversely affected the financial system and limited the banks capacity to respond to economy's demand. The era of 1972-88 viewed a lot of changes in economic management and financial policies. A lot of substantial public investment took place i.e. during 1974-75 public sector program was more than 10.2 percent of GDP. The era of credit ceiling as policy instrument ended in 1990s and was replaced by higher dependence of monetary authorities on OMOs.

SBP has been facing the issues of independence from very beginning. The foremost attempt to gain autonomy was made by S. U. Durrani on 18th September 1971 at 23rd general board meeting. The efforts made remained ineffective as the SBP soon became attached to ministry of finance. The period 1986-93 proved to be destabilizing both politically and for SBP. The autonomy of SBP became relatively prominent in early 1990's. In 1993, the caretaker government proposed separation of fiscal and monetary management in need to improve macroeconomic conditions, so SBP was formally detached from finance ministry (Janjua, 2004). Pakistan followed IMF's three year structural adjustment program and implemented World Bank's financial sector deepening and intermediation project. The reform period mainly focused on: effective regulation of banking system, SBP monetary policy independence and constrained government borrowing form SBP. In February 1994, SBP's 1956 act was amended and SBP was made solely responsible for monetary policy. Moreover another revision in 1997 gave SBP right to restrict government borrowing.

Despite the reforms, some analysts described 1990s as lost decade[2] for Pakistan in terms of economic growth because potential benefits were not gained in that era[3]. The decrement of growth rate in 1990's was due to diminution of capital inflows, production shocks and persistent lags in the execution of structural reforms and stabilization measures. Other factors like deteriorated law and order situation and rampant corruption hindered the country's economic growth. Janjua (2005)[4] considered 1980's as the era of missed opportunities. First there was mounting fiscal deficit due to increasing government expenditures mainly constituted of defense outflow. Second, the implementation of structural reforms should have been initiated when the economy was in a stronger position. After 2000, the country witnessed visible optimism in economic growth; growth rate of 6.4 percent in 2003 and 8.4 percent in 2004-05.

It is important to mention here the interest rate policy of SBP in 2003-04. SBP was reluctant to raise the level of interest rates close to inflation in order to tighten the liquidity in economy and decrease demand pressure. The major reason behind this monetary behavior was the perception that cheap credit is a major source of economic growth. Since August 2003, market interest rates touched very low levels and excess liquidity in the economy gave rise to many problems. Almost in mid-2005, SBP made attempt to curb this approaching liquidity trap economic condition by auctioning of public debt but it remained ineffective. As interest rates were at record low levels, government borrowed heavily from SBP in order to finance its expenses and maturing loans. As of 25th June 2005, government's total borrowed money from SBP stood at Rs. 154.55 billion. The low rate of interest rates helped

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[2] Dr. Ishrat Hussain, 'Economic Challenges Facing Pakistan' Lecture delivered at the Centre for Development & Democracy, Karachi on 19th January, 2001.
[3] Sartaj Aziz, 'Was the 1990s a 'lost decade'?' *Dawn*, Feb. 11, 2001.
[4] Janjua, M. A. (2005). Money supply, inflation and economic growth: issues in monetary management in Pakistan. *The Lahore Journal of Economics*, 73-105.

government to finance many of its development projects and make repayment of expensive external debt. Moreover low cost funds also allowed many corporate sector companies to improve their balance sheet and increase their profitability. But in order to curb the excess liquidity issues, SBP should have opted for OMOs and halted the downward movement of interest rate. But it supported cheap credit-economic growth channel. Finally on 11th April 2005, SBP took its long awaited pragmatic step to increase the discount rate.

From 2007-09, the economy encountered a shock oriented distortionary phase. As the world economy was facing the global financial crises, inflation rate in Pakistan reached its peak of 25 percent. Depreciation of Pakistan rupee occurred by 38 percent[5]. In response to these economic conditions, SBP raised the interest up to 15 percent. A rule based policy i.e. Taylor (1993)[6] may have projected a higher levels of interest rates. SBP was reluctant to further increase the interest rate in fear that higher level of interest rate may slow down the economic activity[7].

Earlier 2016, SBP policy announcement to decrease benchmark interest rate by 25 basis points, from 6.0 to 5.75 percent, describes that SBP motive of promoting output despite continuous increment of inflation for 7 quarters. It means that it has sacrificed the long run target of price stability for shorter period to boost the output growth that may prove healthy for the economy.

State Bank of Pakistan has been pursuing a growth accommodating policy stance. Mishkin (2001) described price and output stability as the most important monetary policy objectives.

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[5] Maqsood, A., & Shahid, W. (2011, September). The Economics of Inflation, Issues in the Design of Monetary Policy Rule and Monetary Policy Reaction Function in Pakistan. *The Lahore Journal of Economics*, 215-232.
[6] Central bank adjusts its policy instrument in response to key economic variables i.e. inflation and output gap.
[7] Cheap credit is source of economic growth.

SBP's primary goals include these objectives along with exchange rate management. SBP does not have a clear cut prioritization of these objectives and decisions are made solely on basis of current situation prevailing in the economy. Interest rate smoothing and regulation of financial sector are also concerning goals of SBP. The targets of key variables are set by government on annual basis. SBP takes its policy decision to achieve these objectives. SBP is doing monetary targeting via following a discretionary policy stance even though there are rules in literature like Friedman k-percent rule and McCullum rule in this type of framework. The intermediate target in Pakistan is M_2 which is broad monetary aggregate; its target is set on annual basis. SBP use monetary base or reserve money as its operational target. After 1990s reforms, SBP gradually switched from direct instruments of credit ceiling to indirect market based instruments like open market operations (OMOs), reserve requirement (RR) and SBP repo rate. SBP also incorporate some forward looking analysis of its policy via forecasting output growth and inflations quantitative values. Now SBP has designed its own policy model in order to evaluate policy decisions and forecast the key variables.

We conclude by stating that the effectiveness of monetary policy in case of Pakistan needs further examination. Moreover, SBP would achieve targeted macroeconomic variables more competently, resulting into improved economic conditions, if it acts as pure autonomous body.

Chapter 4

METHODOLOGY

4.1 Introduction

The prime objective of this study is to check the response of State Bank of Pakistan (SBP) to inflation and output shocks. The variations in these two sensitive variables could cause the state of instability in the economy. As SBP's core targets include price and output stability, so its role is very crucial in various circumstances. Smaller deviations might be absorbed by the individuals and firms. But big shocks should be reacted upon by the monetary authorities. For example large increase in inflation could cause massive public response due to currency depreciation, real wage reduction and uncertainty in the markets. Big output fluctuations should also be encountered by the Central bank as they also cause economic instability.

Small shocks have a transient impact on the system whereas sufficiently large shocks will change its trajectory for long time. Small shocks represent the tolerance level of SBP monetary policy reaction whereas big shocks cause amendments in the reaction function. We will modify the rule to check the response of such shocks.

In order to carry out our analysis, we are following Taylor rule as monetary policy response function. Taylor rule describes the response of central bank's policy instrument to the inflation and output deviations. In order to get optimal monetary policy, we will estimate loss to the society and then optimal rule is selected in the basis of minimum loss.

In order to check how much weightage does SBP gives to interest rate smoothing and exchange rate management, we will incorporate lagged interest rate and exchange rate variables in our regression analysis. The stability of all these variables is very crucial, as price instability is the major source of uncertainty in financial markets, abrupt changes in interest rate is also harmful for financial system and instability of exchange rate destabilizes the international trade. So the perfect mix of all these targets results in optimal policy formulation.

An important point in designing monetary policy is the choice of target variable e.g. inflation rate, exchange rate or interest rate. Here in our case, the core target variables are output gap and inflation rate. Moreover, short term interest rate will serve as policy instrument.

4.2 Taylor Rule as Monetary Policy Rule

The empirical evidence shows clearly that the rule based policies perform well as compared to discretionary policies. Discretionary policy approach has credibility problem. If private agents make wage contracts based on announced targeted inflation then monetary authorities can gain short term benefit by deviation from their announced target. So next time the individuals make contracts based on rational expectations (higher than announced inflation target) to overcome the risk. So in this way the economic indicators which were supposed to be significant become insignificant and economy has to face undesirable long run outcomes.

Kyland and Prescott (1977) described the advantages of rules over discretion- rules as robust, simple and time-consistent. They produce time-consistent outcomes because they make monetary authorities pronouncements credible. In addition to Kydland and Prescott (1977), economists debated on the importance of rules in monetary policy for most of the

20th century. Milton Friedman argued that the policy makers do not have the perfect knowledge, so their best analysis to tackle the problem could end up in further destabilizing the economy. Simmons (1930) argued that the monetary policy rules are more stabilizing, they reduce the uncertainty regarding the price level thus making the financial sector more firm. Similarly, Alesina and Tabellini (1987) also supported that taking the rule based path dampens the magnitude of variation of output and inflation.

There are basically two types of monetary policy rules: instrumental rule and targeting rule. Instrumental rules are simple, robust, reliable and strict. It is basically a simple formula for setting the central banks instrumental rate as a function of few observable variables. A targeting rule specifies a condition that must be fulfilled by the central bank's target variables. A real world example of targeting rule is the one that has been applied by the Bank of England. Monetary policy is always conducted in a lot of uncertainty and a simple and robust monetary policy rule gives central bank an option to fall back on in difficult times. So it is clear that the instrumental rules are more attractive. The best example of instrumental rule is Taylor rule (1993). It is a simple backward-looking monetary policy rule that described that how much the central bank should charge the nominal interest rate in response to changes in inflation, output, or other economic conditions.

Mathematically it is defined as:

$$i_t = r^* + \pi_t + \alpha_y y_t + \alpha_\pi \left(\pi_t - \pi^*\right) \tag{4.1}$$

Here:

i_t : Nominal interest rate

r^* : Real interest rate

π_t : Desired inflation rate

y_t : Output Gap

α_y , α_π : Output and inflation parameters

$\pi_t - \pi^*$: Inflation gap

The monetary authority should raise the policy rates when inflation is above target or output gap is positive. This action decelerates money growth which reduces future inflation. Similarly the policy rates should be decreased when inflation is below target level or when output falls short of full-employment level. This action stimulates economic growth, raising output towards its potential. Taylor rule tries to stabilize economy in short run and inflation in long run. Taylor (1993) recommends that real interest rate should be 1.5 times the inflation rate.

One of the most important part of Taylor rule is the calculation of output gap. The main indicator of current state of the economy is output gap; positive values of output gap reflect boom in economic activity while negative values portray recession. It is basically the difference between the actual and potential output of the economy. There are various methods of calculating the potential output. Moreover, output gap is estimated with the help of five methods namely the linear trend method, quadratic trend method, HP filter, production function method, and vector autoregressive method. The difference between the linear and quadratic trend is that in linear trend the GDP growth rate is assumed to be constant while in quadratic trend this assumption can be relaxed. The Quadratic time trend method is more flexible as compared to linear time trend method and it performs well at the end points of data set. One has to use the appropriate method for the calculation of gaps. The assigning of optimal weights to inflation and output is also very crucial. The original Taylor rule used the value 0.5 for both inflation and output objectives. These weights could be varied. For example if output parameter is 1 and inflation parameter is 0, it means that the motive of central bank's policy is real stabilization and vice versa. In case of Pakistan, studies have shown that optimality for SBP to conduct monetary policy via rule is by using real interest rate equal to zero and inflation target at 8 percent[8].

The original Taylor rule was backward looking. Economists have developed other modified versions which represent its evolution with time. In recent years, studies have shown that the central monetary authority also responds to expected inflation and output. So newer version of Taylor rule have come on the screen entitled as forward looking in nature. Moreover, the ways of measuring inflation and output have also changed. Transition took place from backward to forward looking, from cold turkey to gradualism and from simple measures of inflation, output and unemployment to more complex ones. In addition of price and output stabilization, there are other motives of central banks like financial stability, interest rate smoothing, exchange rate stability and unemployment control. The rule is modified by incorporating these various factors in it. For example, central banks accomplish their motive

[8] Malik, W. S., & Ahmed, A. M. (2010). Taylor rule and the macroeconomic performance in Pakistan. *The Pakistan Development Review*, 37-56.

of interest rate smoothing by incorporating the lagged value of interest rate on independent side. This process is called as gradualism; which allows central banks to change rates in series of small steps in the same direction. In contrast to this, Ben S. Bernanke describes wholesale changes in federal fund rates as cold turkey. Literature provides us with different versions of Taylor rules each with unique significance. For example, Ahmad and Malik (2011) incorporated threshold level of inflation to estimate monetary policy reaction function of State Bank of Pakistan (SBP) when economy falls under high inflationary regime.

4.3 Description of Variables

In this section we described the relationship between the key variables of our study. Mainly how the policy instrument (interest rate) is adjusted against inflation, output gap and exchange rate.

4.3.1 Interest Rate and Inflation

Inflation is referred to the overall increments in the price level of the goods resulting into the decrement in the purchasing power of the currency. The primary target of most of the central banks is to limit inflation so that the economy may face a smooth growth path. The policy instrument the central banks might use is the interest rate, in order to counter the inflationary fluctuations. The interest rate fluctuations also influence the decision behavior of individuals. If the interest rate is high then people will tend to save more money due to higher levels of returns and spend less. As a result, the economy will face a slow growth phase and lower levels of inflation as the pressure exerted on aggregate demand by individuals is low due to less disposable income (higher level of saving). Contrary to this, if the interest rate is lower than people have lower incentive to save. They would rather go for spending and the business cycle will flourish exerting higher pressure on aggregate demand and ultimately inflation would occur.

A central bank may respond to the inflationary distortions using the policy instrument-interest rate. In case of higher level of inflation, central banks may increase the interest rate to reduce the demand pressure so that people may save more and inflation will ultimately decrease. Conversely, if the economy is facing the deflationary phase then the central banks may decrease the interest rate to encourage the spending of people. Resultant would be higher level of growth rate.

4.3.2 Interest Rate and Output Gap

In addition to the price stability, one of the core functions of monetary authorities is to stabilize the output fluctuations. The key challenge for the policy makers is to evaluate the indicators that assess the actual picture of current state of the economy i.e. time when policy is made. In reality, the estimation procedure of the indicators initially is based on incomplete information and afterwards revised as new information is accessible. One of the key economic indicators is output gap. The initial work done on the measurement of output gap was by Mitchell (1927). Output gap is referred to the difference between what the economy is producing and what it is capable of producing when all of its resources are used. It is basically the noisy indicator of the economy due to the presence of potential output (unobservable component), as policy makers have to estimate the potential output. The estimation of output gap based on real time data may provide different result as compared to the estimation based on revised or final data. Another problem concerning to the measurement of output gap is the availability of different types of measurement methods, which provide different results. The prominent methods which are used to measure the output gap are linear trend, quadratic trend, Hodrick Prescott filter (HP), structural vector autoregressive and production function approach. The output gap is abstractly engaging because it provides the indications about inflation developments. Positive output gap represents the overheating of the economy i.e. ascending pressure on inflation while negative output gap represents the descending pressure of inflation as economy is sagging. The efficient and effective measurement of output gap may play a vital role in the conduct of monetary policy.

In response to the output gap, the policy makers respond counter cyclical using the policy instrument i.e. interest rate. If the economy is overheating means output gap is positive, then the monetary authorities may increase the policy rates to decrease the pressure on aggregate demand conversely, in case of negative output gap the monetary authorities may decrease the policy rates to promote the investment behavior of the individuals, boost the demand and avoid the inflation rate to drop below central bank's target rate.

The unemployment gap is the key indicator of the economy closely related to the output gap. The non-accelerating rate of unemployment (NAIRU) is the level of unemployment rate that is stable with the constant level of inflation. The deviation of actual output from its potential is related to the deviation of unemployment rate form NAIRU. Hypothetically, if the monetary authorities could equalize the unemployment rate with NAIRU then the economy will produce at its potential level. We can say that there would be no output gap.

4.3.3 Interest Rate and Exchange Rate

Central bank responds to exchange rate management target using the policy instrument i.e. interest rate. In case the interest rate is higher, the value of local currency would appreciate-as it would attract the foreign capital and ultimately the exchange rate would appreciate.

Higher inflationary levels in the economy would mitigate the impact of higher interest rate-resulting into no capital inflows. Conversely, lower level of interest rate could promote the flow of capital outside the country- making the economic conditions worse off. So to formulate the perfect mix of policy targets incorporated in policy response function is a very tough job for the central banks. Minor deviation in the policy instrument may cause major shifts in vital macroeconomic variables.

4.4 Static and Dynamic Analysis

Prior to the formal estimation, we initiate the process by adopting the static version of Taylor rule, in which short term interest rate is equal to equilibrium real interest rate plus inflation rate and a weighted average of deviation of output from its potential and deviation of inflation from its target level. Mathematically, Taylor rule (1993) is described as:

$$i_t = r^* + \pi_t + \alpha_y y_t + \alpha_\pi \left(\pi_t - \pi_t^*\right) \quad (4.2)$$

As r^* and π^* are assumed to be constants, the estimable form can be as:

$$i_t = \beta_0 + \beta_1 y_t + \beta_2 \pi_t + \mu_t \quad (4.3)$$

Here, $\beta_0 = r^* - \alpha_\pi \pi^*$, $\beta_1 = \alpha_y$, $\beta_2 = 1 + \alpha_\pi$,

The hypothesized values of these parameters are $\beta_1 > 0$, $\beta_2 > 1$, and β_0 may be negative or positive. Exchange rate stability is also one of important objective of monetary authorities. To check whether SBP pursues exchange rate stability, we incorporate difference of exchange rate as additional policy variable.

$$i_t = \beta_0 + \beta_1 y_t + \beta_2 \pi_t + \beta_3 \left(e_t - e_{t-1}\right) + \mu_t \quad (4.4)$$

Here, e is the nominal direct exchange rate, increment in e means that domestic currency has depreciated.

Now we switch to dynamic analysis, here we will incorporate lagged interest rate to check if central bank gradually change interest rate to stabilize financial system; interest rate smoothing. This makes the error term of static version serially correlated. Thus, the appropriate model is constructed as:

$$i_t = \beta_0 + \beta_1 y_t + \beta_2 \pi_t + \mu_t \tag{4.5}$$

$$\mu_t = \rho \mu_{t-1} + \xi_t \tag{4.6}$$

This two-equation system can be solved to determine the dynamic version of the Taylor rule as:

$$i_t = \rho i_{t-1} + (1-\rho)(\beta_0 + \beta_1 y_t + \beta_2 \pi_t) + \xi_t \tag{4.7}$$

Here, $(1 - \rho)\ \beta_1$ and $(1 - \rho)\ \beta_2$ are short-run response coefficients while β_1 and β_2 remain the same in the long run.

Finally, we incorporate the exchange rate into the dynamic version to complete the specification.

$$i_t = \rho i_{t-1} + (1-\rho)(\beta_0 + \beta_1 y_t + \beta_2 \pi_t) + \beta_3 (e_t - e_{t-1}) + \xi_t \tag{4.8}$$

Our main target for doing this analysis is to check either static or dynamic version of Taylor rule best fits in case of Pakistan.

4.5 Non-linear Monetary Policy Reaction Function

The prime target of central bank is to achieve sustainable growth along with stability. Monetary policy is a tool to keep the inflation under tolerance level and output at its potential level. Taylor rule specifies short term interest rate as linear function of the target variables. However under certain circumstances, the response of monetary policy may change due to inflation and output shocks. This response could vary based on the intensity of shock i.e. if the shock is small or big. So in order to analyze our prime objective, we modify our target variables i.e. output gap and inflation.

Many of the central banks follow the motive of inflation targeting in order to achieve the prime objectives of low and stable inflation. Inflation targeting broadly consists of public announcement of medium term target for inflation and institutional commitment to price stability as primary goal of monetary policy. Increased transparency and accountability make it an attractive policy approach for the central banks.

Inflation targeting countries maintain the level of inflation under specified tolerance level. If the level exceeds the specified threshold then the central banks have to act aggressively to correct the undesirable distortion. For instance, monetary authorities of New Zealand follow inflation targeting scheme and maintain the tolerance level of 1-3 percent[9].

In case of Pakistan, we split the behavior of SBP against big and small shocks of inflation and output. Firstly, we calculate the mean and standard deviation of output gap. It provides us with a range of deviations. Now we construct a dummy variable for within and outside 1 standard deviation. Similarly, the mean and standard deviation for inflation be calculated and dummy variable will be constructed for within and outside 1 standard deviation values of inflation.

[9] See RBNZ- Monetary Policy Statement June 2016.

The estimable form can be described as:

$$i_t = \rho i_{t-1} + (1-\rho)\left(\beta_0 + \beta_1 y_t^* D + \beta_2 y_t^* (1-D) + \beta_3 \pi_t^* D + \beta_4 \pi_t^* (1-D) + \beta_5 (e_t - e_{t-1}) + \xi_t\right) \quad (4.9)$$

Here D is defined as dummy variable representing the large shocks while (1-D) represents small shock of same variable. Moreover, all the values within 1 standard deviation are labeled as 0, showing the small shock while outside 1 standard deviation values are labeled as 1, representing the large shocks. So D represents all values outside the range showing both positive and negative large shocks while (1-D) represent all values within range showing small shocks.

The estimation process is carried out in two steps:

1. In first estimation procedure we check the monetary response to big and small shocks of inflation. Here D represents big shock of inflation while (1-D) corresponds to small shocks of inflation.
2. In second estimation procedure, we check the monetary response to big and small shocks of output gap. Here D represents big shock of output gap while (1-D) corresponds to small shocks of output gap.

4.6 An Analytical Framework of Derivation of Taylor Rule

For the simple Taylor rule derivation, we will incorporate simple aggregate demand and aggregate supply model. According to Rudebush-Svensson (1999), the basic demand side IS equation is described as:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 (i_{t-1} - \pi_{t-1}) + \xi_t \quad (4.10)$$

In the above specified equation, output gap is serving as dependent variable described as deviation of actual output from its potential. The equation describes output gap depending on its own lagged value and real interest rate. β_1 describes the monetary transmission mechanism while β_2 captures relationship between real interest rate and output gap. In equation (4.10), ξ_t describes demand side shocks.

The supply side Phillips curve is defined as:

$$\pi_t = \pi_{t-1} + \phi y_{t-1} + \upsilon_t \tag{4.11}$$

In equation (4.11), υ_t describes supply side shocks which is assumed to be white noise. There is negative relation between the output gap and real interest rate. Real side of the economy can be affected by monetary authorities via using the policy instrument assuming that prices are constant for at least two periods.

Solving the above two equations, we develop the econometric form of the rule as:

$$i_t = \psi_0 + \psi_1 \pi_t + \psi_2 y_t - \alpha i_{t-1} + \eta_t \tag{4.12}$$

The equation describes that the central bank change its policy instrument (short-term interest rate) nearer to desired interest rate gradually. This process is called as "interest rate smoothing" generalized as gradualism in contrast to cold turkey[10]. Here, α is the interest rate smoothing parameter. Different values of α are used in literature. Clarida et al. (2000) estimated the value of smoothing parameter to be 0.21 using GMM method.

[10] Cold turkey describes big changes in policy instrument

4.7 Simulations

In the last portion, we use the normative side of the monetary policy rules. We identify the best policy response using simulation analysis- taking the different specification of Taylor rule

In order to measure the loss function, we use the historical and bootstrap simulations. To derive the optimal value of the interest rate, loss function is minimized subject to the constraint and the values of the output gap and inflation rate are calculated which are consistent with the rule based policy. From these reduced form equations we estimated the variances of the output gap and inflation rate, then to find the loss to the society these values of the variances are substituted in the loss function.

The historical simulations can prove to be misleading as a rule performing better in one situation but could prove to be wrong in other situation. So instead of focusing on one policy option we should check the robustness of policy options against a number of scenarios. For stochastic simulations we randomly draw 1000 situations of the structural shock which may hit the economy. For this purpose we need assumption for the probability density function by assuming a particular probability density function of the shock and through this we can draw series of the shock.

This method is not verily accepted as the assumption regarding the density function may be wrong. Another method is bootstrapped simulation in which we assume that the estimated or observed density function is true. Bootstrapping is a computer based method which assigns measure of accuracy to sample estimates. It is basically the procedure of resampling. We compare all the 1000 values of the loss estimated from the historical data and stochastic simulations. We will make a comparison between all monetary policy rules in order to identify the best rule which has minimum loss.

4.8 Specification of Monetary Policy Rule

The core objective of the policy makers is to maximize the welfare to the society via stabilizing the prices and minimizing the output distortions. So authorities must minimize the loss to the society by keeping the inflation to its target level and output to its potential level. Output gap is computed as: ((actual GDP-potential GDP)/potential GDP)*100

In order to estimate the optimal parameter values in case of Pakistan, we will back cast the economy with different combination of parameters in rule and then compare these results. Those parameters which represent the decreased value of inflation and output variability are optimal hence representing minimum loss to the society.

The loss function can be computed as:

$$L = \sum \Omega^i \left[\Theta (Y_{t+i})^2 + (\pi_{t+i} - \pi^*)^2 \right] \quad (4.13)$$

Here, Ω is defined as the discount factor which takes the value less than 1. The policy instrument setting behavior of central bank takes into account the future torrent of expected inflation and expected output gap. The squared terms indicate that deviation of output and inflation on both sides are assumed to be equally costly. Assume that discount factor Ω is close to 1, we can approximate the above mentioned loss function as:

$$L = \Theta V(y) + V(\pi) \quad (4.14)$$

The loss function is composed of variances of output gap and rate of inflation. Θ is the weight given to the output gap as compared to the inflation rate in the loss function, which basically governs the preference of society. The signs of both variances are positive because variability of both variables is considered damaging to the society. Fluctuations in inflation rate negatively effects the long run economic growth. So the inflated expectations about inflation have substantial effect on saving and consumption behavior of individuals and firms. Inflation creates uncertainty in the financial markets causing an environment of inefficiency. When the society is utilizing all of its resources in the best efficient way then it is actually driving on its potential output path. In case of actual output being lower than potential output have negative consequence on the economy in the form of unemployment being the prominent one. So the monetary authorities act in the best possible way to minimize the loss to the society in order to stabilize the economic conditions.

The loss function can also be written as:

$$L = \tfrac{1}{2}\left(y_t^{\,2}\right) + \tfrac{1}{2}\left(\beta\left(\pi_t - \pi_t^{\,*}\right)\right) \qquad (4.15)$$

Where y_t is output gap and $(\pi_t - \pi_t^*)$ represents difference between actual and targeted inflation rate.

4.9 Estimation Methodology

In order to carry out the estimation procedure of above mentioned monetary policy rules, we use OLS methodology by using the quarterly data for the period 1993Q1 to 2015Q3. First we describe either static version or dynamic version of Taylor rule fits in case of Pakistan. Then we estimate the non-linear monetary policy reaction function, splitting the small and big shocks and estimate the monetary response to these shocks.

We also estimate the optimal monetary policy response via historical and bootstrap simulations. For this purpose, we estimate basic macroeconomic model consisting IS and

Phillips curve equations and incorporate their residual series in simulation analysis. Output gap is described by the IS equation while Inflation is expressed via Phillips curve. The rule with minimum loss will represent the optimal response.

4.10 Data and Variables

Quarterly data have been used for Pakistan over the period of 1990Q1 to 2015Q3. Our data time period represents the post reform period[11] of State bank of Pakistan. The key variables in the data set include real GDP, consumer price index (CPI), nominal exchange rate. Moreover, money market rate serves as policy instrument. Inflation is measured as percentage difference of consumer price index (CPI) in the current quarter over the CPI in the corresponding quarter of the previous period. Output gap is estimated as deviation of real GDP from its potential level, we fit quadratic trend in constant prices GDP and then calculate the percentage deviation of actual output from the trend values. The reason is that Pakistan's GDP illustrates a quadratic trend that's why we have used this technique for calculation of potential GDP. The data on GDP, CPI, money market rate and exchange rate is taken from international financial statistics (IFS). We have used Kemal and Arby (2004) real GDP quarterly weights to convert our annual GDP into quarterly data.

[11] SBP got autonomy in the financial sector reforms of early 1990s, before that SBP was attached to finance ministry.

Chapter 5

RESULT AND DISCUSSIONS

5.1 Introduction

In this chapter we will elaborate the results of our econometrical model mentioned in the previous chapter. First we will identify either static or dynamic version of monetary policy rule fits in case of Pakistan. Then we will move to estimation of non-linear monetary policy reaction function. Our main objective is to check the response of SBP to big and small shocks of inflation and output i.e. how much weightage does SBP puts to inflation and output stabilization in case of such distortions. For the estimation of our model, we use quarterly data of Interest rate, CPI, Real GDP and Exchange rate.

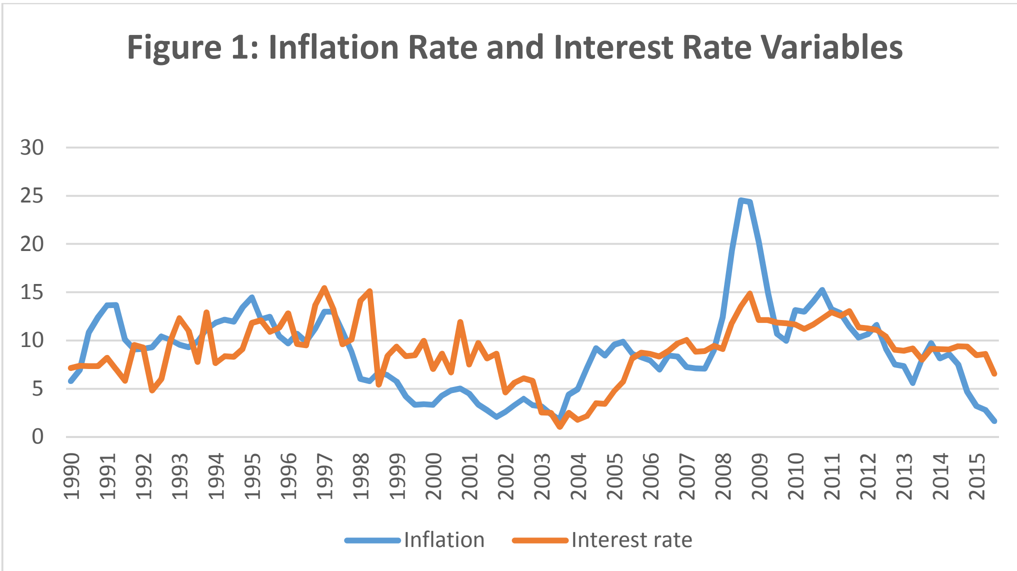
Before embarking to the formal estimation procedure, we carried out some preliminary tests of our data set explained in section 5.2. Section 5.3 deals with estimation of linear monetary policy reaction function. Section 5.4 explains the results of non-linear monetary policy reaction function. The estimation of IS and Phillips curve equation is done in section 5.5. Simulations are incorporated in section 5.6.

5.2 Preliminary Tests:

This section describes the data set. We elaborate how our variables are related to each other. Specifically, how interest rate had been adjusted against inflation, output gap and exchange rate in our data time period.

5.2.1 Interest Rate and Inflation:

Inflation rate averaged to 7.89 percent from 1957 to 2016 in case of Pakistan. The most extreme peak inflation that has hit was 37.81 percent in December 1973 while lowest level recorded was -10.32 percent in February 1959 (Source: Pakistan Bureau of Statistics)**.** So before boarding on to the proper estimation procedure, it is constructive to demonstrate the variables which have been used in this study.



Source: Author's calculations based on data from IFS (2015)

Figure 1 shows that there is a positive relation between the short term interest rate and inflation rate. The trend shows that State Bank of Pakistan (SBP) has been following the counter cyclical policy. The short term interest rate has been adjusted in response to the inflation variations.

In 1991 and 1995, inflation touched almost 15 percent level. From 1998-2003, inflation has remained below the short term interest rate. In 2001-02, it touched the lower grounds 2 percent. After 2003, inflation takes the front seat and takes the upward trend. The major deviating point which can be discussed is the point where inflation touches the peak of 25 percent. After the first quarter of 2007-08, the inflation rate takes the upward trend and reaches the highest peak of 25 percent. The important point to discuss here is the level of interest rate in same year (i.e. 2008) does not seems to be coping with the level of inflation.

State Bank of Pakistan did intended to adjust the interest rate in response to the abnormal behavior of inflation rate but it faced serious criticism from government, industry and academia groups. So the interest rate was set almost less than the half of Taylor rule recommended level. It is also imperative to mention here that in same period, the rupee also depreciated by almost 38 percent and economic activity became sluggish. In response to the economic conditions at that time, the conventional Taylor rule (1993) would have prescribed to set the interest rate at 35 percent. But in reality, it faced serious disapprovals and had to keep the interest rate at 15 percent.

5.2.2 Interest Rate and Output Gap

In case of Pakistan, output for most of its parts has persisted below the potential level regardless of higher than potential levels of employment. The real output growth ranged between 8.7 percent in 1980 and -0.1 percent in 1997. The macro management does not indicate a healthy performance and it is clear that a country cannot attain higher levels of income unless it has stable inflation with sustainable high growth, (e.g. Fischer)[12].

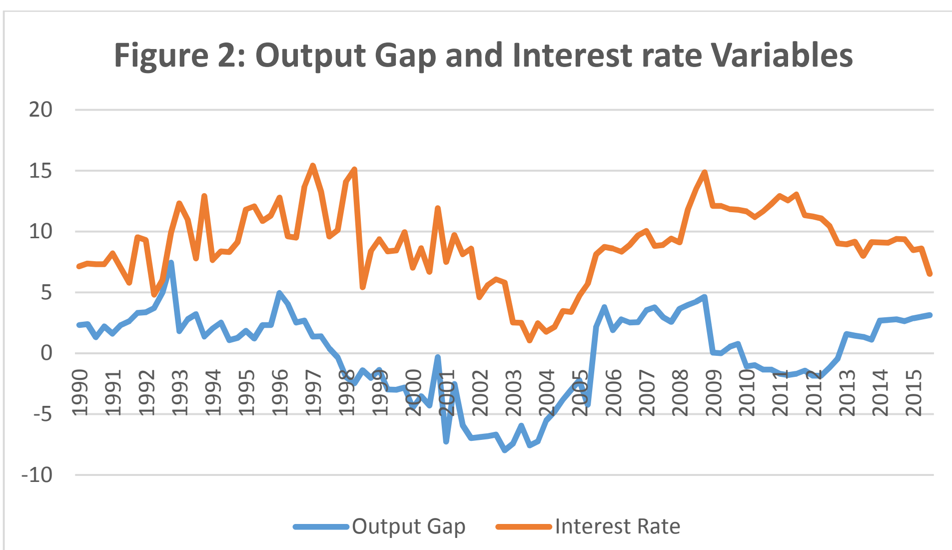


Figure 2: Output Gap and Interest rate Variables

Source: Author's calculations based on data from IFS (2015)

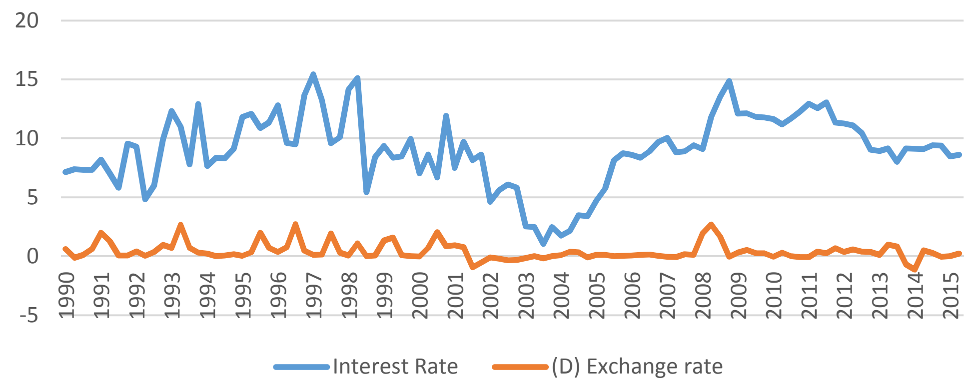
[12] Inflation variations causes uncertainty in the markets so the individuals can't take optimal decisions.

The figure 2 elaborates us that the output gap and interest rate are positively related. The interest rate has been adjusted in response to the output distortions. Where there is positive output gap, interest rate has been increased to confine the demand pressure and stabilize the inflation overshooting. In case of negative output gap, interest rate has been set at lower levels to promote the aggregate demand boosting factors. The positive relation between output gap and interest rate diminish after the year 2007-08 and the graph shows the opposite movement of both the variables. At that time the inflation rate was quite high so State Bank of Pakistan (SBP) had to prefer inflation stabilization over real stabilization.

5.2.3 Interest Rate and Exchange Rate

In case of Pakistan, the relationship between interest rate and exchange rate does not seem to be vivid. However, the Figure 3 shows that after the year 2007-08, the relationship is highly correlated. At that time, there was a tremendous depreciation of rupee against dollar. State Bank of Pakistan had to increase the interest rate up to 15 percent against the 38 percent depreciation of rupee versus dollar. The major motive behind this policy formulation was to discourage the capital outflow, even though SBP did not increased the interest rate up to Taylor rule proposed rate.

Figure 3: Exchange Rate and Interest Rate Variables



Source: Author's calculations based on data from IFS (2015)

5.3 Estimating the Linear Policy Reaction Function

One of our objective is to estimate the linear policy reaction function in order to check either static or dynamic version fits in case of Pakistan. We estimate four specifications of reaction function by using the Taylor rule approach.

i. Static version without exchange rate.

ii. Static version with exchange rate.

iii. Dynamic version with exchange rate.

iv. Dynamic version without exchange rate.

We have formulated the key result table of the four estimations- Table 5.1. In the first rule, the coefficient of output gap is significantly greater than 0 but less than 1. Similarly, the coefficient of inflation is also between 0 and 1. We cannot interpret these results as reliable as the Durbin-Watson value is very low, confirming the presence of strong positive autocorrelation. It indicates the symptom of missing variable in the rule i.e. lagged interest rate. Similarly low value of R^2 also indicates that results are not reliable.

In order to check how much weightage SBP puts on exchange rate management, we have incorporated difference of exchange rate in our static analysis as one of the independent variable to estimate the reaction function. Again the results are more or less the same. The coefficient of exchange rate appears to be very low. Moreover the low values of Durbin-Watson and R^2 indicate the inconsistency of results.

Table 5.1: Estimation results for linear monetary policy reaction function

	Rule 1	Rule 2	Rule 3	Rule 4
Constant	6.38 (0.00)	6.53 (0.00)	2.24 (0.001)	2.55 (0.002)
Inflation rate	0.29 (0.00)	0.22 (0.0008)	0.13 (0.01)	0.098 (0.05)
Output gap	0.20 (0.01)	0.21 (0.008)	0.12 (0.04)	0.13 (0.02)
Lagged interest rate			0.62 (0.00)	0.58 (0.00)
Exchange rate		0.32 (0.00)		0.21 (0.0007)
Adjusted R-squared	0.31	0.38	0.62	0.65
D-W statistics	0.70	0.71		
F- statistics	24.96 (0.00)	22.23 (0.00)	56.73 (0.00)	47.72 (0.00)
LM-Statistic			8.55 (0.013)	1.788 (0.40)

The sample period is 1990:01-2015:03. P-values are given in parenthesis.
Dependent variable: Interest rate
Source: Author's calculations.

Now we move to the dynamic version of policy reaction function, which considers the central bank's motive of interest rate soothing. This time R^2 show significant results. At the same time, however, we cannot reject the null hypothesis of no autocorrelation with a 95 percent degree of confidence. We use the LM statistic to test the presence of autocorrelation as the lagged dependent variable is one of the regressors. The policy response coefficient of inflation and output gap are still statistically different from 0. The high value of coefficient of lagged interest rate indicates that SBP does focus on interest rate smoothing.

Lastly, we estimate the fourth rule which is the dynamic version with difference of exchange rate factor on independent side. It is evident from table 5.1 that the results of rule 4 are robust. R^2 value is significantly high[13]. When we compare the coefficients of inflation and output gap, the results show that SBP puts more weightage on real stabilization rather than inflation stabilization. The lower value of inflation coefficient may be due to the abnormal behavior of price hike in 2008, when economy faced 38 percent depreciation of currency. The conventional Taylor rule proposed 35 percent interest rate in response to the 2008 price hike when inflation rate touched 25 percent but SBP kept the rate at 14 percent. Moreover, the results of dynamic analysis with difference of exchange rate confirms the exchange rate management and interest rate smoothing motive of SBP. We can conclude from the above results that the dynamic version of Taylor rule fits the Pakistani data well.

5.4 Estimating the Non-Linear Monetary Policy Reaction Function

In order to estimate the response of SBP to inflation and output disturbances, we use non-linear dynamic version of Tayler rule with real stabilization, price stability, exchange rate stability and interest rate smoothing as policy targets. SBP may have to respond differently against various economic scenarios. Big shocks of inflation may be aggressively responded by the public. Moreover, big output shock may result in high level of unemployment. So the

[13] The residual series of estimated equation of rule 4 are stationary at level.

following section estimates the response of SBP to big and small shocks of inflation and output.

5.4.1 Response Function to Inflationary Shocks

As mentioned already that high volatility in inflation creates an environment of instability in the market and individuals become reluctant to invest in such a scenario. Moreover, the amplified rate of inflation directly hits the public as their purchasing power decreases. In the developing country like Pakistan, inflation variations have been a major source of instability and the response of monetary authorities to these distortions is important to capture. The policy instrument i.e. short term interest rate is adjusted against inflation variations in case of Pakistan.

The estimation process is carried out twice. First we incorporated the inflationary shocks in order to estimate the response of SBP to big and small shocks of inflation. Specified estimable form in case of inflationary shocks can be written as:

$$i_t = \rho i_{t-1} + (1-\rho)\left(\beta_0 + \beta_1 y_t^* D_\pi + \beta_2 y_t^* (1 - D_\pi) + \beta_3 \pi_t^* D_\pi + \beta_4 \pi_t^* (1 - D_\pi) + \beta_5 (e_t - e_{t-1}) + \xi_t\right) \tag{5.1}$$

$y_t^* D_\pi$: Response coefficient of output to big shock of inflation

$y_t^* (1-D_\pi)$:Response coefficient of output to small shock of inflation

$\pi_t^* D_\pi$: Response coefficient of inflation to big shock of inflation

$\pi_t^* (1-D_\pi)$: Response coefficient of inflation to small shock of inflation

In table 5.2, the coefficient values of inflation against both big and small shocks of inflation are very low which means that SBP gives low weightage to inflation stability in case of both big and small shocks of inflation. However output coefficient shows that SBP weights real stabilization more against big shock of inflation as compared to small distortion in inflation. The four response coefficients of table 5.2 state that for SBP, the high priority target in case of inflationary shock is the real stabilization. Moreover it is clearly stated that SBP follows the motive of interest rate smoothing and exchange rate management.

Table 5.2: Estimation results in case of big and small shocks of Inflation

	RESPONSE COEFFICIENT		
	SHORT RUN		LONG RUN
	Value	P-Value	
CONSTANT	2.721599	(0.0004)	6.530343
$\pi_t{}^* D_\pi$	0.080404	(0.1537)	0.192898
$\pi_t{}^*(1-D_\pi)$	0.089141	(0.1952)	0.213889
$y_t{}^* D_\pi$	0.181717	(0.0541)	0.436021
$y_t{}^*(1-D_\pi)$	0.083842	(0.3289)	0.201175
LAGGED INTEREST RATE	0.583238	(0.0000)	
EXCHANGE RATE	0.217863	(0.0035)	0.522752
ADJUSTED R-SQUARED	0.646589		
D-W STATISTICS	2.127513		
F- STATISTICS	31.49281		

The sample period is 1990:01-2015:03. P-values are given in parenthesis.
Dependent variable: Interest rate
Source: Author's calculations.

To further elaborate the monetary response to big and small shocks of inflation in case of Pakistan, we use Wald test.

Testable Hypothesis

Hypothesis Nature	
Null hypothesis:	SBP does not differentiate between big and small shocks of inflation
Alternative Hypothesis	SBP does differentiate between big and small shocks of inflation

Table 5.3: Wald test in case of inflation shocks

	Small inflation shock=Big inflation shock			
	Against inflation		**Against output**	
	Value	**Probability**	**Value**	**Probability**
T-Statistics	-0.202282	0.8401	0.789833	0.4316
F-Statistics	0.040918	0.8401	0.623835	0.4316
Chi-Square	0.040918	0.8397	0.623835	0.4296

5.4.2 Selection Criteria

$$\text{P-Value} > 0.05$$

If the P-Value is greater than 0.05, we will accept the null hypothesis. In other case, we will reject it.

It is clearly reflected from table 5.3 that the P-value for both restrictions is greater than 0.05. So we accept the null hypothesis that SBP does not differentiate between the big and small shocks of inflation, the response function is same. We may elaborate it further as similar response of SBP to big and small shocks of inflation because it is easier for SBP to respond to small shocks as it requires little adjustment in policy instrument. So either the inflation shock is big or small, the response is same.

5.4.3 Response Function to Output Shocks

Distortions in output may directly affect the employment level in the economy. In case of boom when actual output is above potential, firms may demand higher number of labor. Resulting into labor demand being greater than labor supply. But this boom phase is not sustainable and economy has to face the negative reaction. Alternatively, when actual output is below potential, economy may face higher level of unemployment. Today many economic think tanks consider that decreasing unemployment should be highly prioritized target of policy makers.

In the second estimation process we incorporated the output shocks in order to estimate the response of SBP to big and small shocks of output. Specified estimable form can be written as:

$$i_t = \rho i_{t-1} + (1-\rho)\left(\beta_0 + \beta_1 y_t^* D_y + \beta_2 y_t^* (1-D_y) + \beta_3 \pi_t^* D_y + \beta_4 \pi_t^* (1-D_y) + \beta_5 (e_t - e_{t-1}) + \xi_t\right) \tag{5.2}$$

$y_t^* D_y$: Response coefficient of output to big shock of output

$y_t^*(1-D_y)$:Response coefficient of output to small shock of output

$\pi_t^* D_y$: Response coefficient of inflation to big shock of output

$\pi_t^*(1-D_y)$: Response coefficient of inflation to small shock of output

Table 5.4: Estimation results in case of big and small shocks of Output

	RESPONSE COEFFICIENT		
	SHORT RUN		LONG RUN
	Value	P-Value	
CONSTANT	3.366294	(0.0000)	6.886614
$\pi_t^* D_y$	0.026054	(0.6432)	0.0533
$\pi_t^*(1-D_y)$	0.121972	(0.0250)	0.249525
$y_t^* D_y$	0.237779	(0.0017)	0.486438
$y_t^*(1-D_y)$	-0.070752	(0.5078)	-0.14474
LAGGED INTEREST RATE	0.511183	(0.0000)	
EXCHANGE RATE	0.219901	(0.0025)	0.449864
ADJUSTED R-SQUARED	0.673350		
D-W STATISTICS	2.019827		
F- STATISTICS	35.35639		

The sample period is 1990:01-2015:03. P-values are given in parenthesis.
Dependent variable: Interest rate
Source: Author's calculations.

In case of output distortions, the response of SBP is counter cyclical as described from table 5.4. The response coefficients describe that SBP reacts more aggressively in case of output shocks. High value of coefficient of inflation to small shock of output shows that SBP gives more weightage to stabilizing small shocks.

The larger value of response coefficients of inflation to small shock of output describes that SBP responds more conveniently to small shock. The major reason behind this behavior is that it is easier for SBP to amend the policy instrument by low margin as compared to greater as a policy response to economic variations. But in case of big shocks, policy instrument might require adjustment by greater margin e.g. in 2008 benchmark Taylor rule prescribed short-term interest as high as 35 percent against inflation rate of 25 percent and currency depreciation of 38 percent. So it is rather more convenient for SBP to respond to small shocks.

Response coefficient of output to big shock of both inflation and output attains higher value advocating that SBP responds more seriously to big shocks of output and puts more weightage to real stabilization. SBP also make gradual changes in interest rate to stabilize the financial markets. Table 5.4 also indicates exchange rate management as key goal of SBP.

The responding behavior of SBP can be framed as pragmatic. The central banks have primary motive of stabilizing both inflation and output distortions. But the results show that SBP is keeping price stability as long run target, while minimizing the output distortions in the short run. Recent decision of monetary policy committee to decrease bench mark interest rate by 25 basis point to 5.75 percent describes the SBP's motive of promoting output despite continuous increment of inflation for 7 quarters. It means that it has sacrificed the long run target of price stability for shorter period to boost the output growth that may prove healthy for the economy.

We again use Wald test in case of big and small output shocks to clarify monetary response function to output shocks in case of Pakistan.

Testable Hypothesis

Hypothesis Nature	
Null hypothesis:	SBP does not differentiate big and small shocks of output
Alternative Hypothesis	SBP does differentiate big and small shocks of output

Table 5.5: Wald test in case of Output shocks

	Small output shock=Big output shock			
	Against inflation		**Against output**	
	Value	**Probability**	**Value**	**Probability**
T-Statistics	-2.252543	0.0266	2.311974	0.0230
F-Statistics	5.073951	0.0266	5.345225	0.0230
Chi-Square	5.073951	0.0243	5.345225	0.0208

5.4.4 Selection Criteria

$$P\text{-Value} > 0.05$$

If the P-Value is greater than 0.05, we will accept the null hypothesis. In other case, we will reject it.

It is clearly reflected from table 5.5 that the P-value for both restrictions is less than 0.05. So we reject the null hypothesis that SBP does not differentiate the big and small shocks of output. So the monetary authorities of Pakistan do differentiate between the big and small shocks but in output stabilization.

5.5 Estimating Basic Macroeconomic Model

The estimation results of our non-linear monetary policy model concludes that SBP responds more conveniently to small shocks of inflation as it is easier for SBP to change policy instrument by low margin. Both the big and small shocks of inflation are treated as same. The response coefficient of output illustrates the real stabilization behavior of SBP.

In this section we will estimate basic macroeconomic model. It consists of demand side IS equation and supply side Phillips curve equation. The residual series of both estimated equations will be used in simulation analysis.

5.5.1 Demand Side Equation

We specified the aggregate demand equation as:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 \left(i_{t-1} - \pi_{t-1}\right) + \xi_t \qquad (5.3)$$

Here, y_t is the output gap and independent side consists of lagged value of output gap whereas lagged value of real interest rate is denoted as $(i_{t-1} - \pi_{t-1})$.

Table 5.6: Estimated IS equation

Variable	**Coefficient**	**Probability**
OG(-1)	0.556335	0.0000
OG(-2)	0.351847	0.0003
IR(-1)-INF(-1)	0.08173	0.0487
Adjusted R-squared	0.817763	
D-W statistics	2.007074	

OG is described as output gap, INF as inflation and IR as interest rate.

Table 5.6 describes the estimation of IS equation for period of 1990Q1-2015Q3. The probabilities show that coefficients are significantly related to the output gap. Moreover, the values of Durbin Watson and R^2 represent significant results.

5.5.2 Supply Side Equation

We identified the Phillips curve equation as:

$$\pi_t = \pi_{t-1} + \phi y_{t-1} + \xi_t \tag{5.4}$$

π_t represents the inflation rate. Independent side consists of lagged value of inflation and lagged value of output gap. Two lags of independent variables are used to avoid autocorrelation.

Table 5.7: Estimated Phillips curve equation

Variable	**Coefficient**	**Probability**
INF(-1)	1.396941	0.0004
INF(-2)	-0.560709	0.0000
OG(-1)	0.100706	0.0000
Adjusted R-squared	0.889697	
D-W statistics	1.871698	

INF is described as inflation and OG as output gap.

Table 5.7 describes the estimation of Phillips curve equation for period of 1990Q1-2015Q3. The probabilities show that coefficients are significantly related to the inflation rate. Values of Durbin Watson and R^2 represent significant results.

5.6 Simulation Results

In order to carry out the estimation procedure of monetary policy rules, we have used both historical and stochastic simulation. Further we shall use bootstrapping which is computer based method for allocating the measures of accuracy to samples. It is generalized as resampling method. We found that only the coefficients of the lagged interest rate are consistent, which shows the consistent behavior of the monetary authorities toward the interest rate smoothing objective.

Taylor rule is specified as:

$$i_t = r^* + \pi_t + \alpha_y y_t + \alpha_\pi \left(\pi_t - \pi^*\right) \tag{5.5}$$

Equation specifies that short term interest rate is function of key policy variables like real GDP and inflation. Original Taylor rule incorporated targeted inflation rate of 2 percent and assigned equal weights of 0.5 to deviance of real GDP from its potential level and that of inflation from its target. The signs of both inflation and output should be positive.

We need to examine the performance of economy due to changes in reaction function for that we make historical simulation by allocating different weights to inflation and output. As we have done the estimation procedure twice separately for inflation shocks and output shocks, we will do the simulation analysis separately for both specifications.

We have done the historical simulations by assigning different weights to inflation and output variables. Targeted inflation is taken as 5 percent. Degree of interest rate smoothing is taken as 0.33 percent.

Table 5.8: Rules with degree of interest rate smoothing 0.33 and targeted inflation as 5%

Rule No.	Weights assigned and policy rules	Rule No.	Weights assigned and policy rules
1	$r=2$, $\pi^*=5\%$, $\alpha_y = 0.5$, $\alpha_\pi = 0.5$ (big shocks) $i_t = -0.5 + 0.5y + 1.5\pi$	10	$r=2$, $\pi^*=5\%$, $\rho = 0.33$ $\alpha_y = 0$, $\alpha_\pi = 1$ (big shocks) $i_t = 0.33*(i_{t-1}) + (1-0.33)(-3 + 2\pi)$
2	$r=2$, $\pi^*=5\%$, $\alpha_y = 0.5$, $\alpha_\pi = 0.5$ (small shocks) $i_t = -0.5 + 0.5y + 1.5\pi$	11	$r=2$, $\pi^*=5\%$, $\rho = 0.33$ $\alpha_y = 0$, $\alpha_\pi = 1$ (small shocks) $i_t = 0.33*(i_{t-1}) + (1-0.33)(-3 + 2\pi)$
3	$r=2$, $\pi^*=5\%$, $\alpha_y = 1$, $\alpha_\pi = 0$ (big shocks) $i_t = 2 + y + \pi$	12	$r=2$, $\pi^*=5\%$, $\rho = 0.33$ $\alpha_y = 0.5$, $\alpha_\pi = 0.5$ small shocks), $\alpha_y = 1$, $\alpha_\pi = 0$ (big shocks)
4	$r=2$, $\pi^*=5\%$, $\alpha_y = 1$, $\alpha_\pi = 0$ (small shocks) $i_t = 2 + y + \pi$	13	$r=2$, $\pi^*=5\%$, $\rho = 0.33$ $\alpha_y = 0.5$, $\alpha_\pi = 0.5$ (big shocks), $\alpha_y = 1$, $\alpha_\pi = 0$ (small shocks)
5	$r=2$, $\pi^*=5\%$, $\alpha_y = 0$, $\alpha_\pi = 1$ (big shocks) $i_t = -3 + 2\pi$	14	$\rho = 0.33$ $\alpha_y = 0.5$, $\alpha_\pi = 0.5$ (small shocks), $\alpha_y = 0$, $\alpha_\pi = 1$ (big shocks)
6	$r=2$, $\pi^*=5\%$, $\alpha_y = 0$, $\alpha_\pi = 1$ (small shocks) $i_t = -3 + 2\pi$	15	$\rho = 0.33$ $\alpha_y = 0.5$, $\alpha_\pi = 0.5$ (big shocks), $\alpha_y = 0$, $\alpha_\pi = 1$ (small shocks)
7	$r=2$, $\pi^*=5\%$, $\rho = 0.33$, $\alpha_y = 0.5$, $\alpha_\pi = 0.5$ (big shocks), $i_t = 0.33*(i_{t-1}) + (1-0.33)(-0.5 + 0.5y + 1.5\pi)$	16	$\rho = 0.33$ $\alpha_y = 0.5$, $\alpha_\pi = 0.5$ (small shocks), $\alpha_y = 0$, $\alpha_\pi = 0$ (big shocks)
8	$r=2$, $\pi^*=5\%$, $\rho = 0.33$, $\alpha_y = 1$, $\alpha_\pi = 0$ (big shocks) $i_t = 0.33*(i_{t-1}) + (1-0.33)(2 + y + \pi)$	17	$\rho = 0.33$ $\alpha_y = 0.5$, $\alpha_\pi = 0.5$ (big shocks), $\alpha_y = 0$, $\alpha_\pi = 0$ (small shocks)
9	$r=2$, $\pi^*=5\%$, $\rho = 0.33$, $\alpha_y = 1$, $\alpha_\pi = 0$ (small shocks) $i_t = 0.33*(i_{t-1}) + (1-0.33)(2 + y + \pi)$		

In table 5.8, rule 1 to 6 are demonstrated as linear Taylor rules while rule 7 to 17 represent non-linear rule function where we differentiated big and small shocks and assigned various weights to them. Here, r is real interest rate, π^* in targeted inflation rate, ρ is degree of interest rate smoothing, α_y is the weight assigned to output stabilization while α_π is the weight assigned to inflation stabilization.

Here interest rate smoothing is used as independent variable. We have used 17 rules by giving different weights to the parameters of the output and inflation. Rule no. 1 to 6 represent linear cases of Taylor rule. Standard Taylor rule was used in the first 2 rules with different weights of output and inflation. Rule 3 and 4 represent the monetary policy stance of real stabilization. First we have assigned these weights to big shocks then in rule 4 we have assigned these weights to small shocks and estimated the response. Similarly, rule 5 and rule 6 are interpreted as the monetary policy stance of inflation targeting. In Rule 5, higher weight is allotted to big shock while in rule 6 more weight is given to small shock. Rule 7 to 17 represent the non-linear cases of Taylor rule. In this nonlinear section, we have differentiated big and small shocks by giving different weights. In Rule 12, 14 and 16, small shocks are allotted equal weights and big shocks weights are varied. Similarly in Rule 13, 15 and 17, big shocks are allotted equal weights while small shocks weights are varied.

In our simulation analysis we shall compare the best policy rule from our non-linear (rule 7 to rule 17) cases with minimum standard deviation and minimum loss function.

5.6.1 Historical Simulation

This section examines the effect of various monetary policy rules on the economy. The low variability of key variables i.e. inflation and output gap represents the optimal policy rules. One rule may be better than other if it leads to better economic performances. The results show that the variability of inflation and output was different with different policy rules. In our analysis, we use inflation targeting at π^*=5% and r=2. The reason behind selecting this level of inflation targeting is that it is generally used in literature[14]. Assigning different weights to variables gives us different monetary policy responses.

Table 5.9: Standard deviation when targeted inflation is 5% in case of output shocks

Rule	σ_i	σ_y	σ_π
Actual	3.059702	3.509208613	4.432284
Rule 1	12.7158	4.083475	**3.586487**
Rule 2	14.81337	8.031828	7.444173
Rule 3	10.76853	**3.819444**	4.093944
Rule 4	10.68621	6.621889	6.47587
Rule 5	7.999592	4.632477	4.046678
Rule 6	9.810072	5.198518	5.823728
Rule 7	6.853127	3.467371	3.80161
Rule 8	5.7415	3.355067	4.022832
Rule 9	5.492814	3.471929	4.679023
Rule 10	8.395274	3.779627	**3.646787**
Rule 11	9.595288	4.50453	5.459196
Rule 12	8.191182	4.14345	5.046957
Rule 13	6.755	**3.192484**	4.272675
Rule 14	7.632381	4.547157	4.807997
Rule 15	9.012228	5.278451	5.526077
Rule 16	6.32919	3.703564	4.755697
Rule 17	6.47636	3.205587	4.282662

Here, σ_i is the standard deviation of interest rate, σ_y is the standard deviation of output gap while σ_π is the standard deviation of inflation.

The decision of the best policy depends on the standard deviation of the output gap and inflation rate. In case of linear Taylor rules (Rule 1 to 6), Rule 1 shows minimum standard deviation in case of inflation. In this case SBP puts equal weights to inflation and output stabilization. While the minimum standard deviation in output in linear rule cases is depicted in rule 3 where monetary authorities respond to big shock of inflation aggressively.

[14] Moreover in case of Pakistan, the monetary authorities avoid reaching the double digit rate of inflation. So 5% is taken as a mean value.

In our analysis of historical simulation for output shocks, table 5.9 depicts that the minimum standard deviation in inflation for non-linear cases (Rule 7 to 17) is shown by Rule 10 which is 3.64 while the best response of output is represented by Rule 13. In Rule 10, all weight is given to the big shock of inflation. Minimizing the inflationary atmosphere would strengthen the financial markets and investment will be promoted leading to higher growth level. While in Rule 3, the motive is the stabilization of big shocks of output.

Table 5.10: Standard deviation when targeted inflation is 5% in case of inflation shocks

Rule	σ_i	σ_y	σ_π
Actual	3.059702	3.509208613	4.432284
Rule 1	15.93422	5.54413	**5.067078**
Rule 2	15.25677	9.222871	7.867999
Rule 3	12.55185	**4.971562**	5.095197
Rule 4	12.08446	8.410052	7.236196
Rule 5	20.19033	6.534694	5.268961
Rule 6	18.95855	10.20228	8.556098
Rule 7	7.635053	3.859346	**4.323792**
Rule 8	5.941977	3.586302	4.354372
Rule 9	5.466356	3.417329	4.512651
Rule 10	9.665654	4.224128	4.334426
Rule 11	8.5809	3.60693	4.876376
Rule 12	7.720563	3.818997	4.884391
Rule 13	7.301976	3.54519	4.522078
Rule 14	8.290304	4.765972	5.019148
Rule 15	8.43772	5.058432	5.388747
Rule 16	5.955344	3.666764	4.693216
Rule 17	6.886296	**3.353823**	4.459611

Table 5.10 of historical simulation represents that best policy response with minimum standard deviation of inflation (in case of linear Taylor rule) is rule 1 where we assigned equal weights to big shocks while small shocks are given zero weight. It clearly states that SBP responding the big shocks of inflation and output would result in minimum variance of inflation and output. The output standard deviation for rule 3 turns out to be 4.97 which is

minimum of all linear cases (rule 1 to rule 6). In case of rule 3, monetary authorities target to stabilize big output distortions.

In non-linear cases (Rule 7 to 17), best policy response is explained by rule 7 which has minimum variance in inflation. Even though Rule 17 has minimum variance in output, this rule has higher variance of inflation. In rule 7, big shocks of inflation and output are given equal weights.

5.6.2 Bootstrap Simulation

In this section, we will apply bootstrap simulation on all previously explained Taylor rule specifications. We will select the best policy rule among all 17 rules based on minimum variability of both inflation an output. Moreover our decision criteria for best rule are based on minimum loss to the society. In order to verify the results of historical simulations, we have used bootstrap simulations and estimated the variances of inflation and output 1000 times. We need to identify if optimal rule in case of historical simulation would perform well in various other shocks. The result show that variability of inflation and output is different as compared to actual values.

5.6.2.1 Case for Output Shocks

On the basis of table 5.11 in response to output shocks, we found minimum loss to society in case of Rule 9. In this rule, the optimal monetary policy is to respond only to small shocks.

Rule 9: Real Stabilization: Small shock response:

		Actual	Historical	Stochastic
Interest rate	Average	9.042277	9.179137	
	Standard deviation	3.059702	5.492814	
Output gap	Average	-0.044336443	-0.17669	2.902372
	Standard deviation	3.509208613	3.471929	3.84107
Inflation	Average	8.959992	8.887042	10.56774
	Standard deviation	4.432284	4.679023	3.930033

5.6.2.2 Case of Inflation Shocks

On the basis of table 5.11 in response to inflation shocks, we found minimum loss to society again in case of Rule 9.

Rule 9: Real Stabilization: small shock response:

		Actual	Historical	Stochastic
Interest rate	Average	9.042277	9.15879	
	Standard deviation	3.059702	5.466356	
Output gap	Average	-0.044336443	-0.57792	-2.91082
	Standard deviation	3.509208613	3.417329	5.192519
Inflation	Average	8.959992	8.628154	6.295381
	Standard deviation	4.432284	4.512651	4.955659

5.7 Loss Function

In this section, we select the optimal rule on the basis of minimum loss to the society. We estimated the loss function described in chapter 4. Loss to the society criteria is the best selection criteria for optimal monetary policy rule.

Table 5.11: Loss function

	Inflation shock		Output shock	
Rules	**Historical**	**Stochastic**	**Historical**	**Stochastic**
1	28.20633	35.249	14.76883	24.438
2	73.48338	72.444	59.96298	57.617
3	25.33873	31.324	15.67426	23.067
4	61.54576	59.346	42.89315	41.216
5	35.23209	42.997	18.91772	26.278
6	88.64662	88.195	30.4702	30.988
7	16.79486	21.730	**13.23745**	19.081
8	15.91106	20.687	13.71982	18.704
9	16.02108	**17.751**	16.97377	**18.539**
10	18.31525	22.801	13.79232	20.330
11	18.39449	21.146	25.04681	26.096
12	19.22101	24.364	21.31997	26.107
13	16.50878	21.392	14.22385	19.728
14	23.95317	28.006	21.89674	26.496
15	27.31317	31.685	29.19978	33.572
16	17.73572	20.872	18.16652	21.521
17	**15.56813**	19.962	14.30849	19.133

Actual loss to the society is 15.97

In case of central banks approach to minimize the society's loss, rule 9 has the minimum loss value against both inflationary shocks and output shocks. Real stabilization approach for small shocks is opted here while big shocks are weighted zero.

Historical simulation showed rule 17 to have minimum loss to the society in case of inflation shocks. But that was just confined to our data series. It means that this rule may not have performed well in all scenarios as loss has increased to 19.962. Similarly, minimum loss to society in case of output shocks is depicted in rule 7 by historical simulations which also might not have performed well in other distortionary scenarios.

Out of all these rules, Rule 9 is the optimal rule in response to both inflation and output shocks. This rule may have performed comparatively well in case of other shocks as loss to the society is low as compared to all other values. SBP optimal response against big and small shocks is to tackle the small distortions of inflation and output because it is convenient for SBP to respond to the small shocks. e.g. in 2008 benchmark Taylor rule prescribed short-term interest as high as 35 percent against inflation rate of 25 percent and currency depreciation of 38 percent. So it is rather more convenient for SBP to respond to small shocks.

Responding the small distortions in vital macroeconomic variables would result into their long term stability, resulting into stable economic growth. Stabilizing the small shocks of inflation and output would minimize the vulnerability of economy to face big shock.

Hence, it is not a pragmatic approach to change policy instrument by larger margin. So SBP response should be inclined towards small shocks.

Furthermore, there are many reasons for why SBP should respond only to small shocks. Primarily we may consider the zero interest rate policy (ZIRP) concept. In this concept the central bank maintain 0% nominal interest rate. This is the maximum extent to which central bank may go to drive growth. We have empirical evidence of ZIRP in case of Japan and US and several European countries. In 2008 financial crises year, FED took the unconventional step to lower interest rate. Taylor rule proposed decreasing interest rate against lower levels of output. The idea is to promote economic growth. But these ultimate unconventional methods are not providing expected outcome. We conclude that widely used monetary policy instrument (interest rate) has become ineffective to tackle the big shocks. The effectiveness of interest rate has been confined to block the small shocks.

Another reason that why SBP should respond only to small shocks is the sensitivity of interest rate as policy instrument. Interest rate stability is a very important pre-requisite for the stability of financial markets and promotion of economic growth. In case of a big shock, the policy instrument may require adjustment by large margin[15], which may not prove in favor of the economy. If SBP responds big shocks aggressively via adjusting the interest rate by substantial margin then instead of cooling down the shock effect, many other problems may arise in the economy. Amplified rates of interest against high inflation level may be aggressively reacted upon by public as their borrowing cost increases and an environment of low investment (leading lower levels of growth) may be created.

Lastly, we can elaborate this optimal monetary response (rule 9) in terms of shock time period. It is evident from past experience that big shocks lasts comparatively for smaller time period but carry large impact. So if monetary authorities take an instant decision against the big shock then in next time period the economy may face further recessionary phase. In case of Pakistan (2008), inflation touched unstable high level of 25% but just after two quarters, it narrowed down to 10%. If SBP had belligerently reacted at that time, we may have encountered other economic instabilities.

SBP was reluctant to raise the level of interest rates in 2003-04 in order to tighten the liquidity in economy and decrease demand pressure. As interest rates were at record low levels, government borrowed heavily from SBP in order to finance its expenses and maturing loans. As of 25th June 2005, government's total borrowed money from SBP stood at Rs. 154.55 billion. This explains the confined behavior of SBP to change the policy instrument in response to economic conditions.

[15] In 2008, inflation reached 25% and conventional Taylor rule proposed short term interest rate as high as 35 percent- changing interest rate by substantial margin.

Chapter 6

CONCLUSION

State bank of Pakistan responds more conveniently to small shock of inflation. The major reason behind this behavior is that it is easier for SBP to amend the policy instrument by low margin as compared to greater as a policy response to economic variations. But in case of big shocks, policy instrument might require adjustment by greater margin.

Response coefficient of output to big shock of both inflation and output attains higher value advocating that SBP responds more seriously to big shocks of output and puts more weightage to real stabilization. SBP also make gradual changes in interest rate to stabilize the financial markets.

The responding behavior of SBP can be framed as pragmatic. The central authorities have primary motive of stabilizing both inflation and output distortions. But the result show that SBP is keeping price stability as long run target, while minimizing the output distortions in short run.

Moreover the estimation of optimal monetary policy indicates that rule 9 has the minimum loss value against both inflationary shocks and output shocks. This rule may have performed comparatively well in case of other shocks as loss to the society is low as compared to all other values. This rule advocates that SBP should respond to the small shocks and put zero weightage to stabilize the big shocks. SBP should respond to the small distortions of business cycle so that the economy remains on the optimal growth path. Stabilizing the small shocks of inflation and output would minimize the vulnerability of economy to face big shock.

From the above arguments, we may also conclude that the monetary policy rules perform optimal against small shocks. Moreover worldwide eminent economists also have settled on fact that monetary policy rules are only optimal for small shocks. On a general note, assigning zero weights in rule 9 does not states that big shocks should not be responded. But actually the need of the hour is to establish some other monetary policy approach that may perform well even in case of big shocks.

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Appendix

Simulation Results in case of Output Shocks

			Actual	Historical	Stochastic
Rule 1	**Interest rate**	Average	9.042277	6.09635	

		Standard deviation	3.059702	12.7158	
	Output gap	Average	-0.044336443	3.347709	11.722
		Standard deviation	3.509208613	4.083475	3.719125
	Inflation	Average	8.959992	10.93865	17.78525
		Standard deviation	4.432284	3.586487	4.017201
Rule 2	**Interest rate**	Average	9.042277	21.85111	
		Standard deviation	3.059702	14.81337	
	Output gap	Average	-0.044336443	-16.1553	-14.6771
		Standard deviation	3.509208613	8.031828	8.721702
	Inflation	Average	8.959992	-0.51565	0.180529
		Standard deviation	4.432284	7.444173	6.276219
Rule 3	**Interest rate**	Average	9.042277	8.464561	
		Standard deviation	3.059702	10.76853	
	Output gap	Average	-0.044336443	0.557573	-1.30004
		Standard deviation	3.509208613	3.819444	6.345175
	Inflation	Average	8.959992	9.30641	7.866086
		Standard deviation	4.432284	4.093944	5.259845
Rule 4	**Interest rate**	Average	9.042277	20.46198	
		Standard deviation	3.059702	10.68621	
	Output gap	Average	-0.044336443	-14.5902	-12.2147
		Standard deviation	3.509208613	6.621889	7.10595
	Inflation	Average	8.959992	0.383588	1.614153
		Standard deviation	4.432284	6.47587	6.046709
Rule 5	**Interest rate**	Average	9.042277	-1.40634	
		Standard deviation	3.059702	7.999592	
	Output gap	Average	-0.044336443	13.14984	13.74347
		Standard deviation	3.509208613	4.632477	5.968788
	Inflation	Average	8.959992	16.73662	17.28773
		Standard deviation	4.432284	4.046678	5.001401
Rule 6	**Interest rate**	Average	9.042277	8.349704	
		Standard deviation	3.059702	9.810072	
	Output gap	Average	-0.044336443	1.220771	1.194321
		Standard deviation	3.509208613	5.198518	5.088286
	Inflation	Average	8.959992	9.743725	8.804774
		Standard deviation	4.432284	5.823728	4.241043
Rule 7	**Interest rate**	Average	9.042277	2.711376	
		Standard deviation	3.059702	6.853127	
	Output gap	Average	-0.044336443	7.91219	7.35065
		Standard deviation	3.509208613	3.467371	4.434722
	Inflation	Average	8.959992	13.64628	13.98474
		Standard deviation	4.432284	3.80161	4.649734
Rule 8	**Interest rate**	Average	9.042277	3.78528	
		Standard deviation	3.059702	5.7415	
	Output gap	Average	-0.044336443	6.652018	9.538141
		Standard deviation	3.509208613	3.355067	4.600818
	Inflation	Average	8.959992	12.90951	15.60344
		Standard deviation	4.432284	4.022832	3.492075
Rule 9	**Interest rate**	Average	9.042277	9.179137	
		Standard deviation	3.059702	5.492814	
	Output gap	Average	-0.044336443	-0.17669	2.902372
		Standard deviation	3.509208613	3.471929	3.84107

	Inflation	Average	8.959992	8.887042	10.56774
		Standard deviation	4.432284	4.679023	3.930033
Rule 10	**Interest rate**	Average	9.042277	1.637472	
		Standard deviation	3.059702	8.395274	
	Output gap	Average	-0.044336443	8.395274	10.2367
		Standard deviation	3.509208613	3.779627	3.072787
	Inflation	Average	8.959992	14.38306	15.59659
		Standard deviation	4.432284	3.646787	3.446576
Rule 11	**Interest rate**	Average	9.042277	10.38453	
		Standard deviation	3.059702	9.595288	
	Output gap	Average	-0.044336443	-1.59617	2.085245
		Standard deviation	3.509208613	4.50453	5.856721
	Inflation	Average	8.959992	8.067433	11.12845
		Standard deviation	4.432284	5.459196	5.467833
Rule 12	**Interest rate**	Average	9.042277	11.52999	
		Standard deviation	3.059702	8.191182	
	Output gap	Average	-0.044336443	-.20606	2.047282
		Standard deviation	3.509208613	4.14345	7.502549
	Inflation	Average	8.959992	7.103796	10.44968
		Standard deviation	4.432284	5.046957	6.061366
Rule 13	**Interest rate**	Average	9.042277	9.853388	
		Standard deviation	3.059702	6.755	
	Output gap	Average	-0.044336443	-1.23615	-0.11064
		Standard deviation	3.509208613	3.192484	4.34922
	Inflation	Average	8.959992	8.250376	9.221063
		Standard deviation	4.432284	4.272675	4.346706
Rule 14	**Interest rate**	Average	9.042277	14.3578	
		Standard deviation	3.059702	7.632381	
	Output gap	Average	-0.044336443	-7.19532	-6.4139
		Standard deviation	3.509208613	4.547157	6.586834
	Inflation	Average	8.959992	4.725138	3.341574
		Standard deviation	4.432284	4.807997	5.689472
Rule 15	**Interest rate**	Average	9.042277	16.0344	
		Standard deviation	3.059702	9.012228	
	Output gap	Average	-0.044336443	-9.16523	-11.1313
		Standard deviation	3.509208613	5.278451	6.432847
	Inflation	Average	8.959992	3.578559	0.538823
		Standard deviation	4.432284	5.526077	6.017798
Rule 16	**Interest rate**	Average	9.042277	12.06982	
		Standard deviation	3.059702	6.32919	
	Output gap	Average	-0.044336443	-4.04087	-7.30128
		Standard deviation	3.509208613	3.703564	4.824475
	Inflation	Average	8.959992	6.601188	3.091292
		Standard deviation	4.432284	4.755697	5.17787
Rule 17	**Interest rate**	Average	9.042277	9.372887	
		Standard deviation	3.059702	6.47636	

	Output gap	Average	-0.044336443	-0.62652	0.296163
		Standard deviation	3.509208613	3.205587	2.754449
	Inflation	Average	8.959992	8.612422	8.993399
		Standard deviation	4.432284	4.282662	4.706836

Simulation Results in case of Inflation Shocks

			Actual	**Historical**	**Stochastic**
Rule 1	**Interest rate**	Average	9.042277	7.696357	
		Standard deviation	3.059702	15.93422	
	Output gap	Average	-0.044336443	2.33305	4.366843
		Standard deviation	3.509208613	5.54413	4.170683
	Inflation	Average	8.959992	10.40382	11.86943
		Standard deviation	4.432284	5.067078	3.639108
Rule 2	**Interest rate**	Average	9.042277	25.35519	
		Standard deviation	3.059702	15.25677	
	Output gap	Average	-0.044336443	-21.6098	-17.8435
		Standard deviation	3.509208613	9.222871	9.207509
	Inflation	Average	8.959992	-3.78861	-0.19148
		Standard deviation	4.432284	7.867999	5.790899
Rule 3	**Interest rate**	Average	9.042277	9.990267	
		Standard deviation	3.059702	12.55185	
	Output gap	Average	-0.044336443	-0.45803	0.280331
		Standard deviation	3.509208613	4.971562	6.253836
	Inflation	Average	8.959992	8.762518	8.600103
		Standard deviation	4.432284	5.095197	6.057027
Rule 4	**Interest rate**	Average	9.042277	24.17573	
		Standard deviation	3.059702	12.08446	
	Output gap	Average	-0.044336443	-20.2629	-17.5537
		Standard deviation	3.509208613	8.410052	8.076965
	Inflation	Average	8.959992	-3.0144	-1.53546
		Standard deviation	4.432284	7.236196	6.384696
Rule 5	**Interest rate**	Average	9.042277	5.402447	
		Standard deviation	3.059702	20.19033	
	Output gap	Average	-0.044336443	5.124135	5.952275
		Standard deviation	3.509208613	6.534694	6.011943
	Inflation	Average	8.959992	12.04513	11.24938
		Standard deviation	4.432284	5.268961	4.228127
Rule 6	**Interest rate**	Average	9.042277	26.53466	
		Standard deviation	3.059702	18.95855	
	Output gap	Average	-0.044336443	-22.9566	-17.2568
		Standard deviation	3.509208613	10.20228	9.119291
	Inflation	Average	8.959992	-4.56283	-2.18841
		Standard deviation	4.432284	8.556098	6.650194
Rule 7	**Interest rate**	Average	9.042277	2.924296	
		Standard deviation	3.059702	7.635053	
	Output gap	Average	-0.044336443	8.060749	6.650194
		Standard deviation	3.509208613	3.859346	5.959205
	Inflation	Average	8.959992	13.75922	16.60134
		Standard deviation	4.432284	4.323792	4.558369
Rule 8	**Interest rate**	Average	9.042277	3.819676	

		Standard deviation	3.059702	5.941977	
	Output gap	Average	-0.044336443	6.989128	8.915762
		Standard deviation	3.509208613	3.586302	4.452405
	Inflation	Average	8.959992	13.13023	14.27714
		Standard deviation	4.432284	4.354372	4.175039
Rule 9	**Interest rate**	Average	9.042277	9.15879	
		Standard deviation	3.059702	5.466356	
	Output gap	Average	-0.044336443	-0.57792	-2.91082
		Standard deviation	3.509208613	3.417329	5.192519
	Inflation	Average	8.959992	8.628154	6.295381
		Standard deviation	4.432284	4.512651	4.955659
Rule 10	**Interest rate**	Average	9.042277	2.028915	
		Standard deviation	3.059702	9.665654	
	Output gap	Average	-0.044336443	9.132371	10.30112
		Standard deviation	3.509208613	4.224128	4.864913
	Inflation	Average	8.959992	14.38821	14.53898
		Standard deviation	4.432284	4.334426	4.763536
Rule 11	**Interest rate**	Average	9.042277	10.00714	
		Standard deviation	3.059702	8.5809	
	Output gap	Average	-0.044336443	-1.6203	-0.00997
		Standard deviation	3.509208613	3.60693	4.252927
	Inflation	Average	8.959992	8.024107	8.336221
		Standard deviation	4.432284	4.876376	4.520665
Rule 12	**Interest rate**	Average	9.042277	11.35849	
		Standard deviation	3.059702	7.720563	
	Output gap	Average	-0.044336443	-3.04957	-2.28555
		Standard deviation	3.509208613	3.818997	3.979801
	Inflation	Average	8.959992	7.192492	7.097959
		Standard deviation	4.432284	4.884391	3.705133
Rule 13	**Interest rate**	Average	9.042277	10.03894	
		Standard deviation	3.059702	7.301976	
	Output gap	Average	-0.044336443	-1.45676	0.301707
		Standard deviation	3.509208613	3.54519	4.326254
	Inflation	Average	8.959992	8.123509	8.747453
		Standard deviation	4.432284	4.522078	2.843042
Rule 14	**Interest rate**	Average	9.042277	14.54335	
		Standard deviation	3.059702	8.290304	
	Output gap	Average	-0.044336443	-7.41593	-7.33865
		Standard deviation	3.509208613	4.765972	3.336352
	Inflation	Average	8.959992	4.598272	4.302754
		Standard deviation	4.432284	5.019148	4.103509
Rule 15	**Interest rate**	Average	9.042277	15.8629	
		Standard deviation	3.059702	8.43772	
	Output gap	Average	-0.044336443	-9.00874	-9.55753
		Standard deviation	3.509208613	5.058432	5.857326
	Inflation	Average	8.959992	3.667254	3.858898
		Standard deviation	4.432284	5.388747	4.614514
Rule 16	**Interest rate**	Average	9.042277	12.06316	
		Standard deviation	3.059702	5.955344	
	Output gap	Average	-0.044336443	-4.25752	-9.04738
		Standard deviation	3.509208613	3.666764	5.630752
	Inflation	Average	8.959992	6.462201	2.90174
		Standard deviation	4.432284	4.693216	4.152703
Rule 17	**Interest rate**	Average	9.042277	9.393598	
		Standard deviation	3.059702	6.886296	

	Output gap	Average	-0.044336443	-0.474	-0.3424
		Standard deviation	3.509208613	3.353823	5.084171
	Inflation	Average	8.959992	8.713238	8.694985
		Standard deviation	4.432284	4.459611	5.606537