PhD Dissertation

Tracking the Dynamics of Interaction between Fiscal and Monetary Policy in Pakistan

BY

MUHAMMAD SHAHID
02/PhD/PIDE/2004
PhD Student

Supervisor
Dr. ABDUL QAYYUM

Co-Supervisor
Dr. Wasim Shahid Malik

Submitted to Pakistan Institute of Development Economics,
For the partial fulfillment of Degree of Philosophy in Economics

Pakistan Institute of Development Economics
Islamabad, Pakistan

2017

Pakistan Institute of Development Economics

CERTIFICATE

This is to certify that this thesis entitled: "Tracking the Dynamics of Interaction between Fiscal and Monetary Policy in Pakistan" submitted by Mr. Muhammad Shahid is accepted in its present form by the Department of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree of **Doctor of Philosophy in Economics.**

External Examiner:

Dr. Muhammad Arshad Khan
Associate Professor
COMSATS University
Islamabad

Supervisor:

Dr. Abdul Qayyum
Joint Director
PIDE, Islamabad

Co-Supervisor:

Dr. Wasim Shahid Malik
Associate Professor
Quaid-i-Azam University
Islamabad

Head, Department of Economics:

Dr. Attiya. Y. Javed
Head
Department of Economics
PIDE, Islamabad.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

ACP	Annual Credit Plan
AD	Aggregate Demand
ADF	Augmented Dickey Fuller (Test)
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributive Lag
BD	Budget Deficit
CUSUM	Cumulative Sum
DPCO	Debt Policy Coordination Office
DR	Discount Rate
DSGE	Dynamic Stochastic General Equilibrium Model
ECM	Error Correction Mechanism
FDI	Foreign Direct Investment
FI	Financial Institutions
FMPCB	Fiscal Monetary Policy Coordination Board
FP	Fiscal Policy
FRDL	Fiscal Responsibility & Debt Limitation Act
FY	Fiscal Year
GDP	Gross Domestic Product
IFS	International Financial Statistics
IMF	International Monetary Fund
MMR	Money Market Rate
MP	Monetary Policy
NBFI	Non Banking Financial Institutions
OMO	Open Market Operation
PIB	Pakistan Investment Bonds
PP	Phillips Perron (Test)
Repo	Repurchase Agreement
RSET	Regression Equation Specification Error Test
SBP	State Bank of Pakistan
SBC	Swartz Bayesian Criterion
SILIC	Severely Indebted Low Income Countries
T-Bill	Treasury Bill
WB	World Bank

Dedicated to my Loving Parents, Family, Wife and Son

ACKNOWELDGMENT

I would like to thank my supervisor Dr. Abdul Qayyum, Professor at Pakistan Institute of Development Economics (PIDE), Islamabad and Co-Supervisor Dr. Wasim Shahid Malik, Assistant Professor at Quaid-i-Azam University, Islamabad, Pakistan. They have been kind enough and without their support and guidance, this PhD thesis would never have been completed. Dr. Qayyum made time for innumerable discussions and offered critical observations on the breadth and depth of economics in general and econometrics in particular. Dr. Wasim Shahid Malik provided wise guidance and assistance, deep insights, and thoughtful considerations into the vagaries and intricacies of my dissertation research and key insights into empirical approaches that enhanced the empirical quality of this thesis. Without his help and wise guidance I might still be navigating blindly the ocean of opportunities available for relevant and interesting research. Special thanks to all my teachers in PIDE for excellent teaching, advice and assistance which inspired and pushed me beyond my imagined capabilities. I also pay my gratitude to the members of my dissertation committee. Mentioned to worth, I am grateful and highly indebted to Adnan Haider for his much needed cooperation and constant encouragement. He has the excellent command over DSGE modeling in Pakistan. My parents, brothers and sisters and wife have provided me unconditional love and support and I truly appreciate all what they had done for me. I also want to express the highest level of gratitude for all my friends including Muhammad Javid, Tayyab, Rehmat, as well as my roommates Asif, Raheel, Mukhtar and Tasneem. Additional thanks to Hassan Tariq Butt, Arif Ullah and Wajid for the moral support and constant encouragement. With great love, I want to thank my wife, Seema. She has endured as much as I have, and she rarely complained. I would have been unable to finish this endeavor without her support and patience.

ABSTRACT

Politicians, policy makers and economic managers want to spur economic growth, bring economic stability and to create jobs. Economic growth is not only affected by macroeconomic policies but it is also prone to various types of shocks. Appropriate and timely policy response can at least minimize, if not completely escaped, the distortions and loses associated with shocks. Optimization of economic growth and its sustainability demands the execution of good macroeconomic policies in general and fiscal and monetary policy in particular. Some time fiscal policy seems to be more effective while the environment is more favorable for monetary policy in other times. We also know that both fiscal and monetary policy have different objective with different policy instruments. The macroeconomic situation of Pakistan's is very depressing and the situation demands stark assessment of its macroeconomic policies particularly fiscal and monetary policy.

The objective of this thesis is to investigate the interaction between fiscal and monetary policy using small scale open economy dynamic stochastic general equilibrium model. This thesis explores the responsiveness of monetary policy to fiscal policy vis-à-vis explore the fiscal implications of monetary policy. As we assume a small scale open economy, we also explore the responses of fiscal and monetary policy interaction to technology and foreign output shocks. We also countercheck few results using the techniques of autoregressive distributive lag model.

Our findings reveal the existence of interaction between fiscal and monetary policy in Pakistan. The response of interest rate to fiscal policy, particularly to tax shock is positive. Fiscal and monetary policy behaves as a strategic complements. This is not a good sign for a crippling economy like Pakistan's as two important macroeconomic policies are contractionary simultaneously. Similarly when it comes to spending component, interest rate negatively responds when government increases spending. Both fiscal and monetary authority adopts expansionary policies simultaneously. We also find that higher interest rate discourage government borrowing. Inflation responds negatively to interest rate in DSGE set up while the phenomenon of price puzzle exists in ARDL schemes of things. The response of inflation is positive to both higher taxes and government spending. Government spending reduces in response to a monetary policy shock. Tax revenue also reduces when interest rate shock occurs in the economy. Inflation also raises the revenue from taxes but is very short lived.

Chapter 1

INTRODUCTION

1.1: Introduction and Overview of the issues

objective of policy makers of any country is to bring macroeconomic stability and achieve sustainable growth. In the real world, different economic shocks occur that create boom and bust in the business cycles. This in turn disrupts economic activities. Economic policies are highly exposed to shocks besides its exposure to the developments that takes place both in the domestic as well as in the world economy. Policy makers and economic managers are equipped with different policy tools while having the privilege of numerous policy options to intervene and bring corrections by minimizing the resulting cost of serious economic shocks.

In general, fiscal and monetary policies occupy a very dominant position in the overall macroeconomic policy environment. The contemporary issues like recent financial crisis and recession in the world economy forces policy makers to revisit the conventional role of fiscal and monetary policies to tackle more complex problems. Intervention from economic managers through fiscal and monetary policies in order to deal with crisis and correct these shocks is not only critical but inevitable as well. Treasury and the central banks around the world have learned and are now equipped with the best policy options while trying hard to stabilize their economies. The timely response from policy makers shows that they have redefined the frontiers of conventional approaches in the process of dealing with asymmetric shocks.

Both economic and non-economic factors play an important and crucial role in determining the effectiveness of economic policies, particularly fiscal and monetary policy. Besides economic and non-economic factors, the effectiveness of fiscal and

monetary policy considerably depends on their interaction with one another. Sometimes fiscal policy seems to be more effective while the environment is more favorable for monetary policy in other times. The IS-LM model reveals that conditions conducive for effective monetary policy make the situation less favorable for fiscal policy.

Treasury and the central banks are two different authorities present everywhere in the world. They formulate fiscal and monetary policy respectively with different policy instruments to operate in order to achieve their conflicting objectives. Normally it is perceived, and rightly so, that fiscal managers are liberal and central bankers are conservative. Fiscal branch acts on long run and monetary authority on short run issues. The objective of fiscal policy is to maintain financial discipline, promote economic growth, output and employment while central bank is mainly responsible for liquidity management, price stability and controlling inflation in the economy. Similarly fiscal authority likes discretionary decisions while monetary authority likes rules. These traditional roles assigned to fiscal and monetary authority has left some room for the fiscal authority to play an active role in situations where monetary authority faces some sort of limitations and constraints.

The issue of fiscal and monetary policy interaction and coordination is very important. It takes a center stage in the debate among the contemporary issues in the process of economic policy making. Considerable work has been done, both in the developed and developing countries, on the issue of fiscal and monetary policy interaction and coordination. But the literature available in the developing countries is far behind the developed and industrialized world. Findings of the available literature on the investigation of fiscal and monetary policy interaction are highly heterogeneous and sometimes inconclusive. The possible reasons for the different and heterogeneous outcomes in the developed and developing countries include the existence of

asymmetries and differences in the structure of these economies. The economic and policy environment is not identical in these countries. In some countries, economic policies are more cohesive and coordinated while others experience a very low level of coordination. This is also worth to mention that the process of interaction between fiscal and monetary policy is not homogenous and also differs in its implications in different countries. Some countries follow the set guidelines and rules in the formulation and execution of economic policies while others opt for discretionary policies. Another reason is the conflicting objectives of treasury benches and monetary authority.

The investigation of interaction between fiscal and monetary policy explores the policy implications of the decisions of one authority for another. Fiscal policy has critical implications for monetary policy and can potentially impede it success. This is true even in the presence of a very high conservative monetary authority that heavily focuses on inflation targeting. Despite the extreme commitments by the monetary authority to its targets, pressure from fiscal authority can minimize the effectiveness of monetary policy. Keeping in perspective the monetary implications of fiscal policy, we start from budget deficits and its implication for monetary authority. The reason to start our discussion on fiscal and monetary policy interaction from budget deficit is the available literature on the subject that considers budget deficit as the cause of many economic problems. The growing budget deficits and reduced fiscal space hinder the ability of the monetary authority to control inflation. Quantity theory of money or the traditional monetarist doctrine suggests that inflation is primarily determined by the supply of money in the economy. This implies that strict commitment of the monetary authority is required to bring price stability and control inflation. But this fundamental notion and well-entrenched doctrine is challenged by the fiscalists approach or the fiscal theory of price determination. When the treasury benches set the level of fiscal deficits

or surpluses, public debt and seigniorage independently, then it is the price level that responds and adjusts to satisfy government budget constraint. The response of monetary authority and commitment considerably depends on the behavior of fiscal authority. The proponents of fiscal theory of price determination challenge the conventional dictum of quantity theory of money and initiated a debate on the non-neutrality of fiscal policy and its monetary implications.

There is another avenue through which the fiscal authority influences the central bank. Besides implications for the general price level, budget deficit and the growing level of public debt have interest rate implications as well. The soaring budget deficit and shrinking fiscal space twist the arms of the central bank and forces monetary authority to increase the interest rate. Government's decisions to spend beyond its mean and run budget deficits also play a crucial role in the formation of expectation among investors and ordinary economic agents. Interest rate rise when government adopts expansionary fiscal policy by spending excessively in the presence of a reduced fiscal space. The demand for money among ordinary consumers and investors rises as the government spends excessively. In this situation, investors and depositors lose their confidence and demand higher returns on their saving and investment. This forces the central bank to offer a higher interest rate. Undisciplined fiscal policies and the rising budget deficits in all the developed and emerging economies indicate the growing fiscal pressure that demands a cohesive policy framework.

The current debate on the independence and autonomy of fiscal and monetary authority is important and holds central position in the discussion on fiscal and monetary policy coordination and interaction. In the pursuance of its objectives, monetarists are desperately looking for central bank's independence and autonomy. Sim (1994) explores that monetary policy alone is not enough to achieve stable price

level but public's expectation coupled with fiscal policy are also very critical. Currently in many counties, central bankers are shifting their focus from money supply to interest rate as policy instrument of targeting inflation in order to increase the effectiveness of monetary policy. But this does not mean that the policy of inflation targeting is applicable to all the economies equally. Policy of inflation targeting has different implications for countries with different level of public debt. Interest rate as well as the chances of default surge when the country is highly indebted and the central bank adopts the policy of inflation targeting. In such a situation, the domestic currency depreciates causing the inflationary pressure to increase and deteriorate the value of currency further. This implies that measures taken by the monetary authority to bring price stability are counter-productive. In such a complex policy environment, responsibility somehow shifts from monetary authority to fiscal authority. This situation demands an active and positive role of fiscal policy to play in order to bring price stability and control inflation effectively.

Contemporary research related to the issue of fiscal and monetary policy interaction and coordination has extensively investigated different policy regimes like fiscal and monetary dominance. The independent formulation of fiscal policy from the central bank is a sign of fiscal dominance in the economy. In a fiscal dominant environment, the treasury independently determines the budget targets, government spending, revenues generated from taxes, fiscal deficits, revenue from floating bonds and treasury bills along with revenue from printing money. In such situation, monetary authority has very little or no say in the process of policy formulation. When the central bank is not independent and autonomous, it has very limited options to bounce back government cheques. In this situation, monetary authority unwillingly finances the budget deficits and bridges the gap by providing the required seigniorage. The issuance

of currency by the central bank will definitely contribute to the inflationary pressure in the economy, which is against the core objective of monetary authority. In such a situation, the central bank has less control over inflation and monetary policy is not effective. On the other hand, the independent determination of monetary policy and its instruments, money supply and interest rate, by the central bank shows monetary dominance. In active monetary policy regime, the level of deficit financing and printing of currency is the sole authority of the central bank. The independence of either fiscal or monetary authority can create additional restrictions on one another. The investigation of fiscal and monetary policy interaction is not only helpful in assessing the effectiveness of these policies but also useful in identifying the dominance of either authority.

The fiscal implications of monetary policy also include the application of interest rate to public debt. Determination of the interest rate instinctively affects the finances of the fiscal branch as the amount of public debt servicing changes with changes in interest rate. This implies that monetary policy has the strategic importance in those countries where the level of public debt is high. For example, when the central bank wants to control inflation and bring price stability, it trims down the money supply and increases the interest rate. Such actions of the central bank not only increase the burden on national exchequer but also discourage investment and employment in the country. This threats the interests of the fiscal branch. The higher interest rate also makes it difficult for the Ministry of Finance to pay its liabilities and carry out its outstanding obligations smoothly in the presence of a reduced fiscal space.

The discretionary vis-à-vis rule based fiscal and monetary policy are also at the centre stage in discussion on fiscal and monetary policy interaction. Compare to the central bankers, politicians and the fiscal branch normally violate the limits and adopt

discretionary policies instead of following some rules. The frequent departure from rule based policy leads to the problem of inconsistency. Besides, the behavior of economic managers and policy makers, another factor that can potentially lead to the problem of inconsistency is the behavior of business cycle. The shape of business cycle can force policy makers and economic managers to breach the law and move from rule based policy to discretionary policy. This implies that departure from rule based policy is possible even in the absence of any constrains created by fiscal and monetary authority on one another. The departure from rule based policy to discretionary decisions by design vis-à-vis by default carries critical implications for the interaction of fiscal and monetary policy coordination.

Another dimension of the fiscal and monetary policy interaction is the heterogeneity of outcomes under different policy regimes. Active central banks can effectively constraint the government. When the government adopts indiscipline fiscal policy, fiscal profligacy or indulge in time inconsistent behavior, the central bank can punish the government by adopting tight monetary policy. The active central bank can ensure fiscal discipline by forcing the fiscal authority to restrict its budget deficit and not go beyond the maximum level of debt. Stern actions from the central bank stop the ambitious government from ruthless and excessive spending. This help in the reduction of negative spillovers effects created by treasury for monetary authority. In the presence of spillover effects, the policy outcomes of either policy are not only uncertain but non-optimal as well. This implies the existence of spillovers effects can potentially leads to conflict between fiscal and monetary authority. On the extreme, policy impact is different when monetary authority faces active fiscal authority compare to situations where fiscal authority behaves submissively. Central banks normally set conservative targets for output accompanied by a stable and low inflation. On the other hand an

ambitious government and treasury benches aim and can gear up the economic activities by over stimulating the economy. Such ambitious governments usually carry expenditures beyond their means and normally reluctant to initiate reforms that detest voters. The problem of fiscal profligacy occurs when politicians want to please voters and protect their constituencies. This indicates the dominance of fiscal authority such that an ambitious government forces the central bank to finance the unrestrained budget deficits. This implies that political motives are potential sources that can affect the interaction of fiscal and monetary policy.

The neutrality or non-neutrality of fiscal policy is another interesting dimension in the debate which is based on the validity of Ricardian and non-Ricardian assumptions. The assumption of Ricardian equivalence has some limitations as the policy instruments of treasury are not limited to tax and its impact on income only. Departure from the assumption of Ricardian equivalence substantiates the non-neutrality of fiscal policy and its instruments like taxes and government spending in the determination of price level. Violation of this assumption along with distortionary taxation increases the importance of fiscal policy parameters and provides the logical justification to assess the impacts of fiscal policy on monetary policy, especially its impact on the general price level. The implicit role of fiscal policy, more specifically taxes, government spending and borrowing in the formulation of monetary policy reduces the validity of the assumption of the neutrality of fiscal policy. This also increases the importance of including fiscal policy in the objective function of monetary authority at the time of monetary policy formulation.

There are times when government does not spend in access of revenue deliberately that causes budget deficit. For instance, such fiscal profligacy can be due to the huge level of public debt accumulated in the past. Government that inherited

considerable amount of public debt and faces huge liabilities has to embrace the budget deficit by default. This situation produces another very important dimension of fiscal and monetary policy interaction in the form of swapping. In many countries, particularly developing countries, increasingly involves itself in swapping. In these countries, monetary authority can easily force the government to indulge in swapping. This is very common fiscal implication of monetary policy. Tight monetary policy in the form of high interest rate increases the cost of debt servicing. In such a situation, it is better for the governments to engage itself in swapping by changing the composition of its debt. The central bank forces the fiscal authority to take measures to retire its expensive domestic debt and gets some less expensive external loans.

1.2: History of Legislations about Fiscal and Monetary Policy Coordination in Pakistan

The aggravated economic situation of Pakistan forces the treasury and monetary authority to work jointly while realizing the importance of implications of their decisions for one another. The debate on the subject gets momentum after the establishment of monetary and fiscal policy coordination board (MFPCB) in February 1994. The main objective of the board is to ensure close coordination between fiscal and monetary authority. The formulation and execution of economic policies significantly depend on the interaction between fiscal and monetary authorities. Interaction and coordination or absence of coordination between two important public entities has many dimensions for economic outcomes and has critical implications for macroeconomic policy environment. The effectiveness of fiscal and monetary policy as a stabilization tool also depends on the existence of institutional constraints[1]. In

[1] North (1990) defines institutions as "laws formulated by the policy makers in order to reduce the infringements of rules and regulations. This also limits the behavior of fiscal and monetary authority to breach institutional arrangements".

Pakistan, legislators make institutional arrangements for fiscal and monetary authority, particularly for limiting the power of fiscal branch and for an independent State bank. These institutional arrangements not only provide policy guide lines but also very instrumental in the process of interaction between fiscal and monetary policy. Continuing with the institutional arrangement, government of Pakistan and State bank also made legislations to improve the working environment for fiscal and monetary authority. State bank Acts of 1956 has amended in 1994 in order to increase the coordination between fiscal and monetary authority. The prime objectives of amendments like 9A[2] and 9B[3] is to create such an institutional environment which is favorable for the formulation and execution of effective fiscal and monetary policy.

Other institutional arrangements are made in order to ensure the sustainability of public finances. For instance, Fiscal Responsibility and Debt Limitation (FRDL) act is made to put brakes on the ruthless spending of the government. There are other numerous legislations that have been passed from the national assembly and senate of Pakistan in order to regulate fiscal authority and to ensure an independent state bank in the country. Despite the rules and commitments, treasury benches formulate fiscal policy and make independent decisions regarding spending and revenue which carry very important policy implications for monetary authority.

Amendments in SBP act 1956 is under frequent discussions[4]. Federal government repeatedly announced its commitment to allow state bank of Pakistan to operate freely and independently. But common perception prevails in the academia and

[2] More specifically 9A implies an institutional environment and mechanism in which state bank could independently and freely design monetary policy.

[3] Under the amendments of 9B, the autonomy of the state bank of Pakistan is protected and monetary and fiscal policy coordination board is established. The main objective of such institutional arrangements is to create a consensus and set mutually agreed targets. If the authorities stick to some rules rather than adopting a time inconsistent behavior, the effectiveness of monetary policy increases significantly. Similarly the usefulness of monetary policy also increases if the authority denies the demands of fiscal branch.

[4] The State bank of Pakistan Act, 1956 (As amended up to 13-03-2012).

research circle that monetary and fiscal policy coordination board is useless and not supports the contemporary trends in the modern central banking system. On May 02, 2011 Pakistan's senate endorsed state bank of Pakistan amendment bill. The bill made state bank of Pakistan powerless and helpless to act as a preventive arm and stop the unrestrained borrowing of the federal government. Politicians want to incapacitate the particular rights of the state bank made with the prime objective to resist the irresponsible behavior of the treasury. In this connection senate standing committee on finance amends and unanimously passes the act that brought back state bank of Pakistan under the control of Ministry of Finance. In the preceding bill, state bank of Pakistan was allowed not to provide any kind of loans beyond the stipulated amount. But unfortunately this section has been removed from the endorsed bill. The bill further makes the state bank ineffective by incorporating the clause stating that SBP will not decline any amount of credit demanded by the treasury or any other public agency. Endorsed bill also asked the state bank of Pakistan to coordinate with the Ministry of Finance and obliged the treasury whenever asked. Ironically, paying lip services to the state bank of Pakistan independency, it is mentioned in the draft that treasury needs to justify excess borrowing in front of national assembly in writing. This implies that consent from the national assembly is mandatory for the treasury to carry out additional spending.

In Pakistan, the constant tension and conflict of interests between Ministry of Finance and state bank of Pakistan is a permanent phenomenon. President of Pakistan recently signed and approved state bank of Pakistan amendment Bill 2012. The amended draft reduces the powers of politicians and treasury to influence monetary authority. Besides constrains on government borrowing from SBP, new bill seeks the formulation and execution of monetary policy more freely and independently.

Furthermore, the consented bill also recommends abolishing the existing Monetary Policy Committee (MPC) of state bank of Pakistan and seeks the establishment of a new MPC board. New amendments suggest the inclusion of two more experts in monetary policy committee. But at the same time, power to appoint these experts are granted to the treasury. The senate standing committee on finance also turned down the draft in which governor state bank of Pakistan has the rights to take all types of emergency financial measures. Additional section 20A is incorporated in the draft that restricts state bank lending to federal government or other public entity. But all this seems very impractical in the presence of a very dominant and active fiscal authority. These frequent institutional arrangements indicate the conflict of interests and growing tension between fiscal and monetary authority in Pakistan.

By using dynamic stochastic general equilibrium model for tracking fiscal and monetary policy interaction, we found that monetary and fiscal policy interact with each others. Fiscal policy has substantial and considerable implications for monetary policy when we talk about fiscal theory of price level in Pakistan. Fiscal shock in the form of increased government spending and higher taxes affect price level in the economy. We also observe considerable degree of inflation inertia once it hits the economy. In the process we observed that contractionary or tight monetary policy reduces inflation while expansionary fiscal policy leads to a price hike in the economy. Our estimation established a clear and obvious relationship between budget deficit and inflation and validates the existence of the phenomenon of the fiscal theory of price determination in Pakistan. Our calibration reveals that monetary policy responds positively to inflation in the economy. This thesis further finds that monetary policy responds and State Bank increases the Interest rate in response to tax shock. The analysis shows that policy stance of State Bank in the form of higher interest rate is effective to some extent in

containing government spending and borrowing from the State Bank as well as from commercial banks. Our calibration reveals that another fiscal variable, tax revenue, also significantly and negatively responds to monetary policy shock. Our findings reveal that inflation also carries considerable implications for fiscal policy. Similarly the response of government spending to inflation shock is positive. This thesis explores that our domestic output responses positively to technology shock. Economic problems that Pakistan faces today are not insolvable but Realization of the interaction between fiscal and monetary policy by economic managers is the main issue that matters.

1.3: Objectives of the Study

In Pakistan, the independent formulation and execution of fiscal policy creates problems for state bank of Pakistan. On the other hand monetary authority accommodates the lapses of fiscal branch especially on violation of budgetary pledges. The presence of a dominant and active fiscal and passive monetary policy leads to the initiation of debate on the interaction and coordination between fiscal and monetary policy in Pakistan. So far few studies are available on the issue of fiscal and monetary policy interaction. These studies use different procedures and techniques. Nasir *et al* (2010) investigate the issue of fiscal and monetary policy coordination while uses the techniques of VAR. Farooq and Hanif (2007, 2010) investigate the issue of coordination rather than tracking the interaction between fiscal and monetary policy. They find no coordination or few instances between the two authorities and conclude that both act independently. Their findings of no coordination between fiscal and monetary authority in Pakistan provide some sort of curiosity and encourage me to unearth the interaction between fiscal and monetary policy in Pakistan. None of the cited literature, regarding Pakistan, used the dynamic stochastic general equilibrium model in order to investigate the interaction between fiscal and monetary policy. This

study is significantly different from the existing work on fiscal and monetary policy interaction in Pakistan and the prime objective is to investigate the interaction between fiscal and monetary policy uses dynamic stochastic general equilibrium model. Another objective is to investigate the existence of fiscal theory of price level and effectiveness of monetary policy uses both DSGE techniques as well as the conventional cointegration approach of ARDL. Additionally we also check the effectiveness of monetary policy and existence of price puzzle phenomenon through DSGE and ARDL. The last but not the least objective is to give some policy recommendations from the findings of this thesis.

The timing of this thesis is critical because policy makers along with economic managers are not comfortable with the performance of major economic indicators. Tracking the dynamics of interaction and coordination between fiscal and monetary policies in Pakistan will somehow help in identifying the problems and fixing the responsibilities. This thesis will certainly help different authorities particularly Ministry of Finance and state bank of Pakistan, to identify different areas of coordination on the basis of findings of fiscal and monetary policy interaction in Pakistan.

1.4: Organization of Study

Rest of this dissertation is organized as follow. Chapter 2 of the study elaborates the review of literature. Chapter 3 contains some stylized facts and the contemporary trends in the economy of Pakistan. Chapter four is consists of methodology. Estimation of DSGE model and findings is the subject matter of while chapter 6 explains the findings of ARDL. Chapter 7 contains policy recommendation and wrapping up remarks.

Chapter 2

REVIEW OF LITERATURE

2.1: Fiscal and Monetary Policy Interaction:

There is an extensive debate on the subject of interaction and coordination between fiscal and monetary policy. The debate on the issue of fiscal and monetary policy interaction and coordination is not limited to the interaction of these policies within frontiers. But considerable literature is available that covers the interaction of policies among different nation. Unfortunately the available literature on fiscal and monetary policy interaction is available widely for the developed countries and the subject gets lesser attention for unknown reasons in developing countries and Pakistan is no exception.

Fiscal and monetary policies interact with each other and with other macroeconomic policies. The most important thing is the federal government budget that plays a crucial role in the relationship between treasury and central bank. Government budget constraint plays a central and an important role in connecting fiscal policy with monetary policy. The effectiveness of monetary policy significantly depends on the behavior of fiscal authority. Similarly the usefulness of fiscal policy considerably depends on the formulation and execution of monetary policy. There are many areas where fiscal and monetary policy interacts. Woodford (1996) reveals that a certain type of fiscal instability, namely variation in the present value of current and future primary government budgets, necessarily results in price level instability. In other words, in the presence of fiscal volatility, there exists no such potential monetary policy that ensures equilibrium with stable prices. The validity of the all time tested notion “inflation is everywhere a monetary phenomena”, is questioned in the presence of an active and dominant fiscal authority. Frequently and independent changing

decisions of the fiscal branch about tax cut or increased spending affect aggregate demand. Aggregate demand plays a central role that brings changes in the price level and ultimately affects the level of inflation in the economy. Fiscal profligacy, government spending in excess of its revenue, ultimately require monetization. This can be financed through seigniorage. For this purpose, excessive and unrestrained money printing causes a decline in the value of domestic currency and increases the general price level in the economy. The contemporary research in the field of fiscal theory of price level suggests that fiscal policy can be the main determinant of inflation and price instability. The uncertainty about fiscal consolidation and sustainability of public finances make it difficult for the central banks to exercise monetary policy freely. Zoli (2005) explores that fiscal sustainability is critical for the development of efficient financial markets. It is not easy to run an effective monetary policy if the financial markets have any doubt about fiscal sustainability. Furthermore, sustainability of the public finances is also critical because the transmission channel of monetary policy mainly works through financial markets. Kopits (2000) reveals that large explicit or implicit government deficit or market perception about lack of fiscal sustainability, make an economy more vulnerable to different shocks which reduce the utility of monetary policy. Moses and Nicola (2009) disclose that indiscipline fiscal policy could jeopardize monetary stability. Based on the conventional classical perception that is heavily stands on the quantity theory of money reveal that decisions of the treasury benches effect monetary policy through debt monetization or through a direct effect on the price level. Financing needs of the government and its funding strategy place constraints on the operational independence of the monetary authority. Bahar (2009) investigates the issue of fiscal and monetary policy coordination and explores that fiscal authority uses different sources of financing in order to bridge the fiscal gap. Moving

forward, the author assesses the impact of different sources of financing fiscal deficit and its impact on inflation along with impact on output growth. He concludes that sources of financing deficits are as much critical for monetary policy as the size of budget deficit itself.

Kydland and Prescott (1977) investigate the issue of fiscal and monetary policy interaction and coordination in the presence of some policy rules. Their findings propose that fiscal authority must follow some defined rules in order to avoid the time inconsistent behavior. They suggest that monetary authority should be independent and free from the influence of treasury benches. In the process of reviewing the literature, Benigno and Benigno (2004) find that treasury is normally discretionary in nature while monetary authority follows rules in the course of tracking down their respective objectives. The time inconsistent behavior of the fiscal authority and the rule based policy behavior of the central bankers increase the desire and possibility to give the role of leadership to the monetary authority. In such a situation, it is easy for the monetary authority to keep check on the discretionary decisions of fiscal branch and is easy to constraint its fiscal profligacy. Furthermore, monetary authority restricts the fiscal policy and can ask the treasury to show its current and future requirement for seigniorage in the beginning of financial year. Nordhaus *et al* (1994) find that economy may diverge sharply from the preferred outcome if fiscal-monetary games turn into fiscal-monetary wars. According to their study lack of coordination between the fiscal and monetary authority lead to high inflation, excessive budget deficit and higher interest rate. Absence of coordination between the two important public entities leads to the discouragement of private investment that ultimately deters growth as private investments crowds out. Similarly the objectives of high employment and increased output of the fiscal authority are also difficult to achieve when monetary policy is not

accommodative and declines the demands of the treasury. But this does not mean that monetary accommodation is good in all the times for the economy. For instance, Monetization is not always desirable. Price level in the economy rises and monetary policy effectiveness reduces when the central bank accommodates the fiscal authority's demands and provides the required seigniorage. In this situation, an active and dominant central bank is inevitable to stops the fiscal authority from fiscal slippages. The dominant monetary authority cannot only reject the monetization of the budget deficit but can also forces it to work for balanced fiscal policy. The objectives of monetary policy, especially low inflation and stable monetary growth, are hard to realize in the presence of fiscal profligacy.

Monetary financing of the government budget deficits is the central issue in the debate on interaction between fiscal and monetary policy. The main reason behind this growing debate is the implications of monetization of budget deficits for the determination of price level. Monetization of the budget deficit along with a shrinking fiscal space contributes to the price volatility in the economy. Woodford (1995) identifies the level of government's nominal debt as a dominant and critical factor in the determination of the price level. Cukierman's (1992) findings primarily suggest the establishment of an independent monetary authority for a country seeking to avoid high and volatile inflation. He believes that the main mandate of the central bank is to control inflation rather than to work as a financing agent of the government. Tabellini (1987) finds that public debt cannot be arrested without a connected effort and backup from the treasury. Carlo *et al* (2004) also investigates the issue and unveils that the pre-requisite for central bank and efficient monetary policy is appropriate coordination with fiscal authority. On the other extreme, Herman and Norman (2002) investigate the issue of fiscal and monetary policy interaction and point out a new policy environment in

different countries around the globe. In such an environment, monetary authority is responsible for bringing price stability and committed to controlling inflation. Along with such a central bank, fiscal authority is responsible for fiscal sustainability and do not rely on the inflationary tax to finance its budget deficit.

Besides the usual business cycles, political business cycle plays an important role in determining the relationship between fiscal and monetary policy. Government and fiscal branch has the ability to generate political business cycles and they usually do. Fiscal policy is not entirely designed by the fiscal managers, but interference from politicians significantly affects its formulation. Politicians normally want to protect their constituencies and get re-elected. In the process of getting re-elected, politicians spend excessively and over-stimulate the economy to get the support of the voters. Politicians and the fiscal branch force the Central bank to carry out monetary expansion beyond limits in order to stimulate economic activities and create an artificial boom and prosperity. The creation of such political business cycles and stimulated prosperity pleases the voters but has considerable implications for the operation of monetary policy. The active and dominant fiscal authority also forces the central bank to keep the interest rate low. Such behavior of the politicians reduces the ability of the markets to stabilize itself. Increase in the government expenditures beyond their means and temporary monetary surprises create unstable economic growth followed by a rise in the general price level. Such an unstable economic growth and price volatility holds significant policy implications for central banks. Public profligacy and ill-planned fiscal policy cannot last forever. Producing political business cycles is not productive normally because it creates problems for the operation of monetary policy. Coordination between fiscal and monetary authority in this regard is not only imperative but inevitable in order to reduce the negative spillovers created by the

political business cycles. Coordination failure between fiscal and monetary authority make it difficult to assess the impact and know the causes of frequent changes in economic policies. Keeping in perspective the implications of treasury for the central banks, the importance of simultaneous investigation of fiscal and monetary authority interaction and coordination increases because it is very difficult to observe and isolate the changes generated by either authority. The joint investigation of fiscal and monetary interaction is also important to explore the economic changes produced by either business or political cycles.

Lags, inside as well as outside, also involved in transforming the complete impact of fiscal and monetary policy to correct the economic problems and are crucial in the interaction of fiscal and monetary policy. The main reason behind inside and outside lags is the gap between the decisions taken by the policy makers and the actual realization of impacts of these policies. Series of literature discusses the dynamics of inside and outside lags while analyzing the effectiveness of fiscal and monetary policy. Kuttner and Posen (2002) highlights lags as the potential problems associated with the failure of strategic interaction and coordination between fiscal and monetary authority. They examine the issue and finds that fiscal policy involves long inside lags which make it less attractive for stabilization. On the other hand, the decision as well as implementation lags for monetary policy are usually short compare to fiscal policy. Under such circumstances discretionary fine tuning through fiscal policy is virtually difficult if not impossible. Economist and policy makers develop the consensus that monetary policy has to bear most of the burden of any fine tuning of stabilization policies. Because in extreme situation, monetary policy stance can even be change on daily basis while it takes time to change fiscal policy stance. Legislative process involved in fiscal policy decisions that produce lags. The legislative process involved

in the formulation of fiscal policy also interrupts its strategic interaction with monetary policy. Canzoneri (2002) also explores the issue and finds that decision about government spending and the imposition of tax needs legislations. It is necessary to pass any fiscal changes from parliament or from some other executive body which is a time consuming process. This reduces the effectiveness of fiscal policy and increases the worth of monetary policy because the timely response to economic shocks is very crucial.

The role of government budget constraint gets the centre stage in the debate on fiscal and monetary policy interaction and coordination. Tracking the dynamics of interaction between fiscal and monetary policy, the seminal and influential work of Sargent and Wallace (1981) consider the government inter-temporal budget constraint as the principal factor that effect monetary policy stance. In their paper titled some unpleasant monetarist arithmetic, they point out the price dynamics of the budget constrain. They find that lack of fiscal discipline and absence of coordination from fiscal authority eventually leads to higher future inflation if monetary authority tries to fight current inflation with tight monetary policy. Grohe and Uribe (2001) examine the issue of interaction between fiscal and monetary policy and focused their study on inflation, level of public debt and government revenue especially revenue from taxation. They explore that nominal anchor lost stability in the presence of balanced budget accompanied by monetary dominant regime. Furthermore, they find that fiscal policy exerts pressure and entails constraint on the independent formulation and implementation of monetary policy.

Rules based policy versus discretionary policy is another very important dimension in the debate on fiscal and monetary policy interaction. The deviation from rules or the time inconsistent behavior of treasury and central bank limits the optimality

of fiscal and monetary policy. It further limits the ability of fiscal and monetary authority to bring and ensure stabilization. Benigno and Woodford (2003) also investigate the interaction of fiscal and monetary policy and explore new dimension, welfare aspect, of rules based policies. They find that welfare increases in the presence of rule based policy compare to discretionary policies. Discretionary fiscal policy, unchecked government spending and taxes, usually generates negative spillovers and harmful effects in the economy that creates problem for its monetary counterpart. The separation of policies on the basis of discretion and rules are also critical in the coordination and interaction between fiscal and monetary policy. Blanchard and Perotti (2002) find that monetary policy faces the discretionary part of fiscal policy as a shock. They argue that the existence of dominant and active fiscal policy allows politicians to behave in inconsistent manner while adopting discretionary policies. Such behavior considerably affects the operation of monetary policy and makes the policy environment less favorable for the central bank. On the other hand Canzoneri *et al* (2002) argues that no additional fiscal constraints are required for price stability as far as the non-discretionary component of fiscal policy is concerned. Contrary to the above mentioned literature, Poterba (1994, 1995) investigates the relationship between fiscal and monetary managers and explores that adherence to fiscal policy rules certainly decrease deficit and increase the effectiveness of fiscal policy. A strand of literature investigates the interaction between fiscal and monetary policy with in an environment of commitment and without commitment. The findings reveal that firm commitment of fiscal authority to follow rules brings fiscal consolidation and ensures appropriate adjustment in government spending and taxes. Literature also suggests the design of better institutions to avoid the problem of inconsistency of fiscal and monetary

authority. Such institutional arrangements greatly help in avoiding discretionary decisions and negative spillovers of the indiscipline fiscal policy.

We know that monetary and fiscal policy has conflicting objectives and has different policy instruments to operate. Any confrontation between fiscal and monetary authorities can cause the policy outcomes to be sub-optimal. Dixit and Lambertini (2001, 2003a, b) consider a situation in which the fiscal authority is not conservative. The objective of such a liberal fiscal authority is to maximize social welfare. Maximizing social welfare function requires higher employment and growth rather than low level of inflation. They find that usually fiscal authority deviates from its commitments and shows an inconsistent behavior. In this situation fiscal authority spends beyond their means. The ability of the policy makers to predict precisely also decreases and they cannot talk sensibly about economic outcomes and the validity of economic theories when fiscal authority behave in inconsistent manner. Expectations also play a crucial role in the formation of economic policies and their outcomes but it is very much difficult to form expectation in the presence of time inconsistent behavior of the treasury. Because inconsistency leads to uncertainty that in turns reduces the accuracy of expectations.

There is another dimension of fiscal and monetary policy, and that is the speed of responsiveness of each policy. The time involved in monetary policy response is considerably less than fiscal policy. The active and timely response of monetary policy is important in order to increase the optimality of both fiscal and monetary policy. The objectives of high employment and reasonable growth of the fiscal authority are difficult to achieve when the central bank is not accommodative and does not responds to the needs of the fiscal authority. But this is not always true. At times coordination and accommodative behavior of the monetary authority is harmful. For instance,

inflationary pressure is created in the economy if the fiscal authority is running a budget deficits and the central bank provides the required seigniorage. Similarly, the objective of monetary policy of low inflation and stable money growth is hard to realize if fiscal authority is not cooperative. Fair (1994) investigates the issue of coordination and interaction between fiscal and monetary policy and finds that large amount of government debt can diminish, or even can reverse, the impact of higher interest rates in slowing down the economy and in reducing the inflation, because debt holder's income rises with higher interest rates, thus stimulating consumption. This is an important aspect of the fiscal policy interaction with monetary policy that can potentially hamper the optimality of monetary policy.

Literature unveils another interesting aspect of the fiscal and monetary policy interaction like the strategic substitutability and complementarities of these policies. Von *et al* (2001) find out that interdependence between the two authorities is asymmetric. Expansionary fiscal policy stance is accompanied by tight monetary policy. This asymmetry allows monetary policy to provide room to the treasury to relax its arms by increasing expenditures or exercise tax cut. On the other hand, research of Melitz (1997, 2000) and Wyplosz (1999) generally supports the dictum that two policies are strategic substitutes. Dixit and Lambertini (2000, 2001) investigate the degree of interdependence between treasury and the monetary authority. They develop a model in which monetary authority has partial control over inflation and the price level is also directly affected by the decision of the fiscal branch. They find that policy rules of fiscal and monetary branch are complement. Expansionary fiscal policy has contractionary effects on output and price level. Buti *et al* (2001) recommend that interdependence between monetary and fiscal policy should not be interpreted in terms of conflict or cooperation. The degree of interdependence between fiscal and monetary

policy largely depends on different demand and supply shocks in the economy. For example, in case of supply shocks, fiscal and monetary authorities respond in a very conflicting manner. For instance, when adverse supply shock hits the economy, fiscal authority adopts an expansionary fiscal policy in order to stimulate business activities and to spur economic growth. We know that prices also rise in the presence of adverse supply shocks. In this situation, the central banks adopt tight monetary policy in order to contain the inflationary pressure in the economy. This implies that greater cooperation is required between fiscal and monetary authorities in order to minimize the cost associated with adverse supply shocks. Similarly, demand shocks provoke fiscal and monetary authority to follow consistent policies in order to avoid the negative spillovers of the shocks.

2.2: Fiscal and Monetary Policy Interaction and Time Inconsistency Problem

A strand of literature is available on the issue of discretion versus commitment in operating fiscal and monetary policy. Simon (1936) proposes that fiscal and monetary managers should regard and follow some pre-defined rules for optimal policy outcomes. Barro and Gordon (1983) find that discretionary policies create distortions causing sub-optimal outcomes. Furthermore, these distortions generate short run benefits from unexpected inflation in response. Policy makers and legislators design different institutional and legislative arrangements in order to avoid sub-optimal outcomes of fiscal and monetary policy. But different institutional arrangements produce different equilibriums. The properties of such different equilibrium are not similar and hold unstable welfare implications. They suggest the policy makers to avoid breaching rules, distortions and ensure unwavering and stable equilibrium to optimize policy outcome. Rogoff (1985) suggests that the problem of distortions created by discretionary policy can be minimized by empowering central bank and assigning key

role to monetary authority. Rogoff terms the monetary authority conservative and the one who follows rules. Dixit and Lambertini (2003) consider the behavior of fiscal authority as well. Dixit and Lambertini (2001, 2003a, b) find that monetary authority is conservative and sets lower output and lower inflation targets compare to the targets of fiscal authority. In this structure, commitment on the part of monetary authority is offset by sequential discretionary fiscal policy decisions. They permit general stochastic shocks to the parameter and explore that optimal monetary policy is a non-linear function of shocks. They uncover fiscal policy is a strategic player and commitment to some rules on the part of central bank is not enough. Persson and Tabellini (1993) also allows for a general stochastic structure. Beetsma and Uhlig (1999) examine the interaction between fiscal and monetary policy in an environment where the assumptions of effective commitment on the part of policy makers is absent. In their scheme of things, policy makers are not truly committed to policy rules and follows inconsistent behavior. Such inconsistent behavior and time inconsistency problem on the part of treasury encourage the deviation of actual inflation from its target inflation. The problem of time inconsistency also causes output to deviate. This situation changes the behavior of monetary managers and forces the central bankers to exercise time inconsistent policy. Central banks attempt to stabilize output and bring price stability. But such an endeavor produces inflationary pressure in the economy. Following similar lines, Dixit and Lambertini (2001) consider the time and mutually inconsistent policy behavior of fiscal and monetary authority under different coordination mechanisms. They find that different combinations of coordination mechanisms may or may not diminish the undesirable outcomes produced by inconsistent policies. They find a very different scenario in which loose fiscal stance stimulate inflation but discourage output.

Beetsma and Bovenberg (1999) find that commitment to rules on the part of central bank has a negative effect on the formulation and execution of fiscal policy. The behavior of a conservative central bank badly affects the goals and objectives of fiscal authority particularly the objective to trim down the debt levels. For instance, conservative central bank assigns more weight to price stability than output growth and employment. In order to achieve the objective of low and stable prices, central bank acts in a very conservative manner and keeps the interest rate high. This implies that fiscal adjustment and consolidation is difficult to realize if the country is highly indebted and its central bank is ultraconservative. Alesina and Tabellini (1987) in their model consider fiscal branch that imposes taxes to finance its spending and monetary policy sets the target for inflation. They further assume that fiscal and monetary authority has similar and unambiguous targets for public spending, inflation and output. However they considerably disagree on the degree of tradeoffs among these different goals. Fiscal and monetary authority gives different weights to their respective targets. In this situation, commitment on the part of monetary authority produces socially undesirable outcomes and reduces the welfare. For instance, treasury imposes new taxes when the conservative central bank denies the demand of the fiscal branch for seigniorage. The imposition of new taxes creates distortions and disrupts economic activities. Disruption in business and economic activities cause the output to fall which may offset the gain achieved from stable and lower inflation.

Lambertini and Riccardo (2004) investigate the issue of fiscal and monetary interaction and explore that monetary authority is committed to moderate and stable inflation. They find that coordination from fiscal authority is not crucial in the presence of conservative central bank particularly when it adopts inflation targeting policies. Sargent and Wallace (1981) find that un-sustainable and pre-determined fiscal deficits

make the stance of monetary policy and inflation endogenous. Their influential work encourages the debate on fiscal and monetary policy interaction and declares fiscal discipline inevitable to ensure monetary stability. Leeper (1991) and Woodford (1995) drive the debate on similar lines but in a different perspective. They concentrate and limit their discussion to fiscal theory of price determination while investigating the issue of fiscal and monetary interaction.

2.3: Active/Passive Fiscal and Monetary Policy

Leeper (1991) introduces a new dimension and initiates a different debate in the process of uncovering the interaction between fiscal and monetary authority. Leeper sketches a line between active as well as passive fiscal authority and investigate its implications for both passive as well as dominant monetary regimes. He explains different outcomes of fiscal and monetary policy interaction under different policy regimes. Different policy regimes mean that sometimes fiscal policy is active and dominant while monetary authority behaves submissively. At other times, monetary authority is dominant and adopts proactive approach and the treasury benches behave passively. The impact of fiscal and monetary policy on economy is different under different policy environment. For example, the impact of fiscal policy, specifically government spending and taxation, is not homogenous under active fiscal regime compare to dominant monetary policy regime. Dominant treasury does plan but not implement fiscal policy according to the inter-temporal budget constraint of the government. Active fiscal authority regularly breaches the limits and violates the government budget constraint. Contrary to the dominant fiscal authority, the passive treasury follows the inter-temporal budget constraint and avoids rules infringement. Leeper's findings suggest that debt sustainability and economic stabilization accompanied with a unique solution is possible only when one regime is active and the

other is passive. Woodford (1998) finds that increased public expenditures in the presence of active and dominant fiscal environment persistently drive up output and employment. This in turns inflate prices in the economy. But higher price level is not likely to induce changes in the interest rate when monetary authority behaves passively or monetary regime is not dominant. Leith and Lewis (2000) take the debate on fiscal and monetary dominancy in the same direction but with different findings. Elaborating the active monetary policy along with passive monetary policy, they find that any monetary policy that satisfies Taylor rules is said to be active and dominant. Contrary to Leeper's findings, they suggest that both monetary and fiscal policies ought to be either active or passive simultaneously in order to restore stability and ensure sustain economic growth. Melitz (2002) estimates fiscal and monetary policy reaction function and concludes that both policies are normally lean to move in the opposite direction. Such an attitude of fiscal and monetary authority has no rationale except the presence of conflicting objectives of both the authorities. The movement of two key macroeconomic policies in the opposite direction carries serious repercussions for the economy. Favero and Monacelli (2003) also examine the issue of fiscal and monetary policy interaction and focus their discussion on the degree of dominancy of fiscal authority besides central bank. Their findings reveal that fiscal policy remained dominant in the United States from 1960 to 1987. They suggest that for optimal outcomes and better economic policies, the distinctions between both fiscal and monetary dominant regimes on the basis of empirical models are important. The distinction in policy regime is also critical to trace the dynamics of inflation, time inconsistency problem of policy makers, and to identify models that discuss only monetary policy rules. Favero (2002) investigates the interaction between fiscal and monetary policy for developed economies. He concludes that monetary authority

primarily stabilizes price level and the indiscipline fiscal policy of the treasury does not affect the formulation and execution of monetary policy.

This is also a well documented fact that coordinating behavior of either fiscal or monetary authority is not always productive and do not optimize the policy outcomes. Similarly coordination on the part of fiscal authority has different implications compare to the coordination from the central banks. For instance, Price level in the economy rises with significant economic cost when central bank extends a helping hand and accommodate the demands of the treasury benches. On the other hand, the monetary policy instruments and objectives of central bank is not threatens in the presence of an accommodative treasury. Sim (1988) investigates the relationship between fiscal and monetary policy and finds that treasury is responsive and accommodates monetary policy. He finds that fiscal shocks neither affect inflation nor the policy instrument of the central banks in the presence of a responsible and accommodative treasury. Sim also explains the situation where fiscal authority is active and monetary policy is passive. His findings reveal that in the presence of fiscal dominancy with accommodating central bank, deficit shocks or frequent movements in the government liabilities definitely increase inflation either now or in the future. This implies the existence of dominant treasury benches threatens the neutrality of fiscal policy and any changes in government liabilities affect price level in the economy. On the other hand, the instruments of monetary policy, particularly nominal interest rate is responsive to the ratio of money to debt. This implies that the changing level of public debt and ultimately its ratio to money supply and GDP affects the choices of monetary authority about policy instruments. The bottom line of Sim's discussion is that price level depends on fiscal policy and the behavior of treasury benches has important implications for the monetary policy instruments and implementation. Lambertini and

Rovelli (2004) inspect strategic interaction of fiscal and monetary policymakers under different assumptions. They study the behavior of fiscal and monetary policy over the business cycles under the assumption that both policy makers wish to minimize the deviations of output and inflation. They also assume that central bank takes extra care in order to protect its reputation. They further assume that the mandate of the central bank is decided at the constitutional level and the bank will not deviate from the specified objectives under any circumstances. Their findings reveal the occurrence of negative externalities in environment in which fiscal and monetary authority set their policy instruments independently and in a conflicting manner. They find that exchange of information between fiscal and monetary authority is important in the process of fiscal and monetary policy interaction and for the enhancing policy effectiveness. The exchange of information between the treasury and central bank reduces the chances of sub-optimal outcomes and indicates the coordinated behavior on the part of both authorities. Similarly pro-active approach on the part of fiscal and monetary authorities reduces the deviations of output and inflation and ultimately improves the level of welfare in the economy.

Bas *et al* (2001) examines the interaction and coordination between fiscal and monetary policy using numerical simulations. His findings reveal that cooperation between fiscal and monetary authority increases the efficiency of economic policies. The chances of success of both fiscal and monetary policy increase with incremental increase in the level of cooperation between treasury and central bank. They notice another very interesting and new point in the process of investigating the issue of fiscal and monetary policy interaction. For instance, he points out that gain from coordination for fiscal authority is greater compare to the gain of central bank. Marco *et al* (2001, 2009) examine the issue of fiscal and monetary policy coordination while assuming that

fiscal authority is least bothered about inflation. They find that bilateral cooperation between fiscal and monetary authority increases when the economy is hit by some shocks. More specifically supply shock necessitates the higher degree of coordination between fiscal and monetary authority. Uhlig and Ravn (2002) explores that the increased cooperation from monetary side is provoked by the hope to minimize the deviation of actual output from the potential output as well as reduce the deviation of inflation. In such circumstances, the inclusion of fiscal authority produces inefficient and sub-optimal outcomes because treasury benches are usually concern with employment and output growth. Inflationary pressure gains momentum in the economy in response to the steps taken by the treasury benches for higher employment and growth. These factors, non-neutrality of fiscal policy, inflationary pressure and the objective of stabilization induce the central bank to exercise its power and raise the interest rate. In this situation, greater cooperation from the treasury benches in the form of disciplined fiscal policy helps in bringing down the interest rate. In the Uhlig's scheme of the things, monetary authority ignores the cost associated with higher interest rate. This implies that the crowding out of private investment in response to tight monetary policy is largely ignored by central bank, despite the fact that crowding out holds very important fiscal implications. Here in this situation, central bank needs to rationalize the interest rate in order to decrease its impact on fiscal policy.

In the process of reviewing the literature, researchers assume that interaction and coordination is instigated by the fact that fiscal and monetary policy affects aggregate demand and ultimately price level in a similar fashion. Fiscal policy shocks matters for its influence on the aggregate demand. It is further assumes that fiscal authority does not follow rules and behave in an inconsistent manner. On the other hand, it is assumed that monetary authority likes and follows rules and not indulges

itself in time inconsistency problem. Andersen (2002) in his work concludes that the loss associated with non-cooperative fiscal policy is high if the shocks to the economy are symmetric. Andersen further illustrates that loss is negatively associated with the number of decision making bodies. This implies that optimality of policies reduces as the number of policy makers increases. So if a country wants to increase the policy effectiveness, it should reduce the number of bodies that make decisions. Beetsma and Bovenberg (2001) study the issue and explain a different scenario in which fiscal and monetary policy maker do not show serious attitude and fail to follow their commitments. In their scheme of things, nominal wages are set in prior. Monetary and fiscal authorities are unlikely to stick to their commitments and oftenly follow inconsistent behavior in order to chase targets. They find that for useful and result oriented policies, commitments to rules from fiscal and monetary authority is essential. Baldini and Ribineiro (2008) examine fiscal and monetary policy interaction and coordination of the Sub-Saharan Africa countries. Their findings reveal the existence of active and dominant fiscal policy in some countries while others countries are labeled as monetary dominant regimes. For few countries, the results were mainly inconclusive and unable to distinguish the dominancy of either authority. From most of the reviewed literature, it is evident that fiscal dominancy is not visible in the developed and industrialized countries. Fiscal authority in these countries usually committed to rules and respect the government budget constrain. Contrary to the developed countries, fiscal authority in developing countries plays an active and dominant role. The active and dominant fiscal policy in these countries is a source of great concern for the policy makers, particularly monetary managers in the central banks. Blinder (1982) finds that the clear implications of the current debate on the issue of fiscal and monetary policy interaction suggest the increased cooperation between the two authorities is beneficial

to achieve the policy objectives optimally. He observes the credibility of the central bank does not limited to its autonomy only but it also depends on the fiscal position of the government. Similarly is the case for the fiscal policy. Cukierman *et al* (1992) use aggregate legal index and find that the provision of mandate of controlling inflation to the central bank ensures price stability. Furthermore, they reveal that the frequency of change of the head or governor of central banks indicate the degree of the bank independency. The degree of independency is low if the heads of central bank changes more frequently and vice versa. Acemoglu *et al* (2008) reveal that political factors are very instrumental and carry considerable implications for policies. The policies are expected to be distortionary when the politicians face fewer constraints. Economic and political reforms are result oriented in those countries where the system imposes constraints on the behavior of politicians and policy makers. They find evidences that central banks measures are more effective in controlling inflation in those countries where politicians faces immediate constraints. Furthermore, their research unearthed the seesaw effect where the central bank reforms bring price stability and in response to the government expenditure tends to increase.

2.4: Fiscal Monetary Policy Interaction in DSGE Models

Considerable research is available on fiscal and monetary policy interaction using dynamic stochastic general equilibrium model. The field is new but quite enough literature is available on dynamic stochastic general equilibrium models due to the increased interest of policy makers and academia in this particular emerging area. The importance of dynamic stochastic general equilibrium models brings it out from the contours of academic discussion and forces the central bankers around the world to adopt these models for making policies. In the last several years, the developments in dynamic stochastic general equilibrium modeling are not only phenemenonal but

surprising as well. Following the famous Real Business Cycle (RBC) theory, Kydland and Prescott (1977, 1982) have started work on DSGE modeling that heavily based on the new Keynesian set up. New-Keynesians School of thoughts assigns an important role to both fiscal and monetary policy in order to ensure economic stabilization. The inclusion of different assumptions and the modifications largely contributed in the gradual development of dynamic stochastic general equilibrium models. Researchers, policy makers and economic managers are increasingly interested in the use of dynamic stochastic general equilibrium models for macroeconomic analysis as well. Central bankers in developed and developing economies have modified DSGE model according to the prevailing situation in their respective economies. Tovar (2009) suggests that DSGE model is useful and very productive in exploring the basis of instability in the economy. Dynamic stochastic general equilibrium model is very useful in the estimation and calibration of the factors that causes fluctuations in the economy. The model is also very effective and remarkable in the identification of structural changes besides assessing the anticipated effects of alternate policy regime. Considerable portion of the existing literature is contributed to the panel date. But over the years, remarkable contribution by researchers has been made to the DSGE modeling and they term these models equally useful for time series data. Smets and Wouters (2003) release arms and expose the model to different structural shocks. Allowing the model to various shocks, they find that beside panel data, DSGE models are able to calculate and predict time series data as well. Bernanke *et al* (1999) also include time series data of financial fractions into DSGE models and find these models very effective and useful for such data set. Cespedes *et al* (2004) also investigate DSGE models while incorporating the financial sector and time series data. They find the micro-founded DSGE model significantly helpful in the process of assessing time series data and reveal

considerable impact of firm's balances on the investment. Choi and Cook (2004) incorporate banking sector and examine the performance and effectiveness of policies in a dynamic stochastic general equilibrium framework. Davereux and Saito (2005) developed an alternate approach that allowed for time-varying portfolio in the dynamic stochastic general equilibrium models. Engel and Matsumto (2005) keep the center of attention on complete market and include assets markets along with portfolio choice in the DSGE model. Devereux and Sutherland (2006) further investigate the issue and present a general formula for entire range of assets that is compatible with DSGE models. Fabio and Sala (2006) add to the literature by investigating dynamic stochastic general equilibrium model particularly the identifiability and its repercussions for parameter estimations. An and Schorfheide (2007) revisit the related literature with dynamic stochastic general equilibrium and discuss at length the empirical implications of different models. They find these models very productive for assessing the interaction between fiscal and monetary policy interaction. Christiano *et al* (2007) extend the model into a small open economy framework and modified the model to include financial friction along fraction in the labor market. Adolfson *et al* (2008) studied agent optimization based dynamic stochastic general equilibrium model with numerous assumptions while analyzing the impact of monetary policy and the transmission of different shocks in the economy. They also investigate the trade-off between inflation stabilization as well as output gap stabilization with the help of dynamic stochastic general equilibrium model. Dynamic stochastic general equilibrium model is relatively complex as compared with earlier models for macroeconomic analysis. The main drawback of the previous models that used for macroeconomic analysis, like real business cycles, is the absence of room for policy intervention. Because RBC models suggest that business cycles respond to shocks optimally. Policy

makers have no reason to intervene and play an active role using their policy instruments in minimizing the fluctuation of business cycles. On the other hand consensus exists among researcher and academicians that DSGE model is very effective in analyzing the relationships among variables and the model has the immunity against the famous Lucas critique.

Dynamic stochastic general equilibrium model is frequently used by the central banks for analyzing the effectiveness of monetary policy while the role of fiscal policy is largely ignored. The earlier version of the New-Keynesians dynamic stochastic general equilibrium models assign limited role to fiscal policy. Gali (2003) heavily focuses on monetary policy using dynamic stochastic general equilibrium model and give less importance to fiscal policy. Ratto *et al* (2009) also identified that less attention has been given to the public sector and to the interaction of fiscal and monetary policy in dynamic stochastic general equilibrium models. Realizing the significance of fiscal policy, Muscatelli *et al* (2004) investigate the issue of fiscal and monetary policy interaction and modified the model by including the extended version of fiscal policy transmission channels. Empirically estimating the model instead of calibration, their findings establish the non-neutrality of fiscal policy. This implies that fiscal policy is not neutral. Fiscal policy plays an instrumental role in the interaction process and carries significant implications for the operation of monetary policy.

Fiscal and monetary policy coordination and interaction is a multidimensional phenomenon. As the research develops in the field of fiscal and monetary policy interaction, literature introduces a different dimension in the form of policy as a substitute as well as complement. For instance, fiscal and monetary policy sometimes works as strategic substitutes. Expansionary fiscal policy is accompanied by the tight monetary policy. On the other hand, if fiscal and monetary policies work as a strategic

complements, then expansionary fiscal policy is followed by the loose monetary policy. Supplementing the debate, Charles (1999) finds that fiscal and monetary policy mostly behaves as strategic substitute. Hagen *et al* (2001) study the behavior of treasury and monetary authority and conclude that the relationship between fiscal and monetary authority is asymmetric. This implies that expansionary fiscal policy is accompanied by tight monetary policy stance. Muscatelli *et al* (2001) explore that the concept of strategic substitutability of fiscal and monetary policy does not applied to the all economies equally. Melitz (1997) examines the issue of fiscal and monetary policy interaction in a dynamic stochastic general equilibrium model but his findings are not only ambiguous but inconclusive as well. It is not clear from his findings that the relationship between the policy instruments of the two authorities over the period depends on policy or some structural shocks. Coenen and Straub (2005) realized the active role of the politicians and treasury in policy making process and the impact of their decisions on the economy. They incorporate active and dominant fiscal policy along with non-Ricardian consumer into the DSGE model. Keeping in perspective the permanent income hypothesis, this assumption implies that considerable number of economic agents are non-Ricardian in nature against the standard IS curve which heavily relied on the assumption of Ricardian equivalence. They investigate the consequences of active and dominant fiscal policy. They find the rationale for the significant influence of fiscal policy over macroeconomic variables. They term the micro-founded dynamic stochastic general equilibrium and optimizing agents based model very effective for assessing outcomes of different economic policies.

2.5: Fiscal and Monetary Policy Interaction in Pakistan

The investigation of interaction and coordination between fiscal and monetary policy is a recurring theme in the contemporary issues in macroeconomics. Keeping in

perspective the advantages of dynamic stochastic general equilibrium models, both developed and developing economies are formulating DSGE models for their economies. The central banks around the world are frequently using these models for analysis and diagnosing economic problems and policy formulation. The robustness of the DSGE models has derived the debate on the use of such models in emerging economies for policy analysis as well. Unfortunately the issue of fiscal and monetary policy interaction and coordination is largely ignored in Pakistan particularly under the dynamic stochastic general equilibrium framework. Hanif and Arby (2003, 2010) realizes the importance of the issue and initiate a very healthy and productive debate. They start to explore this neglected area of research with a good attempt and investigate the issue of coordination between fiscal and monetary authority in Pakistan. Their research mainly discusses the institutional arrangements for coordination without going into the details of empirical analysis. Their findings reveal very few instances of coordination between fiscal and monetary authorities in Pakistan. They report rare occurrence of coordination between Ministry of Finance and state bank. Both the authorities in Pakistan primarily work independently since its inception. Nasir *et al* (2010) also attempt to investigate the degree of coordination between fiscal and monetary authority in Pakistan using VAR techniques and observe weak coordination between the two authorities. The area of interaction between fiscal and monetary policy interaction is largely ignored, particularly in a dynamic stochastic general equilibrium framework.

Economies are changing momentarily and it is very much difficult to capture all the dynamism, features and attributes of these changing economies. But the use of different models enables and helps us to get closer to the real picture of the shifts in economic environment. This is very high time to look into the issue of fiscal and

monetary policy interaction and coordination because Pakistan is facing the challenge of slackening economy. To the best of our knowledge, no research on the interaction between fiscal and monetary policy using dynamic stochastic general equilibrium model for Pakistan is available. The objective of this thesis is to bridge this gap by examining the conceptual considerations as well as empirical investigation of the issue on fiscal and monetary policy interaction. Following the seminal work of Christiano *et al* (2005), Coenen and Straub (2005) and Cebi (2012), this thesis investigates the interaction between fiscal and monetary policy in Pakistan using a dynamic stochastic general equilibrium framework. This thesis is an endeavor to identify the problems of fiscal and monetary policy and suggests some timely policy recommendation in the light of findings in order to bring the economy of Pakistan back on the track.

Chapter 3

STYLIZED FACTS OF PAKISTAN'S ECONOMY

3.1: Overview

In this chapter we descriptively analyze different macroeconomic variables and explain the stylized facts of Pakistan's economy. The overview of the economy, the movement of key macroeconomic variables and current scenario, helps us in understanding different issues. This overview also provides some sort of foundation for assessing the impacts of fiscal and monetary policy on one another and their coordination or absence of coordination between the treasury and monetary management.

There is a heated debate on the issue of macroeconomic stabilization in Pakistan. General perception exists that successive governments in Pakistan brought nothing except debt and economic crisis to this country. Currently Pakistan faces deep economic and governance crisis. Economy of Pakistan is going one step forward and two steps back. Political unrest with high uncertainty exists in Pakistan. The economy is also highly expose and policy outcomes are mostly unpredictable because of internal and external shocks. These shocks are largely beyond the control of policy makers. But at the same time absence of active macroeconomic policies to address the prolonged structural economic problems in Pakistan produce a bunch of serious challenges. High inflation, growing fiscal imbalances and deteriorating budget deficit, worsening exchange rate, mounting public debt and higher discount rate are to name the few among many economic challenges this country faces today. This situation demands an active role from fiscal and monetary authority because policy intervention on their part is indispensable. The timely realization and policy response reduces the negative impacts of shocks and helps in correcting grave economic as well as political problems.

The presence of so many economic crises provides a litmus test to check the ability and credibility of the economic managers and politicians.

It is also observed that every successive government in Pakistan breaches economic laws and does not follow economic rules. State bank of Pakistan (SBP) warns time and again that the decisions of the treasury create problems for monetary management in the country. The indiscipline fiscal policy and unrestrained borrowing reduce the effectiveness of monetary policy. Monetary authority repeatedly demands from the federal government to outline a complete plan for the entire financial year which also includes the demand for seigniorage. Infringement and the continuous violation of budget constraints by the Ministry of Finance make the environment less conducive for the operation of monetary policy. Similarly the tight monetary policy stance of state bank of Pakistan increases the problems of the fiscal authority. The higher interest rate increases the debt liabilities of the government because Pakistan pays huge amount on servicing the public debt.

Government of Pakistan takes the initiative and prepared Fiscal Responsibility and Debt Limitation (FRDL) act to stop all the negatives associated with persistent and continuous fiscal deficit. Similarly the problem of excessive government borrowing from the state bank of Pakistan forces the policy makers to establish Fiscal and Monetary Policy Coordination Board (FMPCB). These institutional arrangements are meant to harmonize the decisions of the fiscal and monetary authority and to increase the level of cooperation between Ministry of Finance and state bank of Pakistan. These particular arrangements make it mandatory for the government to issue Economic Policy Statements (EPS) each year to ensure transparency in government spending and revenues and to maintain performance. All the decisions taken by the government that have considerable effect on economy's health should be mention in the Economic

policy statements. FRDL act also proposed the establishment of a Debt Policy Coordination Office (DPCO). Debt Policy Coordination Office is responsible to prepare a ten year plan for debt reduction and to ensure the prescribed limit of public debt as a percentage of GDP. DPCO also monitors the performance of the government, outlined strategy and forces the government to return to debt reduction policy if government violates the debt to GDP ratio for two consecutive years. The institutional arrangements in the form of FRDL and FMPCB aim to bridge the gap between fiscal and monetary authority. FMPCB requires both the fiscal and monetary authority to meet once in four months in order to exchange information regarding the state of Pakistan's economy and to share their respective strategy and policy options.

State bank of Pakistan (SBP) strives hard to establish institutional arrangements. The objectives of such arrangements are to obtain greater autonomy for the state bank and to reduce political influence and pressure. Monetary authority wants to execute policies that ensure price stability and autonomy of the state bank. State Bank of Pakistan amended the 1956 act to carve institutional and operational arrangements for the sole purpose to make the environment more conducive for the effective operation of monetary policy. The amended bill of the State Bank of Pakistan seeks lesser role for the Ministry of Finance in the central bank business. State Bank wants put an end to the federal government right to rescind the authority of the bank. The bill presented in the National Assembly (NA) and was passed unanimously on November 4, 2010. It was hoped that the amended bill is a ray of hope but unfortunately the amended bill gets a knee jerk reaction from the finance committee in the senate. The senate standing committee puts a question mark on the degree of independence of the State Bank of Pakistan. The politicians and senators also oppose the elimination of the government's authority to rescind the monetary authority's decisions. All this shows the disagreement

among politicians, Ministry of Finance and State Bank of Pakistan. This also indicates the severity of the tense relationship between two key public entities.

The deep economic crisis of Pakistan demands even a bigger role for the fiscal and monetary authority to coordinate with each others. Keeping in view the above mentioned institutional arrangements and developments, revival of the economy and macroeconomic stabilization is only possible if they agree on points that align objectives. Coordinated economic initiatives are critical to stop the federal government from the fiscal slippages. But the policy response is lethargic and the process of correcting the crisis is highly bureaucratic.

Overview of the current trends in the economy of Pakistan

3.2: Debt Situation of Pakistan

The main objective of highlighting the debt situation of Pakistan is the considerable implications it holds for the effectiveness of monetary policy. Pakistan is highly indebted country. The country entered in the 21st century with a serious financial crisis and public debt exceeding 90 percent of GDP and more than 600 percent of its annual revenue. Cost of debt servicing mounted to the half of its current revenue. The decade of 1990s experienced an unprecedented increase in Pakistan's debt. Both domestic and external debt rise sharply. Debt was 1 million dollar in 1954 and it reached to 3.7 billion dollars in 1971-72. Pakistan's debt has increased to 38.9 billion dollar by the end of fiscal year 1999 from 20.5 billion dollar in 1990 registered an increase of 89.75 percent. In the corresponding period, gross domestic product declines from 63.5 billion dollars to 58.8 billion dollars. In 2001 Pakistan's total debt stood at 115 percent of GDP. This includes 55 percent of foreign debt and 45 percent as a domestic debt. The outstanding stock of public debt was 400 percent of government revenue in 1980 and reached to 626 percent in 2000. The current situation of public debt is further

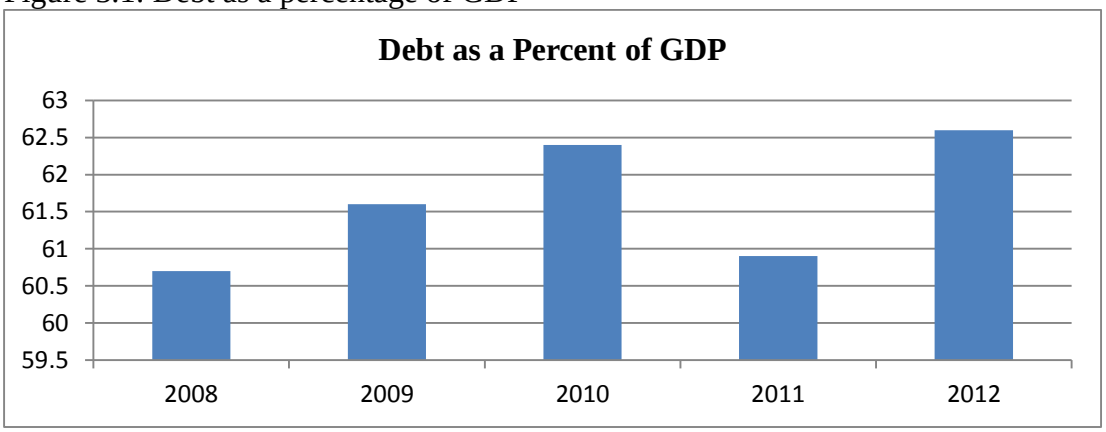
aggravated. In the last five years, the level of public debt as percentage of GDP has reached to 62.6 percent.

Table 3.1: Public Debt as a Percent of GDP, Revenues, Domestic and Floating Debt

	FY08	FY09	FY10	FY11	FY12
Public debt/GDP	60.7	61.6	62.4	60.9	62.6
Public debt/ revenues	414.6	423.3	444.1	486.2	503.6
Domestic debt/total public Debt	52.7	49.3	50.4	54.7	59.1
Floating debt/Domestic debt	50.0	49.3	51.5	53.8	54.2

Source: SBP, MoF, DPCO. Author's Calculation.

Figure 3.1: Debt as a percentage of GDP



Source: State Bank of Pakistan.

From the above figure it is clear that debt to GDP ratio has reached to 62.6 percent of GDP at the end of fiscal year 2012. This is above and against the specified threshold level of 60 percent as indicated in the various Debt Policy Statement (DPS) documents of Debt Policy Coordination Office (2015-16). The efforts of government and the resulting significant decrease in the public debt in fiscal year 2011 proves short lived and add around 1.9 trillion rupees in fiscal year 2012. At the moment the total volume of public debt in Pakistan is 17,380.7 billion rupees (Debt Policy Statement 2015-16). Such a significant figure of public debt mainly causes by the ruthless spending and fiscal

deficit. Pakistan declared and listed in severely indebted low income countries (SILICs) in South Asia by World Bank (WB) in 2001. Since 2000 there is a momentum in GDP growth and the public debt indicators show signs of improvements. The prudent debt management policy and growth in nominal GDP in first seven years (2000 to 2007) pay some dividend led the country to reduce its public debt to 53.4 percent in 2001 from 100.3 of GDP in fiscal year 1999. A considerable rise of 19.22 percent in public debt occurred in FY11 and it increased by 1,751.1 billion rupees in a single fiscal year. The total public debt was 9,107.3 billion rupees in FY10 and reached to 10,858.4 billion rupees in FY11. The latest data provided by the State Bank of Pakistan shows total debt and liabilities of the government soared by 17.37 percent and increased by 1,775.1 billion rupees. Total debt and liabilities in FY12 stood at 14,587 billion rupees as compared to 12,530 billion rupees in FY11. This shows a phenomenal growth of 16.42 percent per annum.

Table-3.2: Public Debt, Liabilities and Debt Servicing Billion Rupees

Year/variables	FY 2011	FY2012	Change	% Change
Total Debt & Liabilities	**12,530**	**14,587**	**2,057**	**16.42**
Public Debt	**10,990.7**	**12,924.3**	**1,933.6**	**17.59**
Total Liabilities	**621.6**	**665.4**	**43.8**	**7.04**

Source: State Bank of Pakistan

The significant share of public debt and interest payments is denominated in Pakistani currency. Besides external financing, federal government also borrows money from domestic commercial bank and local non-bank financial institutions along with some other institutional investors. In fiscal year 2006 total public debt stood at 72 billion dollars. The share of external debt was 47 percent or 34 billion dollars while the share of domestic debt was 53 percent and it stood at 38 billion dollars. Federal government

has gradually switched over to domestic borrowing from external borrowing despite the fact that borrowing internally is expensive than from external sources.

Table 3.3: Debt as a Percentage of GDP

Year/variables	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Total Debt as a percentage of GDP	58.9	63.3	64.0	63.8	63.5
Domestic Debt	32.9	38.1	42.5	43.6	44.5
External Debt	26.0	25.2	21.4	20.2	18.9

Source: Debt Policy Statement 2015-2016: Debt Policy Coordination Office, MoF

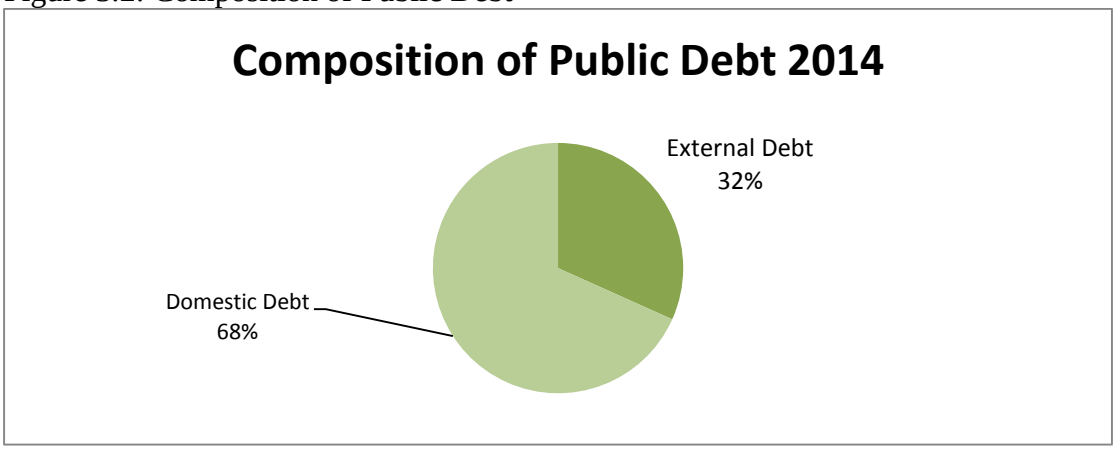
Table 3.4: Debt Composition; Total, Domestic and External Debt
Billion Rupees

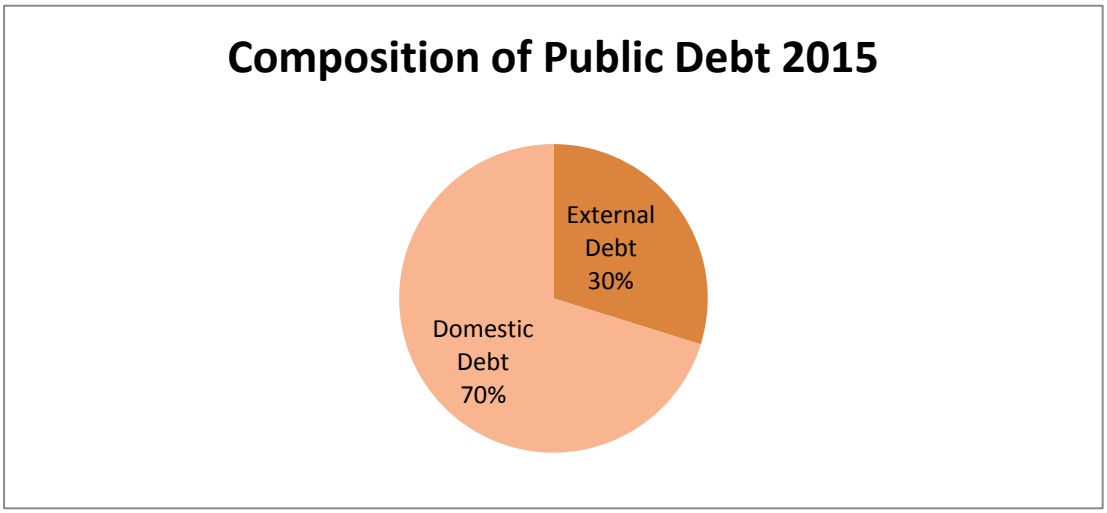
Debt/Year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015(P*)**
Total Debt	7,312.7	9,006.2	10,766.9	12,695.3	14318.4	15,991.5	17,380.7
External Debt	3,452.0	4,351.9	4,750.2	5,057.2	4,796.5	5,071.5	5,181.8
Domestic Debt	3,860.7	4,654.3	6,016.7	7,638.1	9,521.9	10,920.0	12,198. 9

Sources: SBP Annual Report/Economic Affair Division: * P stands for provisional

In fiscal year 2014, the total share of external debt was 32 percent and domestic debt stood at 68 percent of the total debt. In the fiscal year 2015, the share of external debt has decreased to 30 percent while the share of domestic debt has increased to 70 percent. This indicates a gradual rise of the reliance on the domestic borrowing which is not a good sign for the economy.

Figure 3.2: Composition of Public Debt





3.3: Debt Serving

The repayments of debt and the corresponding interest payments on debt gradually grow and it is now the principle component of government expenditure. In seventies the cost of servicing debt was 2.5 percent of Gross National Product (GNP) and reached to 3.5 percent of GNP in the decades of eighties. Higher debt to GDP ratio and the resulting debt services have taken more than seventy percent of total revenue in 2001. Currently high debt servicing become the largest expenditure component in the budget and is more problematic than debt itself. Total debt servicing in fiscal year 2012 was 1260.2 billion rupees compared to 978.4 billion rupees in fiscal year 2010. This shows a mammoth increase of around 281.80 billion rupees, implies a 28.75 percent increase, in total debt servicing. Interest payments on domestic debt increase

from 577.7 billion rupees in FY 2010 to 811.2 billion rupees in fiscal year 2012. This registered an increase of 233.5 billion rupees that shows a rise of 40.41 percent. In FY2010, the total amount of interest payments on external loan was 82.9 billion rupees which reached to 89.8 billion rupees at the end of fiscal year 2012.

Table 3.5: Interest Payments on Debt
Billion Rupees

	FY 2010	FY2011	FY2012	Change	% Change
Total Debt Servicing	978.4	1017.4	1260.2	**281.80**	**28.75**
Total Interest Payments	715.0	807.1	966.3	**251.30**	**35.14**
Domestic Debt	577.7	650.3	811.2	**233.50**	**40.41**
External Debt	82.9	90.6	89.8	**6.90**	**8.32**
Principal Repayment	263.4	210.3	294.0	**30.6**	**11.61**

Source: SBP Annual Report 2012

The increased trend in interest payments and debt accumulation has considerable impact on fiscal and monetary policy. Prudent debt management policy with responsive fiscal and monetary policy is needed to bring debt level down. It is also visible from the pie chart presented in figure 3.3 that the share of interest payments on domestic loans increases compared to the share of interest payments on external loans. This also indicates that government is trying hard and diverting its borrowing from external source to the more easily available domestic sources, which is a dangerous trend.

Figure 3.3: Interest Payments on Domestic and External debt

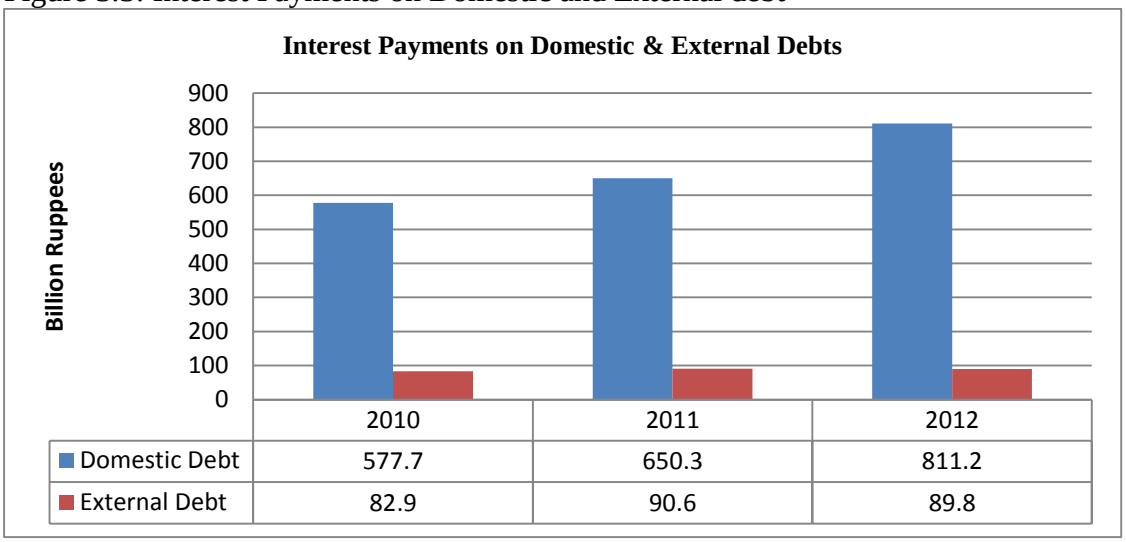
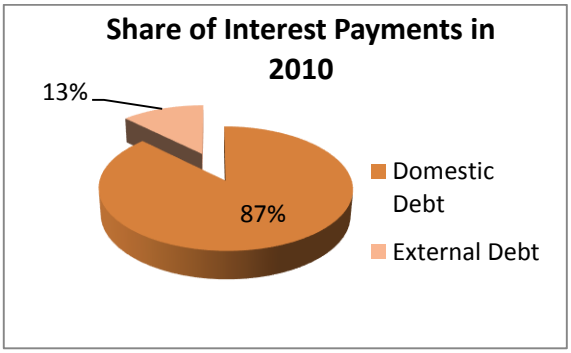
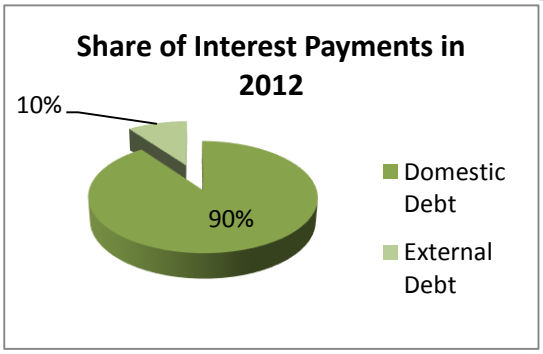


Figure 3.4 shows the share of interest payments on domestic and foreign loan. The share of interest payments on domestic debt has increased to 90 percent in fiscal year 2012 from 87 percent in fiscal year 2010. The growing tendency and reliance on domestic borrowing makes the environment less favorable for the operation of monetary policy.

Figure 3.4: Share of Interest Payments on Domestic and External Debt





Source: State Bank of Pakistan

The stock of domestic debt at the end of fiscal year 2011 was 10,990.7 billion rupees which was 60.9 percent of GDP. In the fiscal year 2012, domestic debt rose to 12,924.3 billion rupees and stood at 62.6 percent of GDP which is above the maximum limit of 60 percent. This shows the grave fiscal position of the government and potential threat to fiscal sustainability. The objectives of monetary authority is very difficult to achieve in an environment where the chances of fiscal sustainability diminishes.

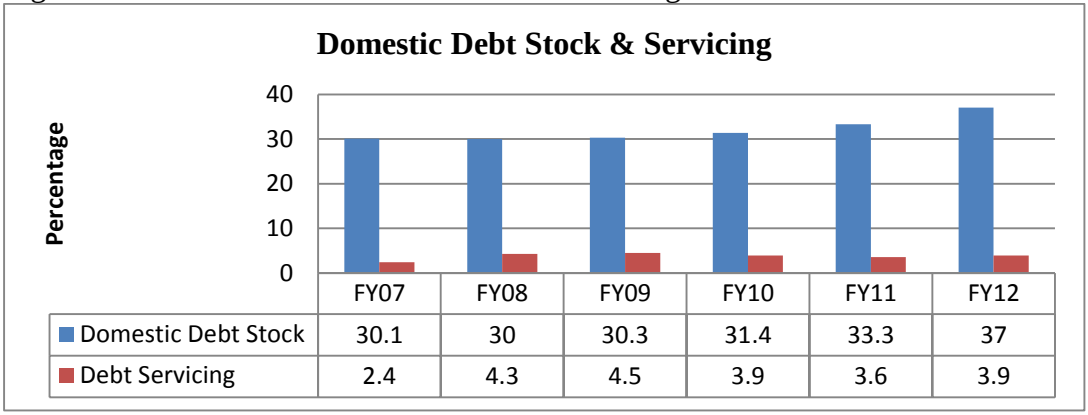
Domestic debt servicing as a percentage of GDP was 3.6 percent in FY11 and increased to 3.9 percent of GDP in FY12. Stock of domestic debt as a percentage of GDP rises from 33.3 in FY11 to 37 percent of GDP in FY12. We frame the stock of domestic debt as a percent of GDP and interest payment on it in Table 3.5.

Table 3.6: Stock of Domestic Debt & Debt Servicing as a Percentage of GDP

Year	Domestic Debt Stock	Debt Servicing
FY2007	30.1	2.4
FY2008	30.0	4.3
FY2009	30.3	4.5
FY2010	31.4	3.9
FY2011	33.3	3.6
FY2011	37	3.9

Source: State Bank of Pakistan

Figure 3.5: Domestic Debt Stock and Debt Servicing



	FY07	FY08	FY09	FY10	FY11	FY12
Domestic Debt Stock	30.1	30	30.3	31.4	33.3	37
Debt Servicing	2.4	4.3	4.5	3.9	3.6	3.9

The above figure and table indicate that there is a persistent rise in the stock of domestic debt as a percent of GDP. This indicates that treasury or Ministry of Finance does not follow the legislation made for the debt limitation. Pakistan has very little resources and funds to repay the principal amount of its debt and to meet the interest payments requirements. The repayment of principle and interest payments on debt entails extra burden on the national exchequer.

Keeping in perspective the current debt situation of Pakistan, we in this thesis strongly recommend sensible and shrewd actions on the part of fiscal and monetary authority for the enhanced policy coordination in order to rescue the crippling economy from this sorry state of affair. Prudent and far-sighted fiscal policy is inevitable for the sustainability of the deficits and debt and for the optimality of monetary policy. There must be some effective and implementable institutional arrangements that change and bring the balance of power between fiscal and monetary authority and to resolve the economic and political issues. State Bank of Pakistan is not in a position to give a cold shoulder response to the Ministry of Finance. This can also be gauged from statement made by the governor of State Bank in which he says, "We *State Bank* cannot bounce back the cheque of federal government or other public sector entity". State Bank injects liquidity and finance the budget deficit because of the limited choices available to it.

This kind of situation demands the determination of treasury and State Bank of Pakistan to fix the problem of ever increasing debt level of the country. Country is on the verge of bankruptcy and the threat of insolvency shattered the confidence of the investors and increases the country's vulnerability to shocks. Pakistan has very limited resources to meet its debt obligations. The increase risk of default forces the government to offer treasury bills, Pakistan investment bond and other government papers at a very higher rate in the international market.

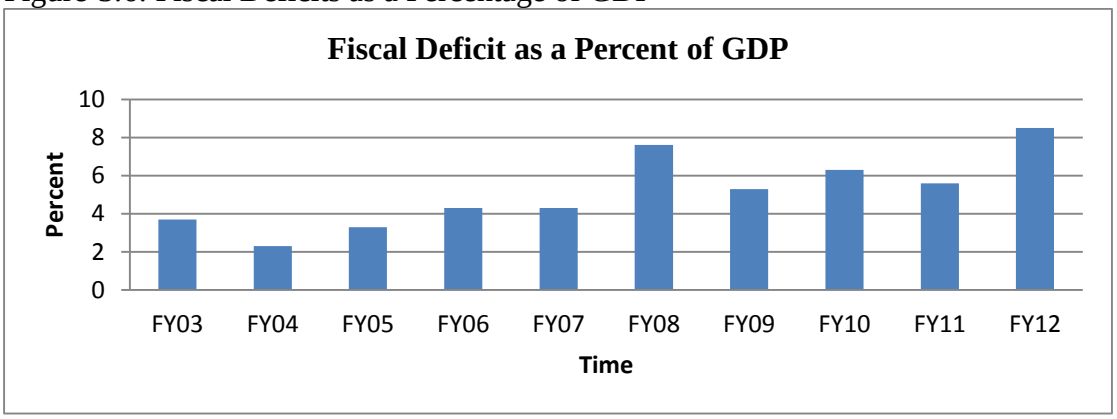
Relocating responsibilities is very important to avoid the country from the danger of default. Government needs to take monetary authority on board in the process of fiscal policy formulation. The treasury also needs to inform State Bank of Pakistan about the level of deficit and the required level of seigniorage in a timely manner. A highly indebted country and the chances of insolvency increase uncertainty. It reduces investor's confidence and discourages production activities. The shrinking activities reduce revenue that forces the government for further borrowing. Government needs to realize the fiscal profligacy and the negatives associated with unrestrained spending. Similarly the monetary management also needs to recognize the implications of monetary policy for fiscal authority. But there are no signs of change, status quo is still intact. Politicians are not ready to make the political environment more conducive for the operation of fiscal and monetary policy.

3.4: Budget Deficit

Inter-temporal budget constraint plays an important role in the process of interaction between fiscal and monetary policy. Budget deficit rises whenever treasury or Ministry of Finance violates this budget constrain. Since its inception, Pakistan faces widening fiscal imbalances and deficits. For decades, the lax control over government spending increases budget deficits and shrink fiscal space. Fiscal deficit is largely

influences by political objectives instead of economic needs. Policy inaction worsens the fiscal position. The monetary policy statement of the State Bank of Pakistan indicates that structural weaknesses of the economy are the main factors that cause these massive budget deficits. Natural calamities, narrow tax base, and inflexible government expenditures are some of the structural factors that multiplies fiscal deficit. In 2008 fiscal deficit was 777.2 billion rupees. In 2009, government successfully implements the programs initiated for macroeconomic stabilization result in substantial fiscal consolidation and reduces the deficit to 680.4 billion rupees. It means a 12.5 percent decline in a single fiscal year. In terms of percentage of GDP, the fiscal deficit is reduced to 5.2 percent in fiscal year 2009. The main reason for the addition to the fiscal deficit in the last quarter of 2009 was the increase in development expenditure in that particular quarter coupled with expenditures incurred on the war against terror. The fiscal deficit in FY10 was 929 billion rupees. The targets set for fiscal deficit in the budget 2010-11 was 4 percent of GDP but at the end of the fiscal year, it stood around 6.3 percent. The target for fiscal deficit in FY11 was 685 billion rupees but at the end of fiscal year the actual deficit stood at 1194 billion rupees. The target for deficit in fiscal year 2012 was 851 billion rupees but unfortunately it reached to 1760.7 billion rupees and registered an increase of 106.9 percent and equal to an amount of 909.70 billion rupees. Such a considerable deviation from the budget deficit from the treasury is very irritating for their monetary counterpart. The following figure shows the level of public deficit over the years.

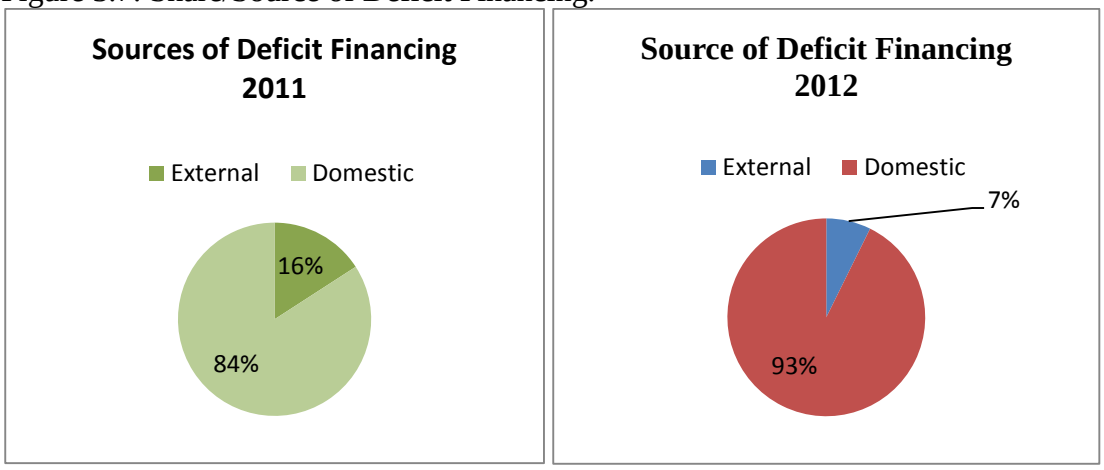
Figure-3.6: Fiscal Deficits as a Percentage of GDP



Sources: SBP, MOF

Fiscal deficit is mainly financed through borrowing from domestic resources as there are many limitations to obtain funds from external sources. In FY11, the federal government borrowed 108 billion rupees from the external sources while significant portion of around 1087 billion rupees come from domestic sources. The trend continued in fiscal year 2012 and government grabbed a significant portion of liquidity of the domestic sector. By June 2012, commercial banks advance 692.3 billion rupees to the government for financing deficit. This has also critical implications for the private sector investment. The share of private sector lending by the commercial banks was 52.4 percent in 2008 and has reduced considerable to 39 percent in 2012. The percentage of deficit financing by the commercial banks has also increased considerable and reached to 34.4 percent in fiscal year 2012 which was just 16.6 percent in 2008.

Figure 3.7: Share/Source of Deficit Financing.



The share of financing fiscal deficit gradually switched from external sources to domestic sources. The above figure indicates that there is a significant decline in the external financing and the share of external and domestic sources of deficit financing has also changed considerably. In fiscal year 2011, the share of external financing was 16 percent while the share of domestic sources of financing was 84 percent. The surge in domestic financing continues and reached to 1632.1 billion rupees while external finance shrinks to a mere of 128.7 billion rupees which is 7 percent of the total financing.

The significant shift in fiscal deficit financing from external sources to domestic sources has many important implication for the economy of Pakistan. First, it increases money supply in the economy and causes price instability and ultimately inflation. This is a major source of concern for the State Bank of Pakistan and monetary managers warn repeatedly about the associated problems. Second, it decreases the liquidity in the domestic financial market and leads to crowd out private sector investment. The resulting inflation and reduced liquidity in the financial market caused the discount rate to rise. The cost of domestic debt surges considerably with the soaring discount rate.

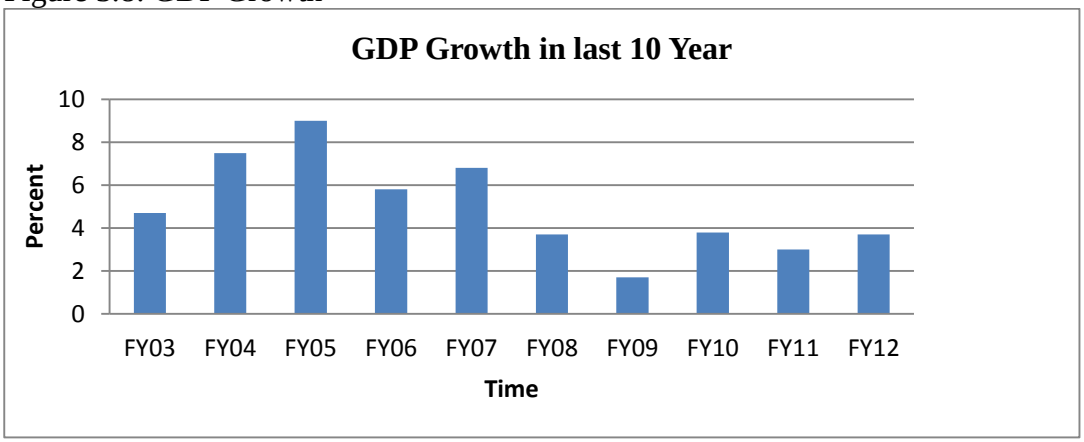
This increases the burden on federal government and reduces fiscal space because cost associated with interest payments on internal debt is very high.

The latest report of State Bank of Pakistan (MPS 2011) reveals that federal government borrowing is the key factor that produces fluctuations in the money market. The report also mentioned that government borrowing and debt management considerations have badly affected the liquidity operation of the bank. The intensity of fiscal stress can also be judge from the disproportionate and excessive dependence on domestic sources of financing. The federal government also received less than what is committed in the coalition support fund. Law and order situation and the ongoing war against terror have multiplied the expenditures. On the revenue side there was a short fall of 118.2 billion rupees. Despite the hectic efforts by the Federal Board of Revenue (FBR), revenue declined to 14.1 percent of GDP as compared to 14.6 percent in previous fiscal year. The targets agreed with IMF were not met despite the efforts by government to stop fiscal profligacy. In the fiscal year 2010-11 the target for revenue was 1,667 billion rupees but was cut downward to 1,588 billion rupees due the devastating flood in the country's history. The federal board of revenue failed to achieve the target and collect only 1,550 billion rupees. Circular debt also played a critical role in the massive fiscal deficit. Government expenditures along with revenue deficit also contribute in substantiating fiscal deficit. Federal government provides huge subsidy in different heads that caused fiscal slippages. In the budget statement the target for subsidy was 127 billion rupees but it stood at 380 billion rupees at the end of fiscal year 2011. These deviations of spending from the government side are creating uncertainty which badly affect the design and operation of monetary policy.

3.5: Growth

The economic recovery remained paltry in FY11. In FY10, GDP growth stood at 3.8 percent. The target for growth was 4.5 percent at the beginning of the financial year but at the end of the year it registers a growth rate of 2.5 percent. Besides the devastating flood in the country's history, high crude oil prices in the international market, energy shortage and the worst law and order situation in the country elucidate the poor performance of the economy. The sluggish growth in GDP is also caused by fiscal profligacy and shrinking fiscal space. The target for GDP growth in fiscal year 2012 was 4.2 percent but it remained limited to only 3.7 percent.

Figure 3.8: GDP Growth

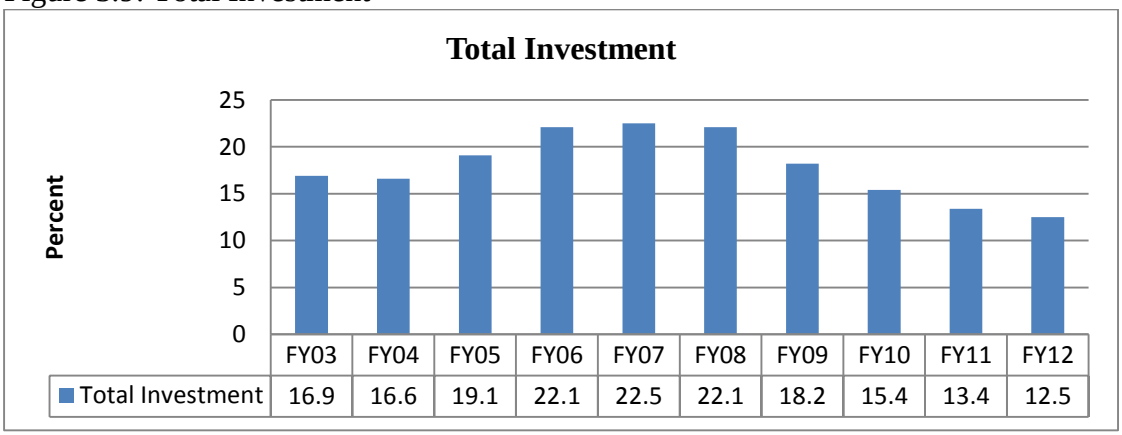


3.6: Investment

Monetary Policy Statement (MPS2011) of the State Bank reveals that gross total investment has declined to the lowest 13.4 percent of GDP in fiscal year 2011 since 1974. Investment plays a critical role in the development of a country. Investment is the cornerstone for a country and the significance of investment for macroeconomic stability cannot be denied. Investment helps in creating jobs and promoting growth in the country. It also helps in transferring technologies and industry to a country. Investment is considered to be the driving force of economic revival and stability. Total investment in Pakistan declines by 12.99 percent in FY11 and 40 percent since FY07.

Total investment diminished to 13.4 percent of GDP in FY11 from 22.5 percent of GDP in FY07. The downward trend continues and investment to GDP ratio further declined to 12.5 percent in fiscal year 2012. In the last 38 years, the GFI as a percentage of GDP is at the lowest. The hostile environment for both domestic and foreign investors considerably reduces the productive capacity of the economy and the creation of new jobs. Many factors are responsible for reversing the growing trend in foreign direct investment. To name the few, policy inaction, poor and bad governance, unchecked corruption, adverse law and order situation and energy crisis are critical factors in discouraging foreign direct investment. These factors lead to a sharp and considerable decline in the overall investment in the country. Foreign investors are shy and reluctant to invest in Pakistan in the presence of these problems.

Figure 3.9: Total Investment

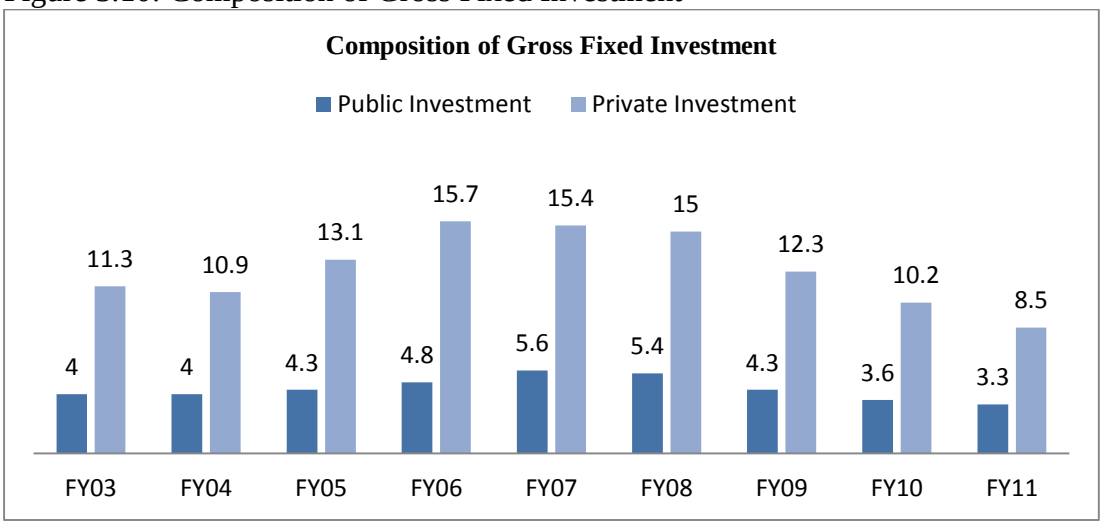


Sources: Ministry of Finance, SBP Annual Report.

Negative growth in foreign direct investment hampers economic development. In the first quarter of the current fiscal year (FY 2011), foreign direct investment stood at 50.1 million dollars down from 290 million dollars in the corresponding period of FY10. Gross fixed investment declined by 14 percent and decrease to 11.8 percent in FY11 from 13.8 percent in FY10. Public investment fell by more than 8 percent of gross domestic product in fiscal year 11. Public investment decreased to 3.3 percent of gross

domestic product in FY11 from 3.6 percent of GDP in FY10. The share of private investment is quite high in fiscal year 2006 to fiscal year 2008. But private investment reports a significant decline of around 16 percent and it declines to 8.5 percent of GDP in FY11 from 10.2 percent of GDP in FY10.

Figure 3.10: Composition of Gross Fixed Investment



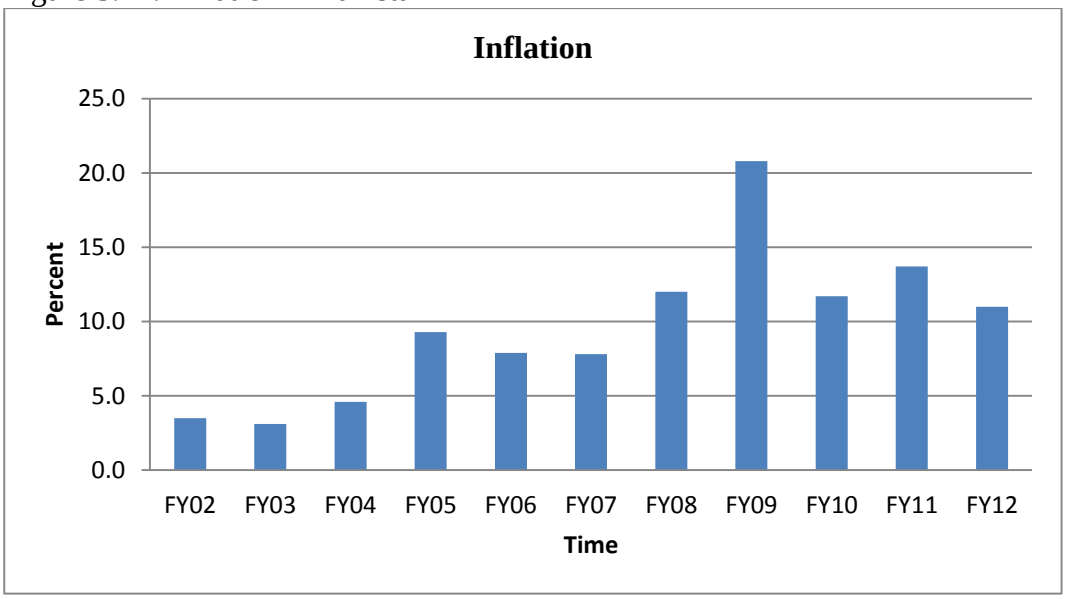
The latest monetary policy information compendium (2011) by the monetary policy department shows that foreign direct investment was 283 million dollar in July-August 2011 which decreased to a mere 59 million dollar in the corresponding period of the current fiscal year. This shows a significant decrease of 79.15 percent. In FY11, total foreign direct investment stood at 1,869 million dollars.

3.7: Inflation

Another important macroeconomic variable that plays an important role in the interaction between fiscal and monetary policy is inflation. We know that fiscal authority or treasury prefers lower unemployment and is least bothered about high inflation. On the other hand monetary authority prefers lower inflation rather than high employments rate. Volatile and high inflation has very important economic as well as political and social consequences. Economic agents, both producer and consumer are averse of inflation. Main reasons for such aversion are the negative impacts of inflation

on output, and the discouragement of saving and investment. Inflation erodes the real value and reduces the purchasing power of money. Pakistan is facing double digit inflation for many years in a row. Like other macroeconomic variables targets, inflation also deviated from its target. The target for inflation in FY10-11 was 9.5 percent which registered an increase on around 46 percent and stood at 13.9 percent at the end of fiscal year 2011. The target for inflation in fiscal year 2012 was 12 percent and the actual inflation stood at 11 percent. The main reason is the base effect. The government has changed the base period from 1999-2000 to 2004-2005, that accommodated the increase and showed a lower level of inflation.

Figure 3.11: Inflation in Pakistan



Inflation is deep rooted in the economy of Pakistan. Violation of commitments made in the Medium Term Budgetary Framework (MTBF) by the federal government make the inflation targets difficult to achieve. Monetary management is doing its best to control inflation by adopting tight monetary policy. But the effects of tight monetary policy and high discount rate are being offset by the fiscal profligacy. Federal government commitments in the form of promises made in the MTBF by improving its fiscal position and decreases its borrowing from the central bank would facilitate both

monetary and fiscal authority to achieve inflation targets. Beside the lack of coordination between fiscal and monetary policy, there is also a gap between supply and demand which creates inflation in the economy. On the one hand excessive government spending stimulates aggregate demand causing the price level to rise. On the other hand the unrestrained borrowing leaves lesser funds for the private investors to invest. Declining investment and the resulting fall in productivity widens output gap. Identifying and admitting the problem of indiscipline fiscal policy, not only monetary but fiscal measures are also critical for controlling inflation. Inflation is in double digit for many years that pushes up the cost of living. Economic growth is at stake and threatens by high and volatile inflation along with the double digit discount rate. High level of managed coordination, exchange of information and targets and some sort of constitutional code between fiscal and monetary authority is the pre-requisite to tackle the economic issues. State Bank of Pakistan is constantly blaming the federal government spending for creating high inflation in the country. This implies that fiscal discipline is inevitable for the consequential cuts in inflation. State Bank in its latest monetary policy also recognized the efforts on the part of government for reducing borrowing from the bank. Government in the last two quarters retired the borrowing from SBP which proved meaningful in improving inflation outlook.

3.8: Discount Rate

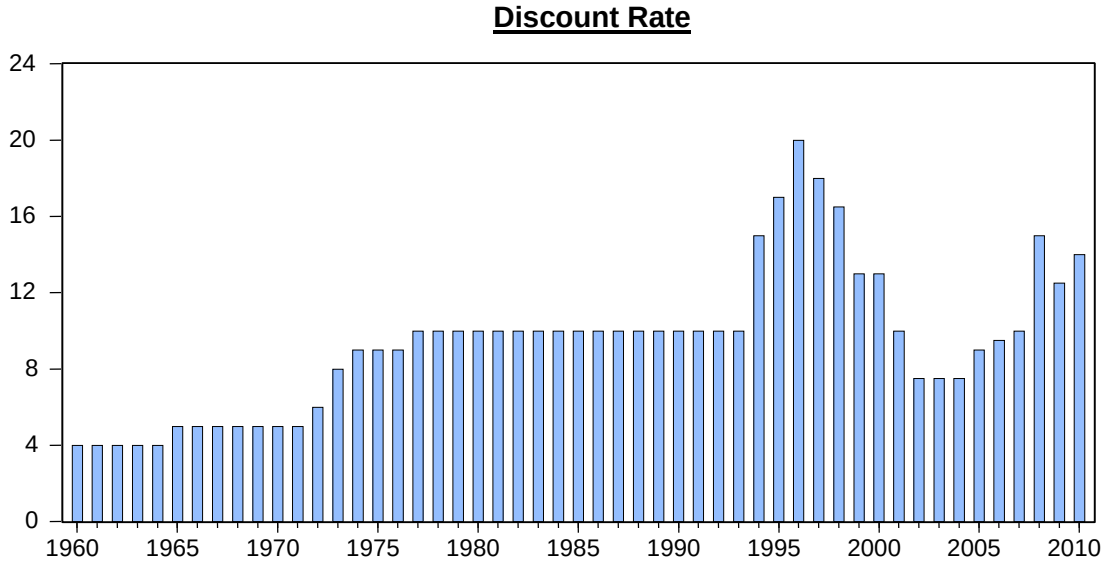
Another important macroeconomic variable is the discount rate. State Bank of Pakistan is currently employing discount or interest rate as a policy instrument. The decisions of the State Bank regarding the determination of interest rate holds important implications for fiscal policy n Pakistan. One of the main reasons for the interest rate importance is the high level of public debt in Pakistan. Any change in monetary policy, interest rate, can potentially disturb the government budget constrain because servicing

debt is the largest component of the federal budget. State Bank of Pakistan considers spending of the government beyond their means as the major source of high discount rate in the country. Broken promises of the fiscal managers and politicians create greater money market volatility and increases prices in the economy. This forces and compels SBP to keep the interest rate high. Violating Fiscal Responsibility and Debt Limitation (FRDL) act and the continuous violation of the commitments made in the Monetary and Fiscal Coordination Policy Board (MFPCB) meetings made the economic environment less favorable for monetary authority. The federal government borrowing from the State Bank of Pakistan is responsible for the higher inflation in the country and it forces the monetary authority to keep the policy rate high. In FY11 the policy rate in Pakistan was the highest among different regional and international economies following Vietnam.

In fiscal year 2010, the debt service of government stood at 5.6 percent of GDP. A major share of the domestic debt contained a floating debt and it is highly responsive to changes in the interest rate. State Bank's decision of keeping monetary policy tight while increasing interest rate by 50 basis points in 2010 contributed almost 34 billion rupees extra to the country's debt servicing cost. Interest payments on debt rocketed to 804.3 billion rupees in FY11. Such type of monetary tightening without appropriate fiscal consolidation is not productive to bring inflation down but it further lead to higher inflation. State Bank increases the interest rate in response to high inflation but it is hardly effective. The reason is simple. Fiscal policy in Pakistan rarely responds to warnings and demands of monetary authority in the past and seems difficult to respond even in the future. In Pakistan fiscal space is low and any monetary tightening would further exacerbates the already aggravated fiscal position. If the State Bank of Pakistan keeps the interest rate high, it will increase cost of debt servicing and will compel the

government to ask for further seigniorage to finance its spending. This kind of monetary tightening would further increase inflation instead of controlling it. In the presence of volatile exchange and uncertainty about the fiscal deficit targets has make the life of State Bank uneasy to manage the supply of money in the economy.

Figure 3.12: Discount Rate



Source: State Bank of Pakistan.

Massive interest payments as debt servicing made Pakistan unable to services its debt. Pakistan experiences many rounds of debt rescheduling. Intense political pressure on State Bank and the demand for seigniorage makes the life of monetary managers difficult. The government is constantly pressurizing State Bank of Pakistan to bring down the interest rate in order to spur economic growth and development even in the presence of higher demands for seigniorage. State Bank of Pakistan sometimes resists the demands of the federal government on the face of high and persistent inflation in the country. Effective debt management is critical to get rid of high debt and the mounting cost of debt servicing. A major component of any debt management strategy is the development of a liquid domestic debt capital market, particularly for

government securities. This reduces the instability of interest rates besides curtailing the cost of funds to the government

The reason for incorporating this chapter and the detailed discussion on the behavior of variables is the potential role of these variables in the process of interaction between fiscal and monetary policy. The discussion on their general behavior gives us a glimpse to observe the actual situation and trend. Before closing the chapter we also want to mention some of the major factors responsible for the overall grave and grim economic situation. The devastating and horrific earthquake in 2005, severe flood in the history of Pakistan in 2010, energy crisis, security, law and order situation and the ongoing war against terrorists and militancy in different parts of the country are the main sources of fiscal slippages. Surge in the development expenditure by the provinces also contributed in the mounting deficit. Political instability, weak economic growth and the resulting unfriendly and low investment environment contributed to higher government spending and lower revenue. These all are symptoms of the crippling economic situation and indicates the lack of sustainable political and economic policies in the country. The grim economic situation forces me to carry out this thesis on fiscal and monetary policy interaction.

Chapter 4

METHODOLOGY, RESEARCH DESIGN AND ECONOMETRIC TECHNIQUES

4.1: Introduction:

This chapter is design to discuss the theoretical model and econometric techniques in order to investigate interaction between fiscal and monetary policy. The objective is to explicitly present theoretical background of fiscal and monetary policy interaction. The chapter is broadly categorized into two sections. In the first section, we explain the theoretical foundation of fiscal and monetary policy interaction. In the second section of this chapter, we elaborate the dynamic stochastic general equilibrium model for tracking the interaction between fiscal and monetary policy.

4.2: Theoretical Considerations and Model for Fiscal and Monetary Policy Interaction

The traditional function of controlling inflation is assigned to the central banks by economic theory which is supported by the most quoted Friedman's notion that inflation is always and everywhere a monetary phenomenon. This implies that money supply is mainly responsible for inflation and the prime objective of central bank is to control inflation and bring price stability. But the proponents of the Fiscal Theory of Price Level (FTPL) have challenged this conventional dictum. The proponents of FTPL view that price level is determined by the decision of fiscal branch. Woodford (2001) finds that controlling inflation requires not only commitment to an appropriate monetary policy but needs commitment to an appropriate fiscal policy as well.

Financing budget deficit from different sources has different consequences. Government can borrow from both external and internal sources. But external borrowing is not unlimited. The government then borrows from the domestic

commercial banks and financial market along with borrowing from the central bank. The use of seigniorage to bridge the fiscal gap plays a crucial role in order to shape the policy choices of monetary authority. The main reason for abruptly changing policy instruments by the central bank is the inflationary nature of seigniorage. Seigniorage is one of the main reasons for high volatile prices and the right reason for calling it inflationary tax. High demand for seigniorage by the government makes the policy environment less conducive for the design and operation of monetary policy. Strand of literature shows that countries heavily relying on inflationary tax experience volatile prices and high inflation rate. Volatile and unstable price level produces uncertainty in the economy which negatively affects the expectation of the economic agents that make environment less friendly for economic activities. Woodford (2001) explores that as for as the developed nations are concerned, revenue from printing money in these countries is very low. Seigniorage is irrelevant for central bank in these countries as the low level of money printing does not affect the policy choices of monetary authority. In these economies it is generally believed that inflation is a monetary phenomenon and the notion of Ricardian equivalence holds. This implies that consumers are rational and decision of the government about its expenditure and revenue has no effect on the aggregate demand and on the price level. But many others find that fiscal developments are critical and alter aggregate demand along with price level.

We start with government budget constraint which plays an important role in linking fiscal and monetary policy[5]. Treasury budget constraint is given by

$$G_{t-1} + i_{t-1}B_{t-1}^{T} = T_t + \left(B_t^{T} - B_{t-1}^{T}\right) + CB_t^{R} \qquad (4.1)$$

The left hand side explains expenditures of the government while the right hand side shows government revenue. G_t represents government spending, $i_{t-1}B_{t-1}^{T}$ explains the

[5] The model is heavily based on Walsh (2003)

interest payments on public debt. On the right hand side of the equation, T_t is the government revenues generated from taxes, $B_t^T - B_{t-1}^T$ is the newly issued amount of interest-bearing debt by the government and CB_t^R is the amount which the federal government receives from the central bank. These are nominal variables and this budget constraint demonstrates that government has the authority to choose the level of government spending, taxes, fiscal deficits and level of public debt. If any kind of shock to the economy disturbs the above equation, government alters either its expenditures, taxes or both. Proponents of the fiscal theory of price determination suggest that the government inter-temporal budget constraint does not supposed to constrain fiscal authority from running budget deficit.

We have also a constraint for the central bank. The budgetary identity for the monetary management is

$$\left(B_t^M - B_{t-1}^M\right) + CB_t^R = i_{t-1}B_{t-1}^M + \left(H_t - H_{t-1}\right) \qquad (4.2)$$

Where $B_t^M - B_{t-1}^M$ shows the central bank's purchases of debt issued by the government, $i_{t-1}B_{t-1}^M$ denotes the interest payments paid by the Ministry of Finance. The central bank receives this amount in the form of interest rate when it purchases government bonds and treasury bills. $H_t - H_{t-1}$ is the change in the monetary base and indicates the changes in the liabilities of the central bank.

Let $B = B^T - B^M$ is the stock of government interest bearing debt held by the public. To get the consolidated government budget constraint, we combine equ (1) and equ (2)

$$G_t + i_{t-1}B_{t-1} = T_t + \left(B_t - B_{t-1}\right) + \left(H_t - H_{t-1}\right) \qquad (4.3)$$

In consolidated budget constraint only debt held by the public represent an interest bearing liability. Equation (3) shows that government spending and debt servicing are

financed either through tax revenues T_t, borrowing from commercial bank and private sector, $B_t - B_{t-1}$ or through monetization of deficit by printing currency, $H_t - H_{t-1}$.

Doing some small manipulation (See the details in appendix), we get

$$g_t + \bar{r}_{t-1} b_{t-1} = \tau_t + (b_t - b_{t-1}) + h_t - \frac{h_{t-1}}{(1+\pi_t)(1+\mu_t)} \qquad (4.4)$$

Equation 4.4 tells us the real value of government spending and the real value of government debt servicing. Government spending is considerably depend on level of resources generated in the economy, inflation rate and on the growth rate of real output. To investigate the role of anticipated and unanticipated inflation for the fiscal and monetary policy operation and effectiveness, let π_t^e is expected inflation and r_t is ex ante real rate of return.

So

$$1 + i_{t-1} = (1 + r_{t-1})(1 + \pi^e) \qquad (a)$$

Now we add

$$\left(\frac{r_{t-1} - \bar{r}_{t-1}}{b_{t-1}} \right) = \left(\frac{(\pi - \pi_t^e)(1 + r_{t-1}) b_{t-1}}{(1 + \pi_t)} \right)$$

to both sides of the consolidated government budget constraint to get

$$g_t + r_{t-1} b_{t-1} = \tau_t + (b_t - b_{t-1}) + \left[\frac{\pi - \pi^e}{1 + \pi_t} \right] (1 + r_{t-1}) b_{t-1} + \left[h_t - \left(\frac{1}{1 + \pi_t} \right) h_{t-1} \right] \qquad (4.5)$$

In equation (4.5) $(\pi - \pi^e) b_{t-1}$ represents revenue from unanticipated inflation. When inflation is anticipated, it is visible in the form of higher interest rate, because the central

bank then adopts tight monetary policy to contain high inflation rate. The decision of the monetary management to keep interest rate high increases the burden on the national exchequer. The last term of the above equation represent seigniorage.

$$S_t = \frac{H_t - H_{t-1}}{P_t Y_t}$$

$$s_t = h_t - h_{t-1} + \left(\frac{\pi_t}{1+\pi_t} \right) h_{t-1} \qquad (4.6)$$

Where $h_t - h_{t-1}$ show the changing position of high powered money.

The growth rate of nominal monetary base holds a prominent position in this scheme of things. Let $\phi = H$ and it indicates the growth rate of the nominal monetary base.

The growth rate of h_t will be

$$\left(\frac{\phi - \pi}{1+\pi} \right) \approx \phi - \pi$$

And

$$d = b + h \qquad (4.7)$$

The total government liability d is composed of interest bearing debt, b and non-interest bearing debt h. Every government prefers to shift its revenue from interest bearing debt to non-interesting bearing debt.

Now we add $r_{t-1} h_{t-1}$ and incorporate total liabilities of the government to the consolidated budget equation (5)

$$g_t + r_{t-1}d_{t-1} = \tau_t + (d_t - d_{t-1}) + \left(\frac{\pi - \pi^e}{1+\pi_t}\right)(1+r_{t-1})d_{t-1} + \left(\frac{i_{t-1}}{1+\pi_t}\right)h_{t-1} \qquad (4.8)$$

And

$$\left(\frac{i}{1+\pi}\right)h = \bar{s} \text{ is seigniorage.} \qquad (4.9)$$

Government budget constraint shows that any change in the revenue from seigniorage will alter and require an offsetting adjustment in the remaining factors of the above equation.

Ignore surprise inflation for a while, the single period budget identity becomes

$$g_t + r_{t-1}b_{t-1} = \tau_t + (b_t - b_{t-1}) + s_t$$

Assuming r to be constant and solving one period forward, we get

$$(1+r)b_{t-1} + \sum_{i=0}^{\infty}\frac{g_{t+1}}{(1+r)^i} = \sum_{i=0}^{\infty}\frac{\tau_{t+1}}{(1+r)^i} + \sum_{i=0}^{\infty}\frac{s_{t+i}}{(1+r)^i} + \lim_{i\to\infty}\frac{b_{t+i}}{(1+r)^t} \qquad (4.10)$$

$$\text{If } \lim_{i\to\infty}\frac{b_{t+i}}{(1+r)^t} = 0$$

This implies that inter-temporal budget constraint of the government is satisfied.

$$(1+r)b_{t-1} + \sum_{i=0}^{\infty}\frac{g_{t+1}}{(1+r)^i} = \sum_{i=0}^{\infty}\frac{\tau_{t+1}}{(1+r)^i} + \sum_{i=0}^{\infty}\frac{s_{t+i}}{(1+r)^i} \qquad (4.11)$$

This equation indicates government's outstanding debt, principal as well as interest payments, and the present discounted value of all current and future government spending equals the present discounted value of all current and future tax revenues and

seigniorage revenue. It implies that government needs to obtain sufficient revenue and carry out its spending.

Let Δ is primary government deficit and is equal to

$$\Delta = g - t - s$$

The inter-temporal budget constraint becomes

$$(1+r)b_{t-1} = \sum_{i=0}^{\infty} \frac{g-t-s}{(1+r)^i} = \sum_{i=0}^{\infty} \frac{\Delta_{t+1}}{(1+r)^i} \tag{4.12}$$

This implies that if government has positive outstanding debt, i.e. $b_{t-1} > 0$ then it is mandatory for the government to generate primary surplus in present value equal to $(1+r)b_{t-1}$. The government requires reducing spending, increasing taxes or generating revenue from seigniorage to produce the required surplus.

Let R indicates gross real interest rate and is equal to

$$R = 1 + r$$

Equation (4.12) implies

$$Rb_{t-1} = \sum_{i=0}^{\infty} \frac{\Delta_{t+i}}{R^i}$$

$$= \sum_{i=0}^{\infty} \frac{g_{t+1} - t_{t+i} - s_{t+1}}{R^i} \quad \text{as } \Delta_{t+i} = g_{t+i} - t_{t+i} - s_{t+i}$$

$$b_{t-1} = \frac{1}{R} \sum_{i=0}^{\infty} \frac{g_{t+1} - t_{t+i} - s_{t+1}}{R^i}$$

$$= -R^{-1} \sum_{i=0}^{\infty} R^{-i} \left(g_{t+i} - \tau_{t+i} - s_{t+i} \right) \tag{4.13}$$

Let $g_t - \tau_t - s_t$ is the primary government deficit and s_t represents seigniorage revenue. And let

S_t^f represents primary government surpluses and is equal to

$$S_t^f = \tau_t - g_t$$

Then

$$b_{t-1} = -R^{-1}\sum_{i=0}^{\infty} R^{-i} S_{t+i}^f + R^{-i}\sum_{i=0}^{\infty} R^{-i} S_{t+i} \qquad (4.14)$$

Government real liabilities are financed by surpluses or by revenue from seigniorage. When the present value of surpluses is reduced, present value of the seigniorage needs to be altered in order to maintain the above equality. If revenue from seigniorage is low, deficit rises and public debt accumulates. This increases the probability of higher tax revenue and seigniorage in future. This implies that fiscal managers should adjust their budget by changing their expenditure and revenue mix. If fiscal authority fails to do so, central bank has no other way except to introduce or promote inflation further.

For checking the relationship between public debt, tax revenue and seigniorage, we set

$$g_t = 0$$

The government budget constraint becomes

$$(1 + r_{t-1}) = \tau_t + b_t + s_t \qquad (5.15)$$

The economic agent or the household receives income y_t and he/she pays taxes denoted by τ_t, household also receives real interest on holding government debt and that is

$$(1+i_{t-1})\frac{B_{t-1}}{P_t} = (1+r_{t-1})b_{t-1}$$

Where i represents interest rate, B show the amount of debt held by the household and P_t shows price level. We know that

$$(1+r_{t-1})b_t = \left(\frac{1+i_{t-1}}{1+\pi_t}\right)-1$$

And the demand for real cash balances is

$$\frac{M_{t-1}}{P_t} = \frac{m_{t-1}}{1+\pi_t}$$

$$= (1+\pi_t)^{-1} m_{t-1}$$

So the household budget constraint can be written as

$$c_t + m_t + b_t = y + (1+r_{t-1})b_{t-1} + \frac{m_{t-1}}{1+\pi_t} - \tau_t$$

$$c_t + m_t + b_t = y + (1+r_{t-1})b_{t-1} + (1+\pi_t)^{-1} m_{t-1} - \tau_t \qquad (4.16)$$

The above equation implies that a rational economic agent allocates his or her resources to consumption, real money holding as well can use resources for the purchase of government debt.

Aiyagari and Gertler (1985) investigate the issue and find that besides the stock of money in the economy, policy of the government regarding fiscal deficit, ultimately it's financing and the accumulation of public debt has important implications for the determination of the price level. Assume that ψ represents the share of interest bearing

debt of the total liabilities of the government and this lies between zero and one. If ψ =1 this implies that debt is completely backed by revenue generated solely from taxes. This means the Ricardian type of fiscal policy (Sargent (1982)). If ψ <1, this implies that debt is not completely backed by revenue produced through taxes. And this situation refers to the non-Ricardian fiscal policy (Aiyagari and Gertler 1985). If the government debt is not entirely financed by revenue from taxes then revenue from seigniorage must be adjusted.

Now

$$T_t = \psi(1 + r_{t-1})b_{t-1} \tag{4.17}$$

T_t denotes the present discounted value of taxes. Where $(1 + r_{t-1})b_{t-1}$ are government liabilities including interest payments on debt

$$T_{t+1} = \psi(1 + r_{t-1+1})b_{t-1+1}$$

$$T_{t+1} = \psi(1 + r_t)b_t$$

$$= \tau_t + E_t\left[\frac{T_{t+1}}{1 + r_t}\right]$$

Substituting T_{t+1} we get

$$= \tau_t + E_t\left[\frac{\psi(1 + r_t)b_t}{1 + r_t}\right]$$

$$T_t = \tau_t + \psi b_t$$

$$T_t - \psi b_t = \tau_t$$

$$\tau_t = T_t - \psi b_t$$

Substituting T_t

$$t_t = \psi(1 + r_{t-1})b_{t-1} - \psi b_t \tag{4.18}$$

Doing small mathematical exercise (See Appendix for detail), we get

$$s_t = (1-\psi)[R_{t-1}b_{t-1} - b_t] \tag{4.19}$$

The above equation implies that when government intends to adjust fiscal policy or carry out some fiscal consolidation program then the government needs to adjust either taxes ψ (as these liabilities are backed by tax revenue) or to alter revenue from seigniorage $(1-\psi)$by printing money.

According to equation (4.16), we know that household budget constraint is

$$c_t + m_t + b_t = y + (1 + r_{t-1})b_{t-1} + \frac{m_t}{1+\pi_t} - \tau_t$$

$$y + (1-\psi)R_{t-1}b_{t-1} - \psi R_{t-1}b_{t-1} = c_t + m_t + (1-\psi)b_t \tag{4.20}$$

This equation has very important implications. When ψ =1, then

$$(1-\psi)R_{t-1}b_{t-1} = 0$$

$$(1-\psi)b_t = 0$$

This implies that the term representing government debt vanishes. It means that only the level of stock of money matters. When ψ <1 it implies that both the level of government debt and money stock matters. Let (See appendix for detailed derivation

$$w_t = m_t + (1-\psi)b_t$$

$$m_{t-1} = w_{t-1} - (1-\psi)b_{t-1}$$

$$y + (1-\psi)R_{t-1}b_{t-1} + \frac{m_{t-1}}{1+\pi_t} = c_t + w_t - (1-\psi)b_t + (1-\psi)b_t$$

$$y + (1-\psi)R_{t-1}b_{t-1} + \frac{m_{t-1}}{1+\pi_t} = c_t + w_t$$

$$y + R_{t-1}w_{t-1} = c_t + w_t + \frac{i_{t-1}m_{t-1}}{(1+\pi_t)} \qquad (4.21)$$

This equation implies that individual can now use income for consumption, for making financial assets or can hold money. The opportunity cost of holding money is

$$\frac{i_t}{(1+\pi_t)}$$

Government debt policy is also critical in the determination of price level but the transmission is not a direct one. To investigate the role of debt policy, lets us assume that the household has a separable utility function

$$\ln C_t + \delta \ln m_t$$

$$MRS_{c,m} = \frac{i_t}{1+i_t}$$

&

$$m_t = \delta c_t \left(\frac{1+i_t}{i_t} \right)$$

The Euler's equation for optimal consumption path is

$$c_{t+1} = \beta(1 + r_t)c_t$$

Household budget constraint is

$$y + R_{t-1}w_{t-1} = c_t + w_t + \frac{i_{t-1}}{(1+\pi_t)}m_{t-1}$$

and

$$m_{t-1} = \delta\left(\frac{1+i_{t-1}}{i_{t-1}}\right)\frac{c_t}{\beta(1+r_t)} \qquad \text{(a)}$$

Now we substitute (a) in the household budget constraint

$$y + R_{t-1}w_{t-1} = c_t + w_t + \frac{i_{t-1}}{(1+\pi_t)}m_{t-1}$$

$$y + R_{t-1}w_{t-1} = c_t\left[1+\frac{\delta}{\beta}\right]\left(\frac{i_{t-1}}{(1+\pi_t)}\left(\frac{1+i_{t-1}}{i_{t-1}}\right)\frac{c_t}{(1+r_t)}\right) + w_t$$

We know that in steady state and in equilibrium

$$c_t = y_t$$

$$y + R_{t-1}w_{t-1} = y_t\left[1+\frac{\delta}{\beta}\right] + w_t$$

$$y + R_{t-1}w_{t-1} = y_t + y_t\left(\frac{\delta}{\beta}\right) + w_t$$

$$y - y + R_{t-1}w_{t-1} = y_t\left(\frac{\delta}{\beta}\right) + w_t$$

$$R_{t-1}w_{t-1} = \left(\frac{\delta}{\beta}\right)y_t + w_t$$

In steady state we have

$$w = w_{t-1} = w^{ss}$$

We also know that

$$W = \left[\frac{M + (1+\psi)B}{P}\right]$$

Substituting in

$$w_t = \frac{\delta y_t}{\beta(R_{t-1} - 1)}$$

$$\left[\frac{M + (1-\psi)B}{P}\right] = \frac{\delta y_t}{\beta(R_{t-1} - 1)}$$

$$P = M + (1-\psi)B\frac{\beta(R_{t-1} - 1)}{\delta y_t}$$

Let in the steady state

$$R - 1 = r^{ss}$$

Substituting in the above equation

$$P^{ss} = \frac{\beta r^{ss}}{\delta y}\left[M + (1-\psi)B\right] \qquad (4.22)$$

When ψ =1 then

$$P^{ss} = \frac{\beta r^{ss}}{\delta y} M \tag{4.23}$$

This implies that price level determination in the economy entirely depend on money stock in the economy. In this case, government finances its spending by imposing taxes. It means that the level of government budget deficits and level of public debt has no role to play in the determination of price level and inflation is independent of it.

But we know that most of the time government faces budget deficits. It means the value of ψ is different from zero. When $0<\psi<1$, we have

$$P^{ss} = \frac{\beta r^{ss}}{\delta y}\left[M + (1-\psi)B\right] \tag{4.24}$$

Above equation indicates that both the level of government debt and money stock are critical for the determination of price level. Changes in the stock of money and the changing level and pattern of fiscal deficits and the level of government debt affect the price level.

As we early discussed that composition of government liabilities plays very important role in the determination of price level. Let λ represents noninterest-bearing debt and a fraction of government liabilities and equals

$$\lambda = \frac{M}{M+B}$$

The value of λ depends on the open market operation by the central bank particularly the level of funds or liquidity in the market. As the open market operation changes, the fraction of money stocks and debt in total government liabilities changes.

$$\lambda(M+B) = M$$

Substitute M in equation (4.22)

$$P^{ss} = \frac{\beta r^{ss}}{\delta y}\left[(1-\psi)(1-\lambda)(M+B)\right] \tag{4.25}$$

This implies that any open market operation that resulted in an increase in λ along with a positive ψ will lead to an increase in the price level because this substitutes money for bonds. Leeper (1991) argued that when all debt is financed through tax revenues, that is when ψ =1 even then the resources used to finance the shocks to government's budget have important implications. For instance, the kind of taxes imposed has significant consequences for output and ultimately for growth and macroeconomic policies. In models of the FTPL, fiscal variables are used instead of money supply as the main determinant of price level and inflation. The emergence of FTPL as appositive theory created many complex issues in the field of monetary economics. Fiscal theory of price determination provides such an environment and conditions.

Consider the household budget constraint

$$D_t + P_t Y_t - T_T \geq P_t C_t + M_t^d + B_t^d$$

Let D represent household wealth and is equal to

$$D_{t+1}^d = (1+i_t)B_t^d + M_t^d$$

Divide both sides by P_t

$$\frac{D_t}{P_t} + \frac{P_t Y_t}{P_t} - \frac{T_T}{P_t} \geq \frac{P_t C_t}{P_t} + \frac{M_t^d}{P_t} + \frac{D_{t+1}^d}{P_t} + \frac{B_t^d}{P_t}$$

$$d_t + y_t - \tau_t \geq c_t + m_t^d + b_t^d$$

$$d_t + y_t - \tau_t = c_t + \left(\frac{i_t}{1+i_t}\right)m_t^d + \left(\frac{1}{1+r_t}\right)b_{t+1}^d$$

Let λ indicates the discount factor and is equal to

$$\lambda_{t,t+i} = \prod_{j=1}^{i}\left(\frac{1}{1+r_{t+j}}\right)$$

And

$$d_t + \sum_{i=0}^{\infty}\lambda_{t,t+i}\left(y_{t+i} - \tau_{t+i}\right) = \sum_{i=0}^{\infty}\lambda_{t,t+i}\left[c_{t+i}\left(\frac{i_{t+1}}{1+i_{t+1}}\right)m_{t+1}^d\right]$$

We also know that government budget constraint in nominal term is

$$P_t g_t + (1+i_{t-1})B_{t-1} = T_t + M_t - M_{t-1} + B_t$$

Divide both sides by P_t

$$\frac{P_t g_t}{P_t} + (1+i_{t-1})\frac{B_{t-1}}{P_t} = \frac{T_t}{P_t} + \frac{M_t}{P_t} - \frac{M_{t-1}}{P_t} + \frac{B_t}{P_t}$$

$$g_t + d_t = \tau_t + \left(\frac{i_t}{1+i_t}\right)m_t + \left(\frac{1}{1+r_t}\right)d_{t+1}$$

$$d_t + \sum_{i=0}^{\infty}\lambda_{t,t+i}\left[g_{t+1} - \tau_{t+1} - \bar{s}_{t+1}\right] = \lim_{T-\infty}\lambda_{t,t+T}d_t \qquad (4.26)$$

Where *s* represent government revenue generated through seigniorage and is equilibrium and is equal

$$\bar{s} = \left(\frac{i_t}{1+i_t} \right) m_t$$

$$\frac{\bar{s}}{\left(\frac{i_t}{1+i_t} \right)} = m_t$$

Equilibrium in goods market means that

$$y_t = c_t + g_t$$

$$c_t = y_t - g_t$$

And supply of money equals demand for money

$$m_t^d = m_t^s$$

Substituting c_t and m_t and Dividing by P_t

$$\frac{D_t}{P_t} = \sum_{i=0}^{\infty} \lambda_{t,t+i} \left[\tau_{t+1} + \bar{s}_{t+1} - g_{t+1} \right]$$

All this implies that government liabilities D_t depend on past policies of the government. This in turn affects the formulation and execution of monetary policy. The sole endogenous variables is the price level P_t that needs to be adjust to satisfy the above equation.

Now

$$D_t = P_t \sum_{i=0}^{\infty} \lambda_{t,t+i} \left[\tau_{t+1} + \bar{s}_{t+1} - g_{t+1} \right]$$

$$D_t \frac{1}{\sum_{i=0}^{\infty} \lambda_{t,t+i} \left[\tau_{t+1} + \bar{s}_{t+1} - g_{t+1} \right]} = P_t$$

$$P_t^* = \frac{D_t}{\sum_{i=0}^{\infty} \lambda_{t,t+i} \left[\tau_{t+1} + \bar{s}_{t+1} - g_{t+1} \right]} \tag{4.27}$$

Any changes in government spending or tax rate definitely disturb equilibrium price level. The government decision to shift its spending from tax revenue to seigniorage can change monetary base. Budget position, deficit as well as surplus and the ultimate level of public debt also matter for the determination of price level in the economy. All these are fiscal variables and have important implications for inflation and ultimately for the operation of monetary policy. The main objective of this whole exercise is to provide the theoretical details for fiscal implications of monetary policy vis-à-vis monetary implications of fiscal policy.

4.3: Dynamic Stochastic General Equilibrium Framework

There is no single study in Pakistan that investigated the interaction between fiscal and monetary policy using dynamic stochastic general model. This thesis uses modified small-scale open economy New Keynesian model as in Fragetta and Kirsanova (2010). Dynamic stochastic general equilibrium model is modified by incorporating fiscal policy in order to see its interaction with monetary policy. Keeping in perspective the advantages of dynamic stochastic general equilibrium models, both developed and developing economies are formulating DSGE models for their economies. The central banks around the world are frequently using these models for analysis and policy formulation. The robustness of the DSGE models has derived the debate on the use of these models in emerging economies for policy analysis. Following

the seminal work of Christiano *et al* (2005), Coenen and Straub (2005) and Cebi (2012), model used in this thesis is an open economy DSGE model. We estimate the parameters for the economy of Pakistan while using DSGE model in order to be consistent with the micro-foundation of our economy.

We take two policy environments. In the first specification, we calibrate the original DSGE model used by Cebi (2012) excluding government borrowing. In the second specification some modification has been made while incorporating fiscal policy, particularly federal government borrowing from State Bank of Pakistan. We check the response of fiscal and monetary policy to each other and to shocks like world output shock as well as technological shock. The objective is to assess and analyze the interaction between fiscal and monetary policy and find avenues for the effective formulation and execution of these policies.

4.3.1: Consumer Optimization

We use a small-scale open economy model for Pakistan. Very limited empirical research for Pakistan exists that used small-scale open DSGE model except Adnan & Haider (2008) but they also missed to incorporate fiscal policy. Following Cebi (2011), Fragetta and Kirsanova (2010), Ortiz et al (2009), Gali and Monacelli (2005), , Fialho and Portugal (2005), the model set in motion with infinitely lived household who seeks to maximize the expected present discounted value of life time utility subject to inter temporal budget constraint:

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma_c}}{1-\sigma_c} + \chi \frac{G_t^{1-\sigma_g}}{1-\sigma_g} - \frac{N_t^{1+\varphi_n}}{1+\varphi_n} \right) \quad (1)$$

Where $\beta = \frac{1}{(1+\rho)^t}$ is the household discount factor and $\beta \in (0,1)$, σ is the inverse inters temporal elasticity of substitution in consumption, φ is inverse labor supply elasticity with respect to real wage and χ is relative weight on consumption of public goods. The aggregate variables in the utility function C_t, G_t and N_t are private consumption, government spending and labor supplied respectively.

4.3.2: Household inter-temporal budget constraint

The household inter-temporal budget constraint is

$$P_t C_t + E_t[Q_{t,t+1} D_{t+1}] + T \leq D_t + (1+\gamma_t) W_t N_t \quad (2)$$

Where $Q_{t,t+1} = \left(\frac{1}{1+r_t}\right)$ is one period ahead stochastic discount factor, r_t is nominal interest rate, T denote constant lump sum taxes and γ_t represent income tax rate. W_t is the nominal wage rate, D_t is nominal portfolio, P_t is consumer price index and C_t is composite consumption index which consist of index of domestically produced goods $(C_{H,t})$ and index of imported goods $(C_{F,t})$. These goods are produced by monopolistically competitive firms.

$$C_{H,t} = \left[\int_0^1 C_{H,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

And

$$C_{F,t} = \left[\int_0^1 C_{F,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

$$P_t C_t = \int_0^1 [P_{H,t}(i).C_{H,t}(i) + P_{F,t}(i).C_{F,t}(i)] di$$

A forwarding looking open economy IS curve by solving FOC,s simultaneously is

$$\hat{y}_t = E_t\left(\hat{y}_{t+1}\right) - E_t\left(\Delta g_{t+1}\right) + \alpha\left(\varpi - 1\right)\left(\rho_{c^*} - 1\right)\hat{c^*}_t - \frac{1}{\sigma_\alpha}\left(\hat{r}_t - E_t\left[\hat{\pi}_{H,t+1}\right]\right) \qquad (3)$$

Where $\sigma_\alpha \equiv \dfrac{\sigma}{(1-\alpha)+\alpha\varpi}$

And $\varpi \equiv \sigma\gamma + (1-\alpha)(\sigma\eta - 1)$

Parameter $\eta \rangle 0$ denotes elasticity of substitution between domestic and foreign goods, α measures the share of domestic consumption allocated to foreign goods (degree of openness) and γ reflects elasticity of substitution between the goods produced in different foreign countries. Endogenous variables are defined as follows:

Output $\hat{y}_t = \ln\left(\dfrac{Y_t}{\hat{Y}_t}\right) = y_t - \bar{y}$

Where $\bar{y}$ denote steady state value of y_t

Government spending $g_t = -\ln\left(1 - \dfrac{G_t}{Y_t}\right)$

Nominal interest rate r_t and domestic inflation $\pi_{H,t} = \ln\left(\dfrac{P_{H,t}}{P_{H,t-1}}\right)$

The forward looking open economy IS curve is given as:

$$\tilde{y}_t = E_t\left[y_{t+1}\right] - E_t\left[\Delta g_{t+1}\right] - \frac{1}{\sigma_\alpha}\left(r_t - E_t\left[\tilde{\pi}_{H,t+1}\right]\right)$$

(4)

Where $\tilde{y}_t = \hat{y}_t - \hat{y}_t^n$ And $\tilde{r}_t = \hat{r}_t - \hat{r}_t^n$

Finally $\hat{y}_t^n$ and $\hat{r}_t^n$ denote natural rate of output and nominal interest rate. These are the equilibrium level of output and interest rate in the absence of nominal rigidities which can be describe as

$$\hat{y}_t^n = \frac{(1+\varphi)}{(\sigma_\alpha + \varphi)}\hat{a}_t - \frac{(\sigma - \sigma_\alpha)}{(\sigma_\alpha + \varphi)}\hat{c}_t^* \tag{5}$$

$$\hat{r}_t^n = \sigma_\alpha\left(E_t\left[\hat{y}_{t+1}^n\right] - \hat{y}_t^n\right) + \sigma_\alpha\alpha(\varpi - 1)(\rho_{c^*} - 1)\hat{c}_t^* \tag{6}$$

Where $\hat{a}_t$ is the log of technology process, A_t.

4.3.3: Behavior of the Firm and Price Setting

Following Cebi (2011) there is continuum of identical monopolistically firms in the economy. These firms produce differentiated products using linear technology:

$$Y_t(j) = A_t N_t(j) \tag{7}$$

Following Calvo (1983), we assume that a fraction $1-\theta$ of the firm can set a new price in each period and a fraction θ of them keeps its price unchanged. To take the inflation persistency in consideration, we also incorporate backward looking behavior in price setting process by following Gali and Gertler (1999) and Cebi (2011)

$$P_{H,t}^b = P_{H,t-1}^* \frac{P_{H,t-1}}{P_{H,t-2}} \tag{8}$$

Where $P_{H,t-1}^* = \left(P_{h,t-1}^f\right)^{1-\zeta}\left(P_{H,t-1}^b\right)^{\zeta}$ is the aggregate prices chosen in period $t-1$ by both optimizing (forward looking, $P_{h,t-1}^f$) and rule of thumb (backward looking, $P_{H,t-1}^b$) price setters. Christiano *et al* (2005) take into account lagged dynamics in the Phillips curve.

Assuming that a fraction $1-\theta$ of the firm can set a new price optimally in each period as in calvo model, the remaining part θ set their prices by using the previous period inflation rate. The rule of thumb price setter take into account the past period inflation rate

$\pi_{H,t-1} = \dfrac{P_{H,t-1}}{P_{H,t-2}}$ as well as aggregate prices $P^{*}_{H,t-1}$ occurred in period t-1,

when they reset their prices in period t.

The existence of backward looking firms besides forward looking firms allows us to obtain a log linearised open economy hybrid Phillips curve in terms of deviation from steady state:

$$\hat{\pi}_{H,t} = \lambda^{b}\,\hat{\pi}_{H,t-1} + \lambda^{f} E_t\left[\hat{\pi}_{H,t+1}\right] + \kappa\,\hat{mc}_t + \varepsilon_t^{\pi} \tag{9}$$

$$\hat{mc}_t = \sigma_{\alpha} + \varphi\left(\hat{y}_t - \hat{y}_t^{\,n}\right) - \sigma_{\alpha}\,\hat{g}_t + \hat{\tau}_t \tag{10}$$

Where $\lambda^{b} = \dfrac{\zeta}{\theta + \zeta\left(1-\theta\left(1-\beta\right)\right)}$

$\lambda^{f} = \dfrac{\beta\theta}{\theta + \zeta\left(1-\theta\left(1-\beta\right)\right)}$

$\kappa = \dfrac{\left(1-\beta\theta\right)\left(1-\theta\right)\left(1-\zeta\right)}{\theta + \zeta\left(1-\theta\left(1-\beta\right)\right)}$

$\hat{mc}_t$ is the marginal cost and

$\tau_t = -\ln\left(\dfrac{1-\gamma_t}{Y_t}\right)$ is a log-linearised tax rate. ε_t^{π} represent cost push shock.

According to equation (10) government spending and tax as well as output gap directly

affect inflation via equation (9). The slope coefficient of Phillips curve κ shows sensitivity of domestic inflation with respect to real marginal cost.

4.3.4: Monetary Policy Rule

Following Cebi (2011) and Smet and Wouters (2007), we define a simple Taylor type interest rate rule based on inflation and output gap (call it specification-I):

$$\hat{r}_t = \rho_r\left(\hat{r}_{t-1} - \hat{r}^n_{t-1}\right) + (1-\rho_r)\left[r_\pi \hat{\pi}_{H,t} + r_y\left(\hat{y}_t - \hat{y}^n_t\right)\right] + \hat{r}^n_t + \varepsilon^r_t \qquad \text{(11-A)}$$

Where $\hat{r}^n_t$ represent the natural level of nominal interest rate. ρ_r is the interest rate smoothing coefficient and lies between zero and one. ε^r_t is interest rate shock and which can be interpreted as non systematic part of the monetary policy. Parameters r_π and r_y show the central bank preferences about inflation and output gap. Since the main aim of the central bank is price stability, the parameter r_π should be higher than r_y. This kind of monetary policy rule implies that Central Banks change nominal interest rates in response to deviation of inflation from its steady state value and deviation of output from its natural level. Additionally, Central Banks also take into account past value of nominal interest rates (when $\rho_r \neq 0$) when they reset their current nominal interest rates. The high value for the degree of interest rate smoothing reduces the contemporary responsiveness of the nominal interest rates to inflation and output gap.

Following, Choudhri and Malik (2012) and Kumhof *et al*. (2008) we also augment Taylor Rule with a new variable, that is change in government borrowing. It

is well defined in political macroeconomic literature, Chari and Christiano (1991) leeper (1991) and Sim (1994), in the presence of fiscal dominance, central bank also put some weight on change in government borrowing while setting policy interest rates. The modified version of Taylor rule (call it specification-II) is given as:

$$\hat{r}_t = \rho_r\left(\hat{r}_{t-1} - \hat{r}^{n}_{t-1}\right) + (1-\rho_r)\left[r_\pi\,\hat{\pi}_{H,t} + r_y\left(\hat{y}_t - \hat{y}^{n}_t\right) + r_b\left(b_t - b_{t-1}\right)\right] + \hat{r}^{n}_t + \varepsilon^r_t \quad \text{(11-B)}$$

Where, parameter r_b is relative weight assigned to change in government borrowing. This specification is also consistent with an empirical paper by Malik (2007) for Pakistan economy which also considers government borrowing as an important variable while extending simple Taylor type monetary policy rule.

4.3.5: Fiscal Policy Rules

Following Cebi (2011) and Muscatelli and Tirelli (2005) we consider a backward looking form for the fiscal policy reaction function by taking into account lagged responses of fiscal policy to economic activity. We also assume smoothing of fiscal instruments, as Favero and Monacelli (2005) and Forni, Monetforte and Sessa (2009).

$$\hat{g}_t = \rho_g\,\hat{g}_{t-1} + (1-\rho_g)\left[g_y\left(\hat{y}_{t-1} - \hat{y}^{n}_{t-1}\right) + g_b\,\hat{b}_t\right] + \varepsilon^g_t \quad (12)$$

$$\tau_t = \rho_\tau\tau_{t-1} + (1-\rho_t)\left[\tau_y\left(y_{t-1} - y^{n}_{t-1}\right) + \tau_b b_t\right] + \varepsilon^\tau_t \quad (13)$$

Parameters ρ_g and ρ_τ denote the degree of fiscal smoothing. Parameters g_y and τ_y demonstrate the sensitivities of government spending and tax to past value of output gap. Parameters g_b and τ_b correspond to feedback coefficient on unobservable debt

stock. ε_t^g and ε_t^τ are government spending and tax shocks and which represent the non-systematic component of discretionary fiscal policy.

4.3.6: The Government Solvency Constraint

Finally the model is completed by fiscal constraint. As in Cebi (2011), Kirsonva *et al* (2007), and Fragetta and Kirsonva (2010) a log-linearised government solvency constraint or fiscal constraint can be expressed as:

$$\hat{b}_{t+1} = \hat{r}_t + \frac{1}{\beta}\left[\hat{b}_t - \hat{\pi}_{H,t} + (1-\beta)\left(\hat{\tau}_t - \hat{y}_t\right) + \frac{\bar{C}}{\bar{B}}\left(\hat{g}_t - \hat{\tau}_t\right)\right] \qquad (14)$$

Where

$$b_t = \ln\left(\frac{B_t}{P_{H,t-1}}\right),$$

B_t is nominal debt stock. $\bar{B}$ indicates steady state debt to GDP ratio, and $\bar{C}$ represents steady state consumption to GDP ratio.

4.4: Estimation Methodology

Strand of literature is available that discussed different techniques and procedure for the estimation of dynamic stochastic general equilibrium model. An and Schorfheide (2012) broadly categorized these techniques as calibration, generalized method of moments, full information likelihood and Bayesian estimation. Besides these techniques, minimum distance estimation technique is also used for the estimation of dynamic stochastic general equilibrium model. We first estimate structural parameters values as well as shocks to the parameters. We do determine some of the values of parameters described in the model while few others are taken from other studies in this area particularly that of Haider and Khan (2008), Ahmed *et al*, (2012) and Choudhri and Malik (2012). We then use the technique of calibration to estimate dynamic

stochastic general equilibrium model for investigating the interaction between fiscal and monetary policy. Furthermore, we use the conventional techniques of ARDL in order to counter check the findings of DSGE specifically the existence of FTPL and the phenomenon of price puzzle in Pakistan.

Chapter 5

ESTIMATIONS AND FINDINGS OF DSGE MODEL

This chapter discusses the findings of our thesis in detail. In the first section, we determine and explain the values of parameters of the model for calibration. In this thesis, our main objective is the investigation of interaction between fiscal and monetary policy using dynamic stochastic general equilibrium model. Besides the responsiveness of fiscal and monetary policy to each other, we also report the response of technology as well as world output shock. The main reason for reporting these things is the use of small scale open economy model. Economic theories identified and recognized numerous shocks. These shocks have different implications for different macroeconomic variables. Some affect aggregate supply while others affect aggregate demand. Some shock affects both aggregate demand and aggregate supply simultaneously. There are also some sorts of shock that affect nominal anchors of the economy and negatively affect the desirable outcomes of fiscal and monetary policy.

We use Dynare tool box for MATLAB to estimate our dynamic stochastic general equilibrium (DSGE) model. We determined the values of parameters by calibration. Structural and shocks parameters are calibrated for annual frequency. We have six shocks parameters that include government spending, tax, interest rate shock, inflation shock, world output and total factor productivity or technological shock.

5.1: Shocks and Calibration

This thesis considers six shocks including both internal and external shocks. Internal shock includes shocks to government spending, taxes, interest rate shock, inflation shock and technological shock. External shock includes world output shock. It is assumed that these shocks follow AR (1) process.

1. Government Spending Shock:

$$\varepsilon_t^g = \rho_{\varepsilon_t^g} \varepsilon_{t-1}^g + \mu_t^g$$

2. Government Tax shock:

$$\varepsilon_t^T = \rho_{\varepsilon_t^T} \varepsilon_{t-1}^T + \mu_t^T$$

3. Monetary Policy or Interest Rate Shock:

$$\varepsilon_t^r = \rho_{\varepsilon_t^r} \varepsilon_{t-1}^r + \mu_t^r$$

4. Inflation Shocks:

$$\varepsilon_t^\Pi = \rho_{\varepsilon_t^\Pi} \varepsilon_{t-1}^\Pi + \mu_t^\Pi$$

5. Technology Shock or Total Factor Productivity Shock:

$$\varepsilon_t^a = \rho_{\varepsilon_t^a} \varepsilon_{t-1}^a + \mu_t^a$$

6. World Output shock:

$$\varepsilon_t^{C^*} = \rho_{\varepsilon_t^{C^*}} \varepsilon_{t-1}^{C^*} + \mu_t^{C^*}$$

All parameters in this thesis are calibrated for annual frequency. These parameters include 6 shocks related parameters and 17 structural parameters. These parameters are reported in table A1 on the next page. We estimate the dynamic stochastic general equilibrium model using government tax, spending, inflation, interest rate, technology or productivity shock and world output shocks. This thesis calculated some parameter values while others values are borrowed from the existing literature.

TABLE 5.1: Selection of Parameter Values

Parameter	Description	Value	Reference
α	Degree of Openness	0.23	Haider and Khan (2008)
β	Subjective Discount Factor	0.99	Ahmed et al., (2012)
θ	Degree of Price Stickiness	0.24	Haider and Khan (2008)
φ	Inverse Elasticity of labor supply	1.00	Haider and Khan (2008)
σ	Inverse Elasticity of substitution in consumption supply	0.59	Ahmed et al., (2012)
λ_r	Degree of interest rate smoothing	0.28	Ahmad et al., (2012)
γ_π	Taylor rule coefficient on inflation	1.48	Ahmad et al., (2012)
γ_y	Taylor rule coefficient on output gap	0.52	Ahmad et al., (2012)
λ_g	Degree of govt spending smoothing	0.78	Ahmad et al., (2012)
β_y	Spending Coefficient on past output gap	0.01	Author's Calculations
λ_τ	Degree of tax smoothing	0.22	Author's Calculations
τ_y	Tax Coefficient on past output gap	0.01	Author's Calculations
β_b	Spending Coefficient on debt	0.03	Author's Calculations
τ_b	Tax Coefficient on debt	0.01	Author's Calculations
ζ	Degree of backwardness	0.76	Haider and Khan (2008)
ρ_a	AR coefficient of Technology	0.91	Ahmad et al., (2012)
ρ_{y^*}	AR coefficient of world output	0.36	Ahmad et al., (2012)
σ_a	SD of Technology innovation	0.02	Ahmad et al., (2012)
σ_π	SD of Inflation innovation	0.05	Author's Calculations
σ_{y^*}	SD of world consumption innovation	0.02	Author's Calculations
σ_r	SD of interest rate innovation	0.02	Ahmad et al., (2012)
σ_g	SD of govt spending innovation	0.14	Ahmad et al., (2012)
σ_τ	SD of tax innovation	0.06	Author's Calculations

The parameters $\alpha = 0.23$ represent the degree of openness indicating the share of imports. $\beta = 0.99$ explains the subjective discount factor and taken from Ahmed *et al* (2012). The degree of fiscal smoothing $\rho_g = 0.78$ and government spending

coefficient on past output gap is $g_y = 0.01$. Similarly the degree of fiscal smoothing specifically tax smoothing $\rho_t = 0.22$ and tax coefficient on past output gap is $\tau_y = 0.01$. Contrary to the deterministic model in which the agent has perfect foresight of the future, in the stochastic model, the best we can do is to spell out a decision, policy or use some feedback rules for the future to get the model calibrated and simulated. This is why we have used very low values for the fiscal feedback parameters and the coefficient attached with output gap and debt. In other words, the basic reason of the closeness of the spending and tax coefficient of past output gap, g_y and τ_y, close to zero allows us to get feedback about fiscal policy whether the policy of treasury is contractionary or expansionary. In this situation the optimal outcome is determined by the possible realization of shocks. Furthermore, fiscal feedback parameters on debt, that is government spending coefficient on debt $g_b = 0.03$ and tax coefficient of debt $\tau_b = 0.01$ respectively. The degree of price stickiness $\theta = 0.24$. this implies that the degree of price volatility in Pakistan's economy is very high, that is $(1-\theta) = (1-0.24) = 0.76$. It carries a very important policy implication. The policy effectiveness considerably reduces in such a volatile environment. As Pakistan experienced sustained and high inflation, producers in Pakistan are also likely to alter prices, and wages more frequently compared to producers in the developed and industrialized world. Following Haider and Khan (2008), and Ahmed *et al* (2012), this thesis uses $\varphi = 1.00$ for inverse elasticity of labor supply and $\sigma = 0.59$ for inverse elasticity of substitution in consumption. Concentrating on Taylor-type monetary policy rule, State Bank seems to follow active monetary policy by assigning more weight to inflation, $\gamma_\Pi = 1.48$ while showing a lesser concerns for the output gap, that is $\gamma_y = 0.52$. Following standard literature, the values of those parameters that are not

estimated by calibration are taken from the existing literature regarding Pakistan's economy.

5.2: Impulse Response Function

Once the process of simulation is over, we use the model for policy analysis in this step. Figure 5.2.1 to 5.2.6 summarizes the impulse response functions to different shocks that are generated in the process of simulation. Here this is important to note that we have two specifications. The red lines in graphs show first specification and represent the original model for Turkey by Cebi. The second specification is indicated by the blue lines and explains the results for Pakistan.

The first schematic presentation outlines the response of domestic output to technology shock. The figure reveals that output follows the usual behavior consistent with economic theory and has a positive response to technological progress. Level of domestic output deviates from the steady state as the technology shock hits the economy. In the beginning the output increase abruptly and formed a hum shaped. The response of domestic output also shows a high degree of persistence as it remains above its steady state for sufficiently long period of time. We know that DSGE model is largely based on micro foundation and have the attributes of real business cycle. The response of domestic output to positive technological shocks is large and considerable. This is compatible with the existing literature as standard economic theory considers technological advancement as positive supply shock.

Second figure shows the response of domestic output to world output shocks. It is a well documented fact that no single country remains cut off from the outside world in the current globalized world. Higher degree of financial integration and improved means of transportation and communication expose economies to external shocks. Mundell-Fleming model explores the vulnerability of domestic economy to shocks,

especially world output and world interest rate shocks. These shocks are supposed to be transmitted from one economy to another. Our economy is also vulnerable and exposed to external shock in this globalized world. Keeping in view the limitation of this thesis, we just incorporate world output shock and employed a small open economy DSGE model. We find that domestic output responds positively to world output shock. In the beginning domestic output rises sharply and remains above its steady state. It starts then declining, converges to its steady state and goes below steady state for some period. Positive world output shocks inflate the commodity prices in the international market. Pakistan heavily depends on imported oil and any increase in the prices of oil negatively affects the output growth in the country. This is one of the possible reasons for the decline of domestic output below its steady state in the latter stage.

The third graph shows the response of domestic output to inflation shock. High price level distorts economic activities and damages the macroeconomic performance of the country. When inflation hits the economy, output starts to decline and it remains below steady state for sufficiently long period of time. The decline in output is considerable and is highly persistence in Pakistan. Our calibration follows the exact specification of Cebi. There are at least three major channels through which higher prices effect output level in the economy. First, an increase in the price level reduces consumer's wealth that discourages them to spend less. A decrease in consumer's purchasing power reduces demand in the economy resulting a fall in the overall output of the country. Second, higher price in the economy induces the central bank to adopt tight monetary policy by increasing interest rate in the economy. Cost of doing business goes up as the capital gets expensive with the higher interest rate. This crowds out private investment spending and reduces the overall level of output in the economy. There is another channel through which higher prices discourage domestic output.

When there is inflationary pressure in the economy and the price level is rising, domestic currency depreciates that makes our imports more expensive. Economic activities decrease with expensive imported materials and cause a decline in the domestic output. Furthermore, inflation causes the value of the currency to decrease. People start spending their savings in the presence of inflationary pressure in the economy. Lower saving in the country also leads to a decrease in investment and discourages capital accumulation. The long term productivity falls that ultimately causes lower level of domestic output. So we report that inflation has negative impacts on domestic output and hinders economic growth in Pakistan.

Next schematic presentation is the area of our interest. Here we investigate the response of domestic output to monetary policy. Interest rate is an important factor in the determination of output and economic growth. In our analysis the response of domestic output to monetary policy shock is negative. Domestic output falls with the tight monetary policy stance of the State Bank of Pakistan. Output declines and remained below steady state for sufficiently long period of time. After some periods domestic output starts rising but it again die out very quickly. The high negative response of output to monetary policy shock implies that nominal rigidity is not high in Pakistan. In the presence of nominal rigidities, mean when prices are sticky, output is not responsive too much to monetary policy shock. It means that prices are highly flexible and volatile in Pakistan.

We find that output declines in response to government tax and we have a very valid reason for such behavior of domestic output. The push to raise revenue through taxes is driven by the growing pressure on public budget to reduce government deficits. This is contractionary in nature and negatively affects output in the country. The government wants to reduce budget deficit and want to promote growth. These

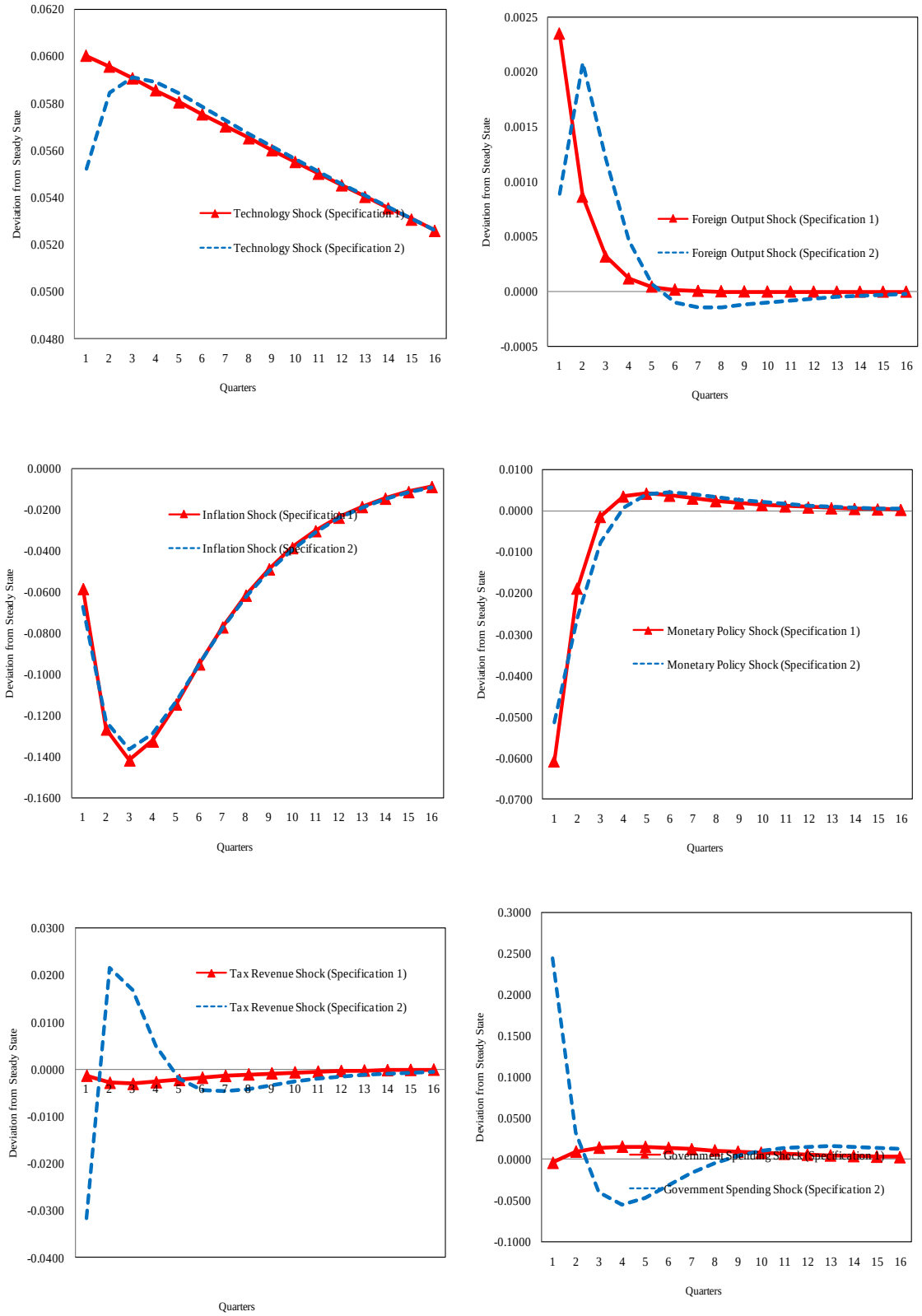
disparate objectives are very critical to the economy. To achieve the revenue targets, the government reforms must focus on the reduction and rationalization of tax rates and adapting measures to broaden the tax base. We also know that continuous increase in the tax rate increase the chances of theft and tax evasion by tax evaders.

We also investigate the response of domestic output to government spending shocks. Economic theory suggests that government spending promote economic activities and output growth. We find the positive response of output to government spending shock. After the initial rise, domestic output starts to decline with government spending shock. We in Pakistan have very legitimate reason for such an unusual behavior and response of domestic output. First, major share of the government budget normally goes to debt servicing and payments of foreign as well as domestic loans. It means that these expenditures are not incurred on the purchase of goods and services, development of infrastructures and carrying out public investments. Secondly, State Bank of Pakistan also takes corrective measure and increase the interest rate in the presence of shrinking fiscal space. Contractionary monetary policy crowd out private investment and cause the domestic output to decline. This means that continuous spending of the government in Pakistan undermines growth. Government extracts resources from the more productive sectors of the economy to finance its spending on less productive activities particularly on debt financing. This implies that fiscal shock, both higher spending and higher taxes; bring considerable volatility to domestic output. We know that output instability in the country reduces the impact of nominal variables on real variables. The impact of financial sector of the economy, monetary policy, has lesser impact on the real sector of the economy, fiscal policy. The impact of policy intervention reduces considerably in the presence of volatility. Government needs to

correct its behavior by rationalizing its spending and revenue in order to improve the policy environment.

If we compare the two specifications, it is visible that tax shocks and government spending shocks has a limited influence over output in the first specification. In Cebi's specification, he does not incorporate government borrowing from the central bank. Output remains tied to its steady state and fiscal shock has a negligible influence over domestic output. Contrary to Turkey, the inclusion of government borrowing in our model gives different results. Therefore fiscal consolidation is needed. We need a responsible fiscal policy and the treasury benches or government needs to realize the negatives associated with fiscal profligacy.

Figure 5.2.1: Response of Domestic Output



In the second figure 5.2.2, we trace the responsiveness of domestic inflation to different shock, particularly shock to fiscal and monetary policy. In the first schematic

presentation we report the response of inflation to technology shock. Technology advancement has a considerable impact on output and ultimately on inflation in the country. With a technology shock, inflation reduces because fewer units of effective inputs are needed to produce the same output. Inflation reduces considerably and remains below its steady state for very long period. Inflation takes considerable time to converge its steady state. We have very interesting findings. If we compare the two specifications, it is visible that when technology shock hits the economy, decline in inflation in Cebi specification is not as much robust as in our case. This may be due to the inclusion of government borrowing from State Bank of Pakistan that is largely ignores by Cebi. Cebi's model does not consider government borrowing. This shows that technological shock has greater impact in the presence of government borrowing and fiscal policy is more effective. Inflation reduces to a greater extent in our scheme of things compare to the original model. This implies a greater role for fiscal policy in collecting the positive spillovers of the technological shocks. State Bank of Pakistan needs to consult fiscal authority before the formulation of monetary policy particularly contractionary monetary policy in order to bring price stability.

Our next schematic presentation reveals that inflation in Pakistan positively responds to world output shock. Positive world output shock causes prices in the international market to rise. The increased economic and productive activities lead to the rise in price of different commodity particularly oil prices. Pakistan imports a major share of oil from the international markets. Any increase in the world oil price has a consequential impact on the economy of Pakistan in general and inflation in particular. The figure shows that domestic price level in the economy is highly responsive. Inflation remains above its steady state for a very long period and do not converges abruptly. Any increase in the world output and commodity prices cause drive up the

cost of factors of production. This has considerable impact on production and ultimately on inflation.

Next we document the response of inflation to monetary policy shock. This is also the main area where we want to see the interaction of fiscal and monetary policy. Impulse response function shows a significant decline in inflation in response to monetary policy shock. When monetary policy shock hits the economy, inflation declines and it remains below its steady state for sufficiently long period of time. The figure shows that inflation never returns to its steady. This implies that tight monetary policy stance of State Bank of Pakistan is effective in controlling inflation in the country. Here this is important to note that another research of Kashif and Javid (2010) revealed the existence of price puzzle phenomenon in Pakistan where the contractionary monetary policy stance of the State Bank is not effective in controlling inflation. There are many possible explanations for this conflicting finding. First, data covering period as well as the frequency of the data are different. Second reason is the issue of Prize puzzle in DSGE model discussed by Rabanal (2006). The other interesting thing between the two specifications is that in our case State Bank of Pakistan has assigned weights to federal government borrowing from the central bank as well as from the domestic commercial banks. Cebi model has not included government borrowing from the central bank and the response of inflation to tight monetary policy shock is not as much significant in his findings as in our case. In our case monetary policy is more effective when it takes into accounts the government borrowing.

The conventional views suggest that monetary policy tightening are associated with declines in output and inflation. In this particular thesis, we find that monetary policy is effective in controlling inflation under the DSGE techniques while price puzzle phenomenon holds under the conventional techniques of ARDL. There are two

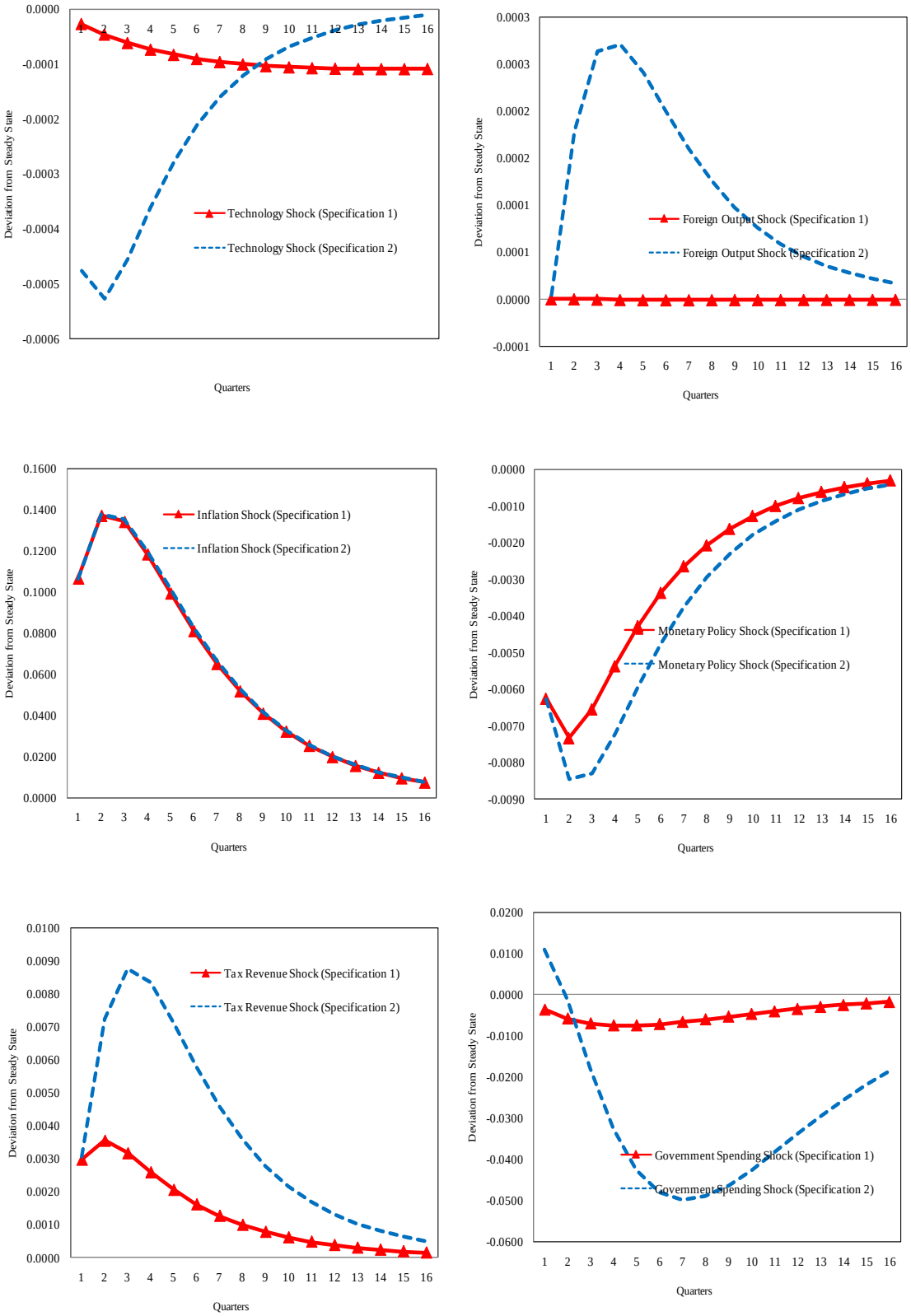
possible explanations for the different findings under DSGE and conventional techniques. First explanation suggests that VAR or ARDL models cannot properly measure the forward-looking component of monetary policy, and hence, do not properly measure monetary policy shocks. We know that expectation plays a very instrumental role in macro-policy making particularly in monetary policy making. For instance, the central bank expects higher inflation in the future, due to productivity shocks, increase in the price of oil in the world market, responds by increasing the interest rates. Before announcing the increase in interest rate, those shocks may have already occurred and been built into the economy. This creates the possibility of simultaneous increase in policy rate and prices. In this case the price puzzle phenomenon exists. Secondly, the supply side effects of monetary policy are also worth to be mentioned. If the central banks decide to raise the policy rate, cost of doing business also increases that may likely produce inflation in the economy. Barth and Ramey (2001) find that supply side effect of monetary policy dominate the traditional demand-side effect. Keeping in perspective the analytical tractability of DSGE, we find in our thesis that monetary policy in effective in controlling inflation. Rabanal (2006) explains that there is no room for a cost channel of monetary policy in the baseline model: increases in interest rates always cause inflation to decline.

The next impulse response function shows the responsiveness of inflation to tax shock. We find that fiscal policy shock, that is tax shocks, causes price level in the economy to rise. Inflation is highly responsive to tax shock. It deviates and remains above the steady state level. The response is also very persistent as inflation remains there for considerably long time as positive government tax shock persist, and never return to its steady. The imposition of taxes in the economy increases the cost of production. Producers normally shift the incidents of taxation to the final consumers by

including taxes in the prices thus resulting upward pressure in price level in the economy. When tax shocks hit the economy, price level rises in the economy. If we compare our findings with Cebi's findings, it is visible that elasticity of inflation with respect to taxes in our economy is high. This implies that producer in our country largely add taxes to the prices of their commodity and bear less or no burden themselves.

We know that any increase in tax is contractionary in nature and slow economic activities in the economy that ultimately brings down the price level in the economy. In case of Pakistan, government is persistently running budget deficit and mostly forces the State Bank to finance the deficit by bridging the gap between revenue and expenditures. This kind of financing nullifies the effects of contractionary fiscal policy and cause an upward trend in the price level. In figure 5.1.2, we observed that contractionary or tight monetary policy reduces inflation while contractionary fiscal policy increases inflation. This implies that fiscal and monetary policy works in the opposite direction and the situation demands for greater cooperation between fiscal and monetary authority in Pakistan. The next figure shows the response of inflation to government spending in the country. Price level stays well above its steady state rate of inflation as positive government spending shocks prevail. The findings validate the existence of fiscal theory of price determination. When government spending increases, it also increase the budget deficits and printing of money and thus fuel inflation. Here we have a very important policy lesson. The role of the government is increasing in controlling inflation. Appropriate fiscal policy is needed beside an appropriate monetary policy if the government is contributing towards inflation in the country.

Figure 5.2.2: Response of Domestic Inflation



The impulse response function of figure 5.2.3 shows the response of monetary policy, e.g. interest rate, to different shocks. In the first figure, we analyze the response of

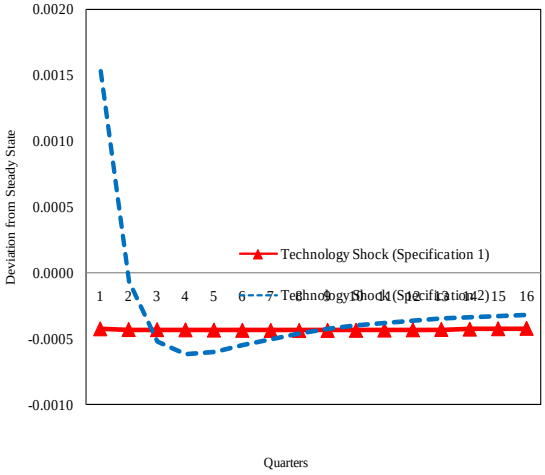
interest rate to technology shocks. Initially positive technological shock increases interest rate in the beginning and remains above its steady state. After that it immediately decline and stayed below the steady state for enough long time. This implies that monetary policy is contractionary in the beginning and expansionary in latter stages in response to positive technology shock. Here it is also very important to compare the two specifications. In Cebi's specification, he does not assign any weight to government borrowing. In his set up, the response of interest rate to technology shock is not significant and it fell slightly. This also supports the findings of Gali (1999) that central bank is not fully accommodative to technology and the monetary policy is not highly responsive. The response of interest rate remains flat for sufficiently long period of time. In our specification, we incorporate government sector and gave weight to federal government borrowing from State Bank of Pakistan. In this case interest rate rises in the beginning.

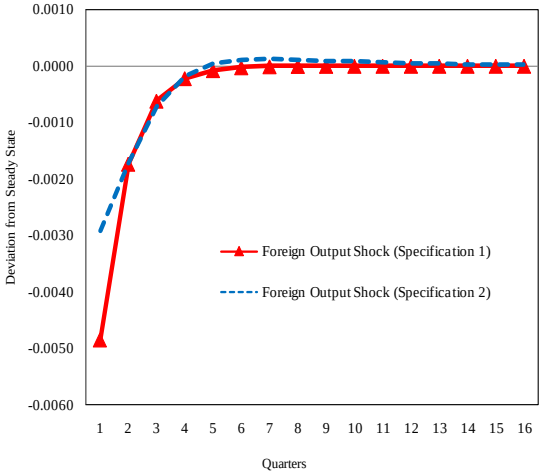
We also investigate the response of monetary policy to inflation shock in the economy. State Bank of Pakistan responses positively and increases the interest rate to contain inflationary pressure in the economy. Interest rate responses actively and deviate from its steady state when inflation triggers in the economy. Interest rate remains above its steady state and remains there for a sufficiently long time. Purchasing power of money erodes with price hike in the economy. State Bank responds pro-actively in order to control the erosion of purchasing power of domestic currency and to bring price stability in the country.

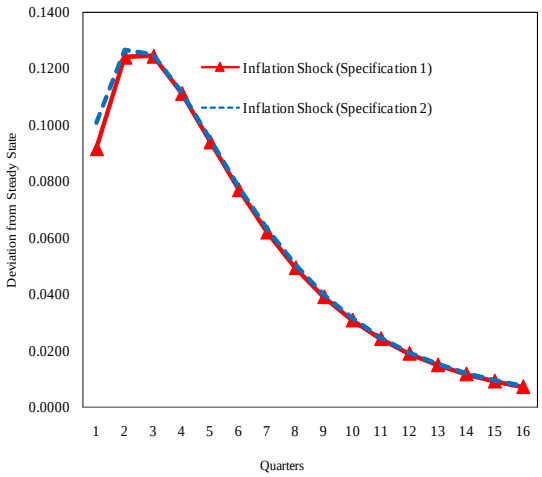
We further investigate the response of monetary policy to fiscal policy shock. We check both tax as well as government spending shock. State Bank responds to the treasury decision of increased taxes. In the beginning interest rate rises in response to tax shocks. Interest rate rise and it remains above its steady state that raises concerns

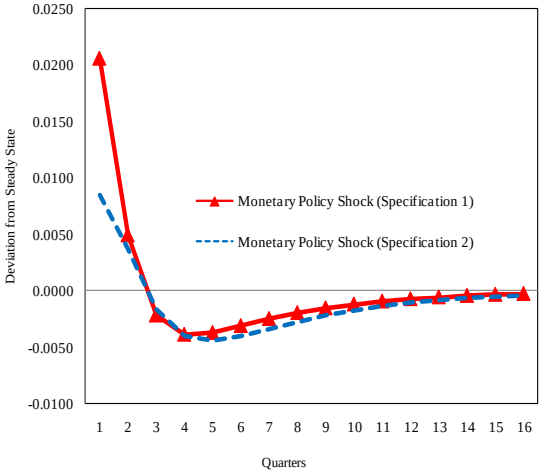
among policy makers about the potential negatives associated with it. The response of monetary policy is significant and interest rate declines gradually but remains above steady state for many years in a row. Economic theory and policy makers suggest that central bank need to follow expansionary monetary policy to avoid the slackening impact of contractionary fiscal policy. Obtaining revenues from increased taxes means a contractionary fiscal policy. In Pakistan evidence indicates the opposite and the SBP has the genuine concerns and legitimate reasons to offset the inflationary effects of higher taxes. But state bank needs to take exceptional steps to reduce the price of money, interest rate, to offset the undesirable effects of contractionary fiscal policy. But unfortunately State Bank of Pakistan increases the interest rate along with higher tax rates. It means that both Ministry of Finance and State Bank of Pakistan follow contractionary fiscal and monetary policy simultaneously. This also gives the impression about the absence of coordination between the two important authorities. There are important considerations and implications for the economy of Pakistan because the increase in taxes and interest rate simultaneously is not a good sign. We also know that the growth rate of Pakistan economy is not only sluggish but disappointing as well. If the fiscal branch is following tight fiscal policy then State Bank of Pakistan must adopt loose monetary policy in order to restore a modest growth in Pakistan's economy. There is a room for the treasury and State Bank of Pakistan to increase coordination because both higher interest rate and higher taxes badly affects the already plunging output and macroeconomic performance of the country. Interest rate negatively responds to the government spending shocks. One possible reason may be the positive impact of government spending on output which we have already reported in previous impulse response function. Increased in output due to increase in government spending ease pressure on inflation and thus SBP opt easy monetary policy.

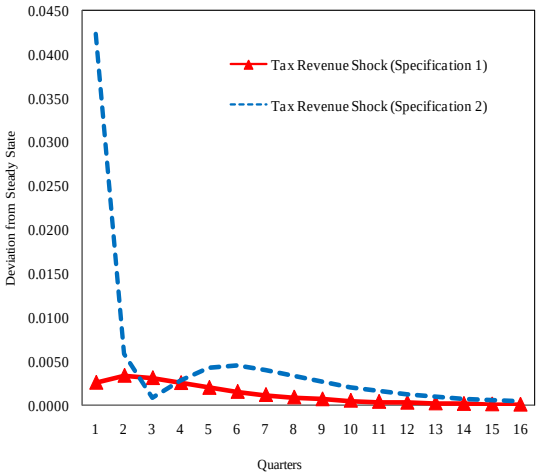
Figure 5.2.3: Response of Interest Rate

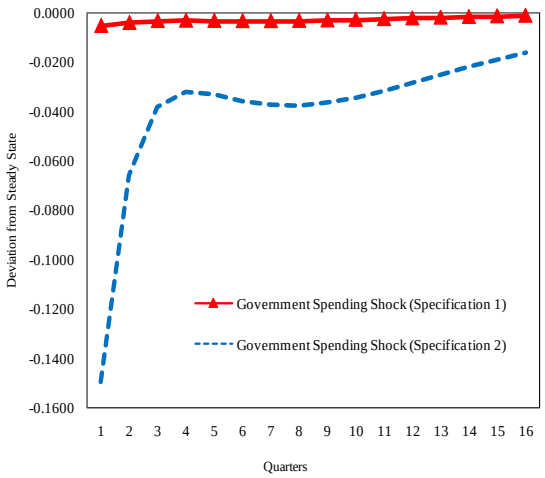












Impulse response function of figure 5.2.4 explains the responsiveness of government borrowing to different shocks in the economy. Shock to both technology and world output increases government spending and ultimately borrowing. Government borrowing is also responsive to the triggering inflation in the economy. When there is inflation shock in the economy, government borrowing increases. Government borrowing deviates from its steady state initially and witness a gradual declines afterwards. The main reason is that government is now paying more and incurred extra expenditures for the same goods and services.

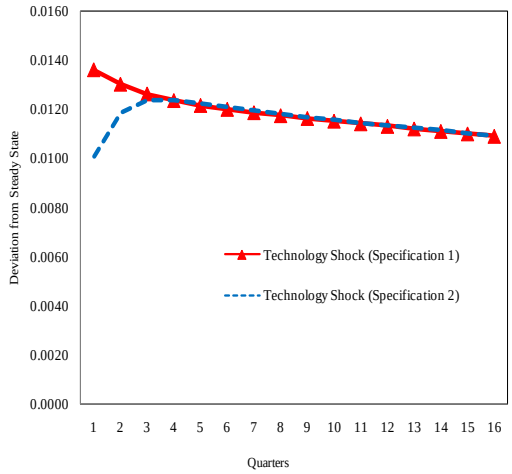
Next we examine the response of government borrowing to monetary policy shocks. In the beginning, government borrowing decreases in response to interest rate shock but abruptly starts rising. State Bank of Pakistan is well aware of the fact that budget deficits and borrowing of the federal government from State Bank create many problems. State Bank keeps the interest rate high in order to contain the excessive borrowing of the government and to ensure price stability. But we also know that Pakistan is heavily indebted country and huge sum of its federal budget is allocated to the payments of loans and servicing the debt. The objectives of State Bank are hard to realize because the bank cannot reject the demand of federal government for deficit monetization. The higher discount rate of the State Bank put extra burden on the national exchequer and ultimately government borrowing.

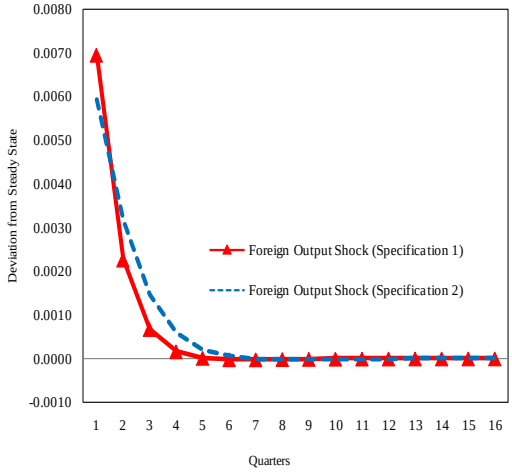
We further examine the response of government borrowing to fiscal policy shock. Government borrowing increases in response to a positive tax shock and remain above its steady state for enough long time. There are many reasons for the positive response of government borrowing to tax shock. First taxes erode production activities and discourage capital accumulation. Low economic activities reduce government revenue from taxation. The slackening economic activities force the federal government

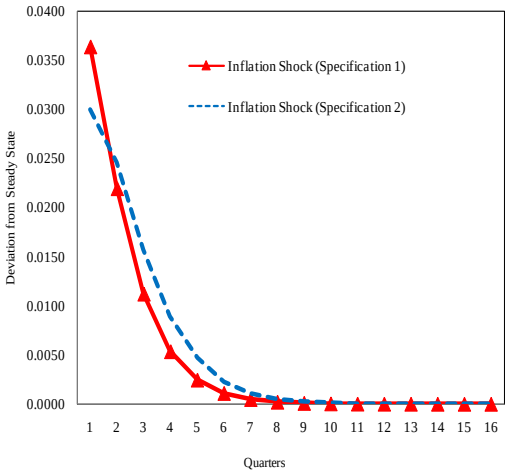
to finance its spending with increased level of borrowing from the banking system. Second, tax revenue is not enough to finance excessive federal government spending in Pakistan. In this situation where higher taxes discourages economic activities and causes the government's revenues o decline, treasury and State Bank need to initiate serious dialogue and shape fiscal and monetary policy in a more thoughtful manner.

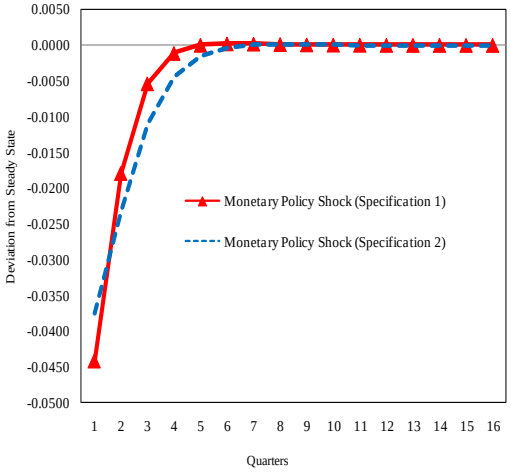
We also investigate the response of government borrowing from State Bank of Pakistan to fiscal shocks specifically government spending shock. Government borrowing decreases initially and then start rising. There are many possible justifications for the negative response of government borrowing from State Bank of Pakistan to government spending shock. We have seen in figure 5.1.1 that government spending increases economic activities and ultimately output. This increases government revenues and allows the government to free its arms without indulging in further borrowing from the State Bank. We also witness in the previous impulse response function that SBP responds positively to government. So, when the federal government increases its spending and the expenditure are greater than the revenue generated from taxes, then government resort State Bank for providing money. State Bank of Pakistan in return keeps the discount rate higher in order to restrict government borrowing from State Bank of Pakistan. In this case it seems that monetary policy of State Bank of Pakistan is somehow effective in controlling federal government borrowing from the State Bank. After some time, there is surge in government borrowing as the treasury ruthless spending persists.

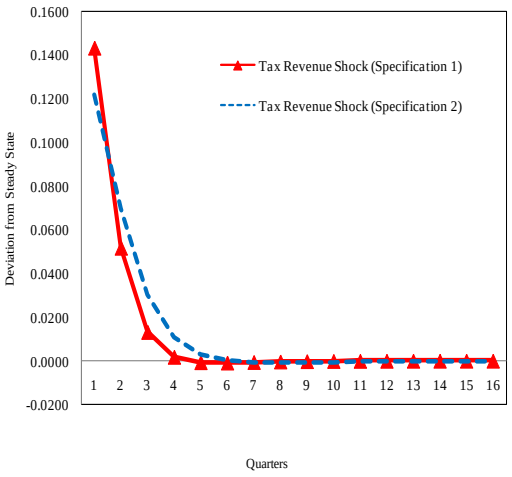
Figure 5.2.4: Response of Government Borrowing

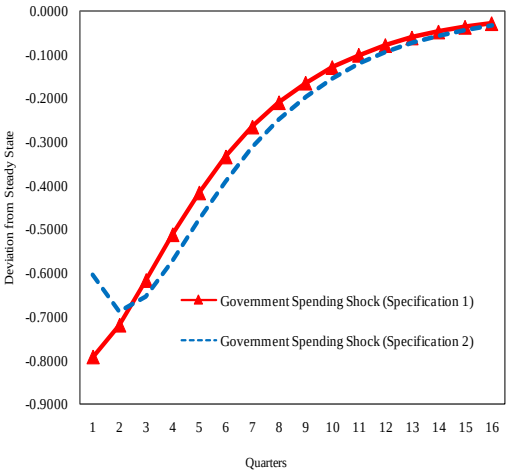












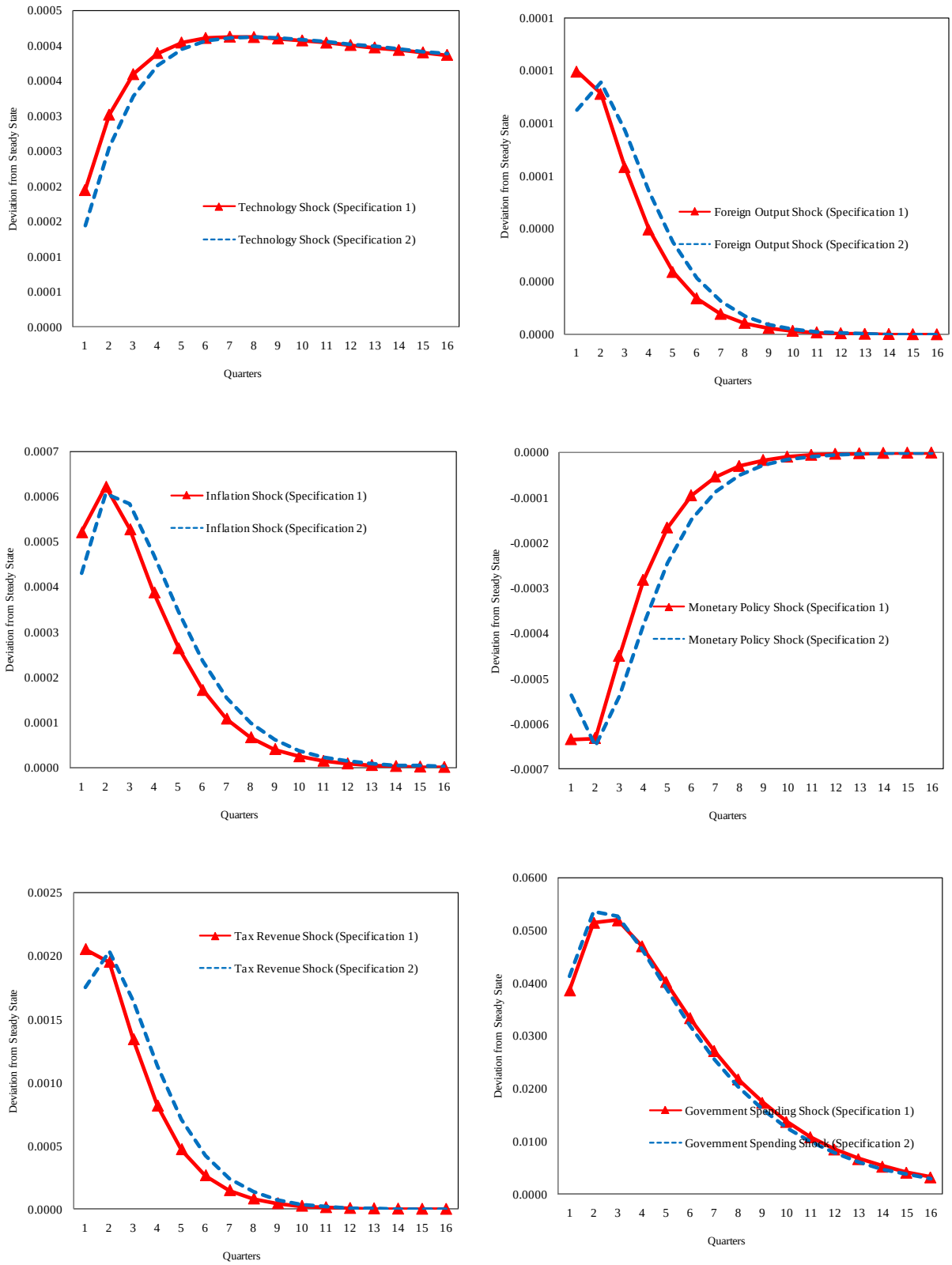
The responsiveness of fiscal policy, specifically government spending, to various shocks including monetary policy shock in the economy is examined in figure 5.2.5. A rise in total factor productivity or technology shock causes government spending to surge. Government spending deviates and remains above its steady state for many periods. This implies that there is a positive relationship between government spending and positive technology shocks. This shows a pro-cyclical fiscal policy behavior in Pakistan. In earlier figure we noticed that output respond significantly to technology shocks. When economic activities stimulates in the country, government revenue also increases that enables and allows government to relax its arms and to spend more and more on the welfare of its public. World output shock is also propagates as a positive external shock to the economy of Pakistan and increases government spending. World output shock increases the prices of commodities particularly the price of oil in the international market. This significantly increase the import bill of Pakistan and ultimately government spending.

The next schematic presentation of impulse response function shows the response of government spending to inflation. The existence of inflationary pressure in the economy forces federal government to increases its spending. Just like individual consumers, higher prices also hurt purchasing power of the government because rising prices means paying more for the same amount of goods and services. We think that the existence of higher inflation in Pakistan forces the fiscal authority to behave in inconsistent manner. This surely leads to the problem of time inconsistency on the part of treasury. So inflation forces government to deviates spending from the target level specified in the budget.

The next schematic presentation of impulse response function shows response of government spending to monetary policy shock. State Bank of Pakistan adopt tight

monetary policy by keeping interest rate high in order to control the ruthless spending, inflation and government borrowing from the banking system. Ministry of Finance responds quickly to the rapidly growing interest rate and reduces its spending. Monetary policy mainly influences aggregate demand and we know that government spending is an important element of aggregate demand equation. So the active and timely response from the State Bank of Pakistan seems fruitful and productive. The next schematic presentation of impulse response function shows the response of government spending to tax revenue shocks. It is visible from the figure that government increases public spending in response to a positive tax shock. When government's revenue increases from taxes, additional resources are now available making it easy and possible for the government to increase its spending. We then witness a gradual declining impact of higher taxes on government spending in Pakistan. The possible explanation for such a declining spending is the negative impact of contractionary fiscal policy on the economy and ultimately on government revenue and spending.

Figure 5.2.5: Response of Government Spending



The next figure 5.2.6 shows the response of fiscal policy, tax to various shocks. Technology shocks play an important role and bring business fluctuation and economic

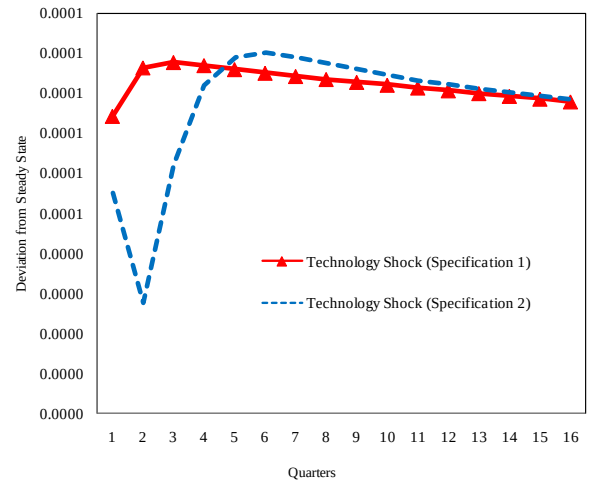
volatility. Our analysis shows that government revenue responds to technology shocks. Total factor productivity and economic activities increase with a positive technology shock. Income level of the economy rises and tax revenue also increases with the rise in income. We also trace the response of tax revenue to inflation. Initially tax revenue increases with triggering inflationary pressure in the economy. This validates economic theory. In the beginning, price shock maximizes producer's profit and they respond to it by increasing production. This increases tax revenue in the short run. But such a rise in government revenue persists for a short interval and it dies out very quickly. In latter stages, producers cut their production on the face of higher cost of production. This discourages economic activities and shrinks the output and aggregate supply. So in the short run, revenue increases with inflation and declines in the long run.

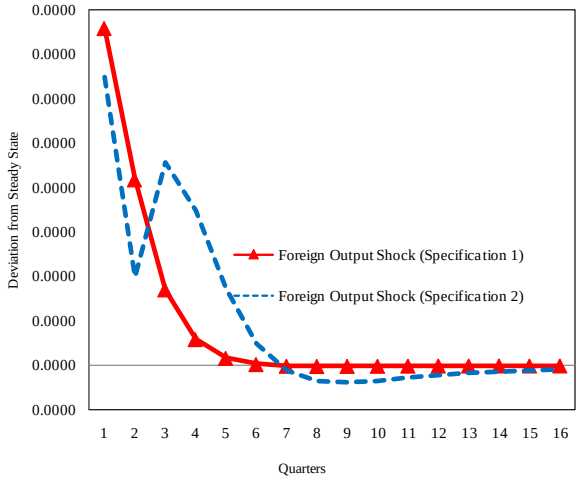
The response of tax revenue to monetary policy shock is significant. Quantitative tightening in the form of reduced money supply or higher interest rate increases the cost of doing business. Higher interest rate crowds out private investment. Businesses find it harder to get easy and cheap credit that further hinder economic growth to stimulate. This lowers economic growth. Government revenue from taxes also slacks with low economic growth. There is another channel through which higher interest rate reduces government revenue from taxes. Contractionary monetary policy of the State Bank of Pakistan increases the prices of money that discourage consumers spending. Consumers increase their saving and reduce consumption. This further reduces government revenue from low economic activities through taxes.

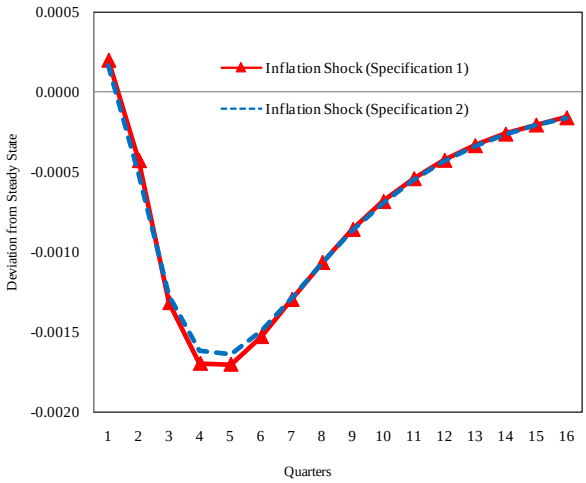
We also investigate the response of tax revenues to government spending shock. Tax revenue responds negatively as government spending increases. We know that federal government does not generate enough resource from taxes. In the presence of a reduced or shrinking fiscal space, government spending increases budget deficit.

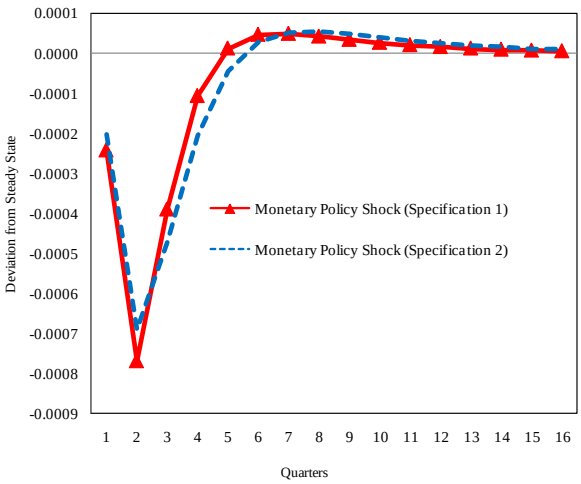
Government increases its borrowing from State Bank and other commercial banks in order to bridge the fiscal gap and finance the budget deficit. Monetization of the federal budget deficit by the State Bank of Pakistan increases the interest rate in the country. This drives up the cost of capital and private investment crowds out. Business and economic activities decline in response to the contractionary monetary policy stance of the State Bank of Pakistan. Tax revenue also decreases with slower economic activities.

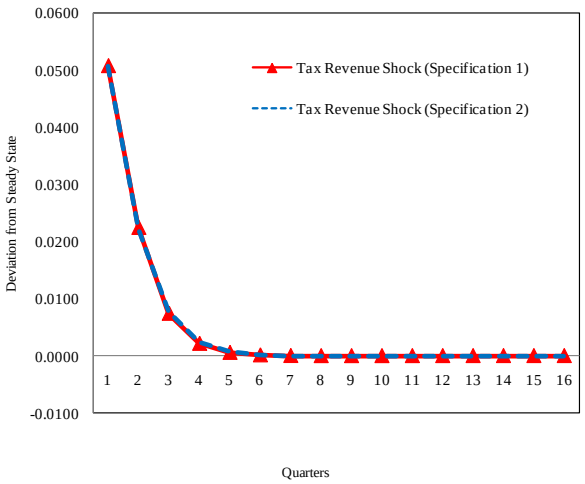
Figure 5.2.6: Response of Tax Revenue

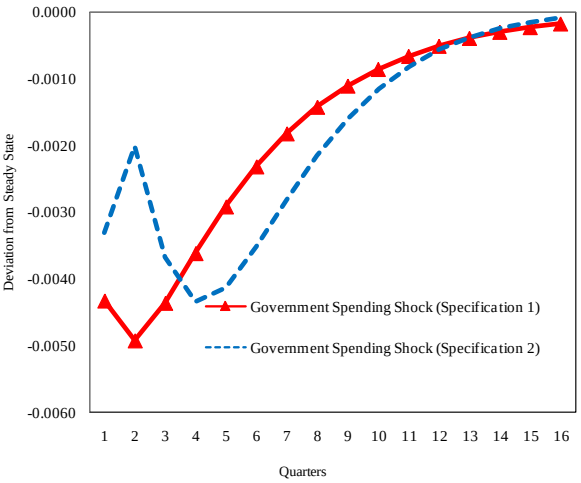












Chapter 6

ESTIMATIONS AND FINDINGS OF ARDL MODEL

So far we have focused on the primary objective of our thesis and investigated the interaction between fiscal and monetary policy using dynamic stochastic general equilibrium model. Now we counter check the existence of FTPL and monetary policy effectiveness using autoregressive distributed lag model in order to examine the quality of our results and the application of different techniques to investigate the same objective. So this chapter explains the outcomes of conventional technique of Autoregressive Distributive Lag Model (ARDL) as a countercheck to the dynamic stochastic general equilibrium model. As we mentioned above that primarily we are concern with the investigation of interaction between fiscal and monetary policy in Pakistan, this exercise is just for the sake of comparison of the results from two different techniques.

6.1: ARDL Model Specification and Bound Testing

In this section, we check the cointegration or long run relationship between inflation, public debt and money market rate. This specification not only helps us in investigating the fiscal theory of price determination but also prove helpful in evaluating the effectiveness of monetary policy in controlling inflation. Along these, this is also important to countercheck few results of the DSGE as well to check whether the price puzzle phenomenon exists in Pakistan or not. The specification of the basic model is

$$P_t = f\left(MMR, DB_t, \varepsilon_t\right) \qquad \text{(a)}$$

P_t is the price level, DB_t is the public debt MMR_t is the money market rate.

For Model (a), we have

$$P_t = \lambda_o + \lambda_1 P_{t-1} + \lambda_2 MMR_t + \lambda_3 DB_t + \varepsilon_t \qquad \text{(b)}$$

A priori expectation about the parameters signs are such that $\lambda_1 > 0,\ \lambda_2 < 0,\ \lambda_3 > 0,$ and ε_t is the error term. Priori expectation is based on the theoretical economic background of the relationships among these variables. The Error Correction Model (ECM) for the model is

$$\Delta P_t = \lambda_0 + \sum_{i=1}^{q} \lambda_i \Delta P_{t-i} + \sum_{j=0}^{q} \Phi_j \Delta DB_{t-j} + \sum_{k=0}^{q} \zeta_k \Delta MMR_{t-k}$$

$$+ \gamma_1 P_{t-1} + \gamma_2 DB_{t-1} + \gamma_3 MMR_{t-1} + \varepsilon_t$$

Where ε_t is the white noise and Δ is the first difference operator and represent changes from period t-1 to t.

Bound Testing:

ARDL approach is employed to get the short and long run parameters simultaneously. This methodology starts with the bound test of no cointegrating relationship by estimating the above equation. Using conventional F-test, the hypothesis is

$$H_0 : \gamma_1 = \gamma_2 = \gamma_3 = 0$$

$$H_a : \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq 0$$

In other words it means that

$H_0 : \gamma_{i's} = 0$ Against $H_a : \gamma_{i's} \neq 0$ Where i=0, 1….3

The above null hypothesis means the existing of no long run relationship between inflation and other explanatory variables. The calculated F-statistic is compared with the critical value of Peasran *et al.* (2001). The existence of cointegrating relationship or long run relationship allows us to move further and estimate the Error Correction Model (ECM):

$$\Delta P_t = \lambda_0 + \sum_{i=1}^{q} \lambda_i \Delta P_{t-i} + \sum_{i=0}^{q} \Phi_i \Delta Z_{t-i} + \kappa ECM_{t-1} + \varepsilon_t$$

Where the parameter κ represents the speed of adjustment.

In the first step of estimating autoregressive distributed lag model, equation (a) is estimated to investigate the long-run relationship between inflation, money market rate and public debt.

6.2: Explanation of Autoregressive Distributed Lag Model Results

In the first step of estimating autoregressive distributed lag model, we investigate the existence of the phenomenon of fiscal theory of price determination in Pakistan. We also examine and investigate the effectiveness of monetary policy and the existence of price puzzle phenomenon. The objective of using the autoregressive distributed lag models for the investigation of the above mentioned phenomenon in Pakistan is to countercheck and compare these findings with the results we derived from dynamic stochastic general equilibrium model. In this we check the cointegrating or long-run association among inflation, money market rate and growth of public debt.

Table 6.1: Estimated Long Run Coefficient: ARDL (1,1,1) Estimates Based AIC: Dependent variable Inflation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF_{t-1}	**0.4583**	**0.1167**	**3.9271**	**0.000**
MMR	**-1.2422**	**0.3443**	**-3.6079**	**0.001**
DBg	**0.4356**	**0.1350**	**3.2266**	**0.002**

Table 6.2: Error Correction Representation for the Selected ARDL (1,1,1) Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
dMMR	**1.3585**	**0.3642**	**3.7300**	**0.001**
dDBg	**0.1257**	**0.0406**	**3.0927**	**0.003**
ECM(-1)	**-0.5416**	**0.1167**	**-4.6407**	**0.000**
R-Squared	**0.5825**			
DW-statistic	**1.8614**			

ECM = INF-0.2147*MMR -0.4356*DBg

Table 6.3: F-Statistics for Co-integration Relationships

Equation	F-calculated	Critical values at 5%		Outcome
		I(0)	I(1)	
$P_t = f(DB, MMR_t, \varepsilon_t)$	11.6676	2.8539	4.0778	**Co-integration**

Source: Author's Calculations

The above table shows that calculated value of F, 11.6676, is greater than the upper critical value of 4.0778. It implies an existence of long run association between price

level and level of public debt and money market rate. The results of the long run and short run relationships of the above mentioned variables are presented below.

6.3: Long Run Coefficients

$$P_t = 0.4583 * INF_{t-1} - 1.2422 MMR_{t-1} + 0.1102 DBg_{t-1}$$

(3.9271) (-3.6079) (2.6462)

6.4: Short run Coefficients

$$P_t = 1.3585 \Delta MMR + 0.1257 \Delta DB - 0.5416 \text{EC}M(\text{-}1)$$

(3.7300) (3.0927) (-4.6207)

We used autoregressive distributed lag models (ARDL) for checking the cointegrating relationship or long run association between growth in level of public debt, money supply and inflation. Parentheses contain t-values that are to be judged whether it is significant or not at 5 percent level of significance. Our estimation shows that inflation considerable depends on its lag. The coefficient is 0.4583 and test statistic is 3.9271 which is quite significant and implies that price level in the current period *t* is considerably affected by the price level in the past period *t-1*. This means that inflation demonstrate a trend to stay high if it is higher in the previous period. Inflation has the tendency to be persistent in Pakistan. The test statistic is significant and indicates the considerable degree of inertia. Persistency in the inflationary pressure in the economy is likely to be one of the major factors for the continued deceleration in the pace of economic growth. Such situation in the country demands serious attention from Ministry of Finance and State Bank of Pakistan.

Our estimations also reveal that growth in the level of public debt has both contemporaneous as well as long run effects. The short run coefficient of the growth in public debt is 0.1257 and the test static is 3.0927 which is significant. The long run

coefficient is also greater than 2 and statistically significant. This implies that growth in the level of public debt triggers inflationary pressure in the economy. Our findings in the autoregressive distributed lag model validate the findings of the dynamic stochastic general equilibrium model. This implies that phenomenon of fiscal theory of price determination exists in Pakistan. This also indicates the central role of the treasury and fiscal dominancy in Pakistan. In fiscal dominance regime, politicians and the fiscal authority or the treasury benches always run budget deficit and has no regards for the policy choices of State Bank of Pakistan. Treasury set its targets for revenue and expenditure independently. Fiscal authority oftenly breach the limits set in fiscal responsibility and debt limitation act. When this is the situation, federal government has no other option to bridge the fiscal gap except to contact State Bank of Pakistan. State Bank is the principal and active player that usually bridges the gap between government revenue and expenditure by providing the required senignorage to finance the deficit. The accommodative and cooperative behavior of State Bank induces domestic monetary growth and alters aggregate demand that put upward pressure on the prices in the country. This implies that State Bank plays an important role and contributes in fueling inflation in the country rather than controlling it.

Generally it is believed, and economic theory also suggests that there is a negative relationship between inflation and interest rate. This means price level decreases with increase in the interest rate. But there are also instances, contrary to the established economic theory, of the positive relationship between interest rate and the price level. Pakistan frequently experiences high and volatile inflation. State Bank of Pakistan (SBP) is doing its business by keeping interest rate high in order to control inflation. Here in our ARDL setup, we document very interesting results contrary to the findings of DSGE model. Price level and money market rate move in the same

direction. Above table shows a strong and robust relationship between money market rate and inflation in the economy of Pakistan at least in the short run. In the short run, money market rate is positively associated with the inflation and the test statistic is 3.7300 with a positive sign. The monetary policy of State Bank has statistically significant contemporaneous impact but in opposite direction. This implies that the phenomenon of price puzzle holds in Pakistan at least in the short run. This supports the famous notion of prize puzzle introduced by Bernanke and Blinder (1992). The positive relationship between interest rate and price level validate and consistent with findings of Javid and Kashif (2011). However monetary policy of the State Bank is effective in the long run and control inflation with some lags. The test statistic with one lag is 3.6079 with a negative sign. This is significant statistically and shows the effectiveness of monetary policy in the long run. This implies that monetary policy takes time to have its full impact on inflation in Pakistan. Our result also validates Friedman's (1972) findings that monetary policy takes almost a year before it has full impact on inflation.

This is worth to mention that findings of dynamic stochastic general equilibrium (DSGE) model and conventional autoregressive distributed lag (ARDL) model are contradictory. In the DSGE settings, impulse response function reveals that when monetary policy shocks hit the economy, inflation starts declining which implies that monetary policy is effective. On the other hand, conventional ARDL approach suggests that the phenomenon of price puzzle holds in Pakistan. Such kind of situation is indicated by Rabanal (2006) and this opens new avenues for research in this area particularly in Pakistan.

Error correction mechanism (ECM) holds very prominent position in autoregressive distributive models once the long-run association established among the

variables. Our estimation results also reveal that coefficient of error correction term holds the much expected negative sign, that is -0.5416 and with a significant test statistic of -4.6407 at 5 percent level of significance. The considerable significance of error correction mechanism validates the existing of cointegrating relationship and advocates the long run association between the variables under consideration. There is cointegration between growth in public debt, money market rate and inflation in the economy. Growth in public debt has a considerable impact on inflation both in the short as well as in the long run. Error correction mechanism of -0.5416 means that 54.16 percent of the previous year disequilibrium caused by shocks is corrected. We can say that speed of adjustment is fairly high.

6.4: Structural Stability Test

We also carry out test for the structural stability of our model. For structural stability we use cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ) tests. Cumulative sum (CUSUM) test is use for tracking systematic changes while cumulative sum of square (CUSUMSQ) tests is used to identify abrupt changes. Figure A1 shows the cumulative sum (CUSUM) and figure A2 shows (CUSUMSQ) test. The two straight lines show 5 percent level of significance.

Figure 6.1: Cumulative Sum of Recursive Residuals

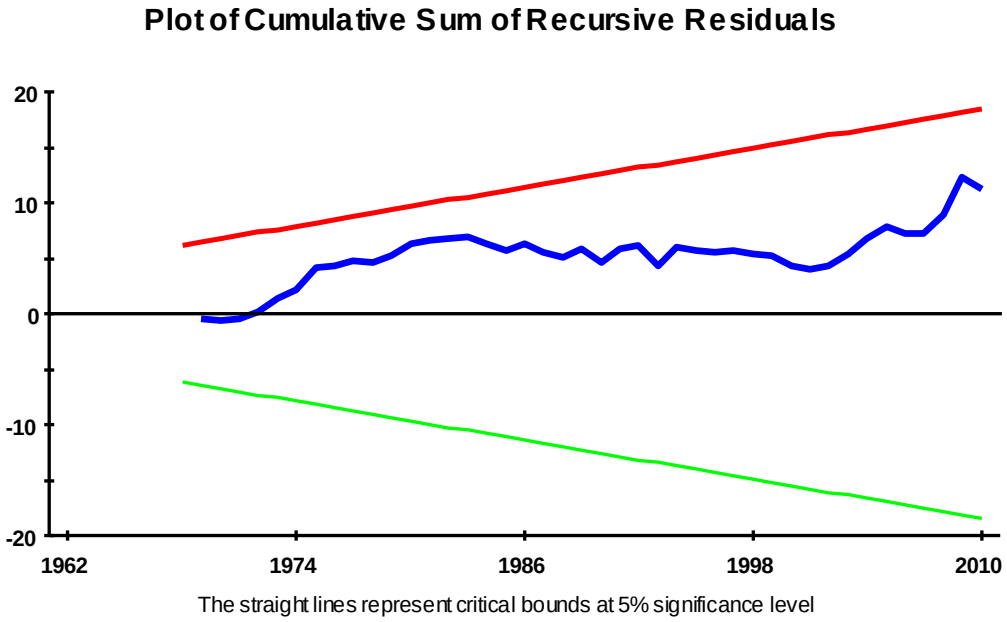
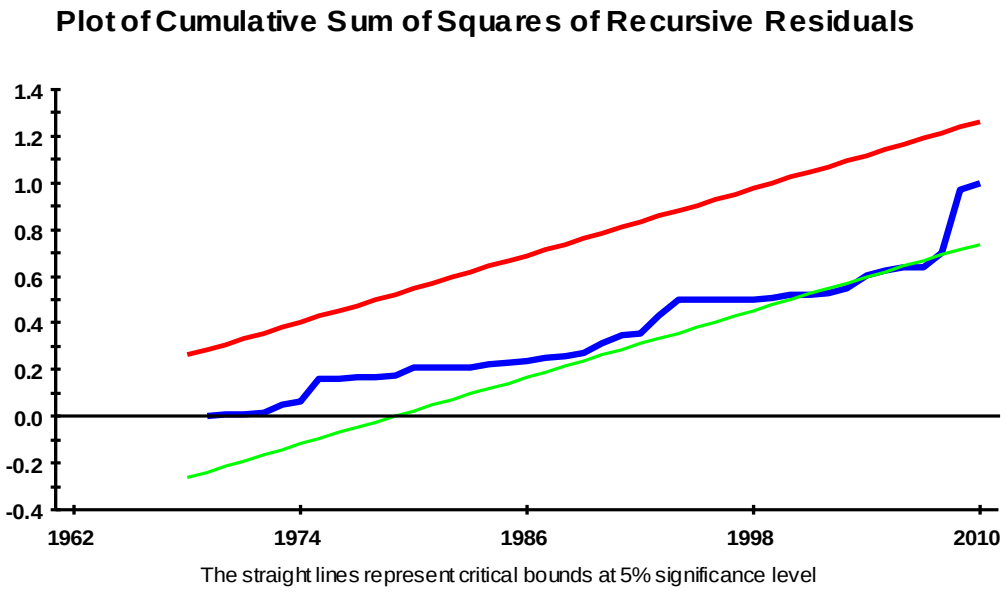


Figure 6.2: Cumulative Sum of Squares Recursive Residuals:



The cumulative sum (CUSUM) test and cumulative sum of square (CUSUMSQ) tests for the variables under observation is largely within the 5 percent band. This implies that there is no structural break in the model under consideration.

Chapter 7

CONCLUSION AND POLICY RECOMMENDATIONS

Current grave and sorry state of Pakistan's economy along with the growing tension between fiscal and monetary authority are the main factor that forces me to write this thesis on the issue of fiscal and monetary policy interaction in Pakistan. Using a dynamic stochastic general equilibrium model in this thesis, we primarily investigate whether fiscal and monetary policy interacts with each other in Pakistan or not. Secondly, we counter check the issue by investigating the impact of fiscal policy on price level and the effectiveness of monetary policy in controlling inflation through conventional techniques of Autoregressive distributed lag model.

By using dynamic stochastic general equilibrium model for tracking fiscal and monetary policy interaction, we found that monetary and fiscal policy interact with each others. Fiscal policy has substantial and considerable implications for monetary policy when we talk about fiscal theory of price level in Pakistan. Fiscal shock in the form of increased government spending and higher taxes affect price level in the economy. Our calibration reveals that price level responds positively to government spending in Pakistan. Fiscal deficit and its ultimate monetization generate inflationary pressure in Pakistan. Inflation is also highly responsive to tax shocks. Price level in the economy goes up with the increase in tax rate. We also observe considerable degree of inflation inertia once it hits the economy. As it is clear from our calibration that fiscal policy significantly affect the price level in Pakistan. The policy recommendation for State Bank of Pakistan in the presence of FTPL suggests that it should take great care in the formulation and execution of monetary policy. In the process we observed that contractionary or tight monetary policy reduces inflation while expansionary fiscal

policy leads to a price hike in the economy. This implies that fiscal and monetary policy works in the opposite direction and the situation demands for greater cooperation between fiscal and monetary authority in Pakistan.

Our estimation established a clear and obvious relationship between budget deficit and inflation and validates the existence of the phenomenon of the fiscal theory of price determination in Pakistan. Ministry of Finance knows the distortions associated with revenues from seigniorage. But government has no other option to bridge the fiscal gap because financing of the unrestrained fiscal deficits and borrowing from external sources is next to impossible. On the other hand, State Bank of Pakistan is accommodative and extends a helping hand to the federal government in order to bridge the gap between government revenue and expenditure by providing the required seigniorage. The persistent and continuous monetization of budget deficit by printing money is causing inflationary pressure in the economy. Financing of deficit with domestically created money increases aggregate demand and put upward pressure on the prices. Here the coordination and accommodative behavior of State Bank is creating problems and is not desirable, because such a cooperative behavior of State Bank leads to hike in the general level of price.

Dynamically inconsistent behavior of fiscal managers in Pakistan also plays critical role in the determination of price level. State Bank of Pakistan suggests time and again that Fiscal Responsibility and Debt Limitation acts should be modify in order to make these rules more stringent and difficult for politicians not to avoid it. The presence of rules restricts the behavior of treasury as well as State Bank to avoid time inconsistent behavior. This will make it obligatory for the government to inform State Bank in advance for its seigniorage requirements. For instance, State Bank can ask the treasury to devise such rules that positively specify the budget deficit at the beginning

of the fiscal year. The explicit specification of the seigniorage requirements of the government for a particular period is critical because the anticipated and unanticipated inflationary tax has different implications for the price level and ultimately for monetary policy.

Currently Pakistan is experiencing a very high and volatile inflation rate. Our calibration reveals that monetary policy responds positively to inflation in the economy. State Bank of Pakistan is striving hard and uses increased interest rate as a policy instrument in response to inflation shock. Interest rate increases as inflationary pressure occurs in the economy. We know that purchasing power of money erodes with price hike in the economy. Tight monetary policy stance is needed in order to control the erosion of purchasing power of domestic currency and to bring price stability in the country. On the other hand response of inflation to monetary policy is very interesting. In the dynamic stochastic general equilibrium model framework, monetary policy is effective in controlling inflation. Price level in the economy tends to fall when interest rate shocks hit the economy. On the other hand, using the conventional techniques of ARDL, interest rate as a policy instrument is not effective in controlling inflation. Inflation positively responds to the interest rate. This implies that the phenomenon of price puzzle exists in Pakistan. Rather than questioning the effectiveness of monetary policy, such conflicting findings opens new avenue for future research in the field of monetary economics particularly with reference to Pakistan. We also feels no hesitation to write that standard models of monetary economics about interest rate determination is not as much suitable for the developing countries as it works in the developed and industrialized world. The main reason for such differences is the different economic structure of developed and developing economies. Rabanal (2006) explores the conditions where monetary policy tightening increases inflation. He finds two main

justifications for very controversial phenomenon of price puzzle in the literature. First, the conventional models do not include the unexpected part of monetary policy shocks. The forward looking components of monetary policy are very crucial. Monetary managers increase interest rate when they expect some shocks like productivity shock, oil price shock, exchange rate developments in the future. At the time of increase of interest rate, these shocks have already been built into the economy. In this situation, simultaneous increase in both the interest rate and price is witnessed. Secondly, financing of wage bills and working capital makes the nominal interest rate responsible for affecting marginal cost and ultimately inflation. Sim (1992) also examine the issue and suggests that inclusion of commodity prices in the conventional models vanish the price puzzle phenomenon.

Fiscal policy shocks, particularly tax shock forces the monetary authority to respond. This thesis finds that monetary policy responds and State Bank increases the Interest rate in response to tax shock. Interest rate deviates from its steady state and increases as tax rates in the economy become high. Both higher taxes and higher interest rate adversely affect economy. This implies that both treasury and State Bank of Pakistan simultaneously follow contractionary fiscal and monetary policy. They behave as strategic complements, that is, the contractionary policy of the treasury is followed by the contractionary policy of State Bank of Pakistan. This should not be the case because this is not a good sign for the economy like Pakistan. State Bank should not increase interest rate if government obtains revenue from increased taxes. State Bank needs to follow expansionary monetary policy to offset the slackening impact of contractionary fiscal policy. This also necessitates the importance of more cohesive fiscal and monetary policy.

There is another and important dimension of fiscal and monetary policy interaction in Pakistan. In our specification, State Bank of Pakistan has assigned weights to the federal government borrowing from the central bank as well as from the domestic commercial banks. Cebi (2012) does not include government borrowing from the central bank in the model. The response of inflation to monetary policy shock is not much significant in Turkey compare to the response in our model. In our case monetary policy is more effective when it takes into accounts the government borrowing. The policy lesson is that State Bank always needs to take into account fiscal policy while formulating monetary policy. The inclusion of government spending, borrowing, revenue from taxes and the level of budget deficit in the objective function of State Bank of Pakistan can significantly improve the environment for fiscal and monetary policy to achieve the desired results. The significance of government borrowing provides the justification about the inclusion of government budget in the objective function of monetary authority.

Monetary managers in the State Bank are well aware of the fact that budget deficits and borrowing of the federal government from State Bank create many problems. State Bank of Pakistan keeps the interest rate high in order to discourage the growing trend of fiscal deficit and its habitual monetization. Along with the main objective of controlling inflation, the decisions of monetary authority are instrumental and carry out significant implications for the Ministry of Finance. Besides external indebtedness, Pakistan is severally indebted domestically. Floating interest rate on public debt causes significant budget fluctuations. Fiscal policy is sensitive to the decisions of the SBP because the huge chunk of the federal budget of Pakistan is allocated to pay the debt and interest payments. In this case higher discount rate from the State Bank of Pakistan put additional burden on the national exchequer. Our

calibration finds that government borrowing negatively responds to higher interest rate. This implies that government borrowing somehow decreases in response to interest rate shock. The tight monetary policy stance forces the federal government to rationalizing its huge spending. Another fiscal implication of monetary policy is the negative response of government spending to the tight monetary policy stance of State Bank of Pakistan. Monetary policy mainly influences aggregate demand and we know that government spending is an important element of aggregate demand equation. State Bank of Pakistan adopts tight monetary policy to keep pressure on the treasury in order to stop fiscal profligacy. The analysis shows that policy stance of State Bank in the form of higher interest rate is effective to some extent in containing government spending and borrowing from the State Bank as well as from commercial banks. But here we also have a dilemma. Government relies on the expensive domestic sources of borrowing despite the higher interest rate. The main reason for such an expensive borrowing is the non-availability of foreign loans. This is surely not a healthy sign for the overall economy of Pakistan. For this purpose, State Bank needs to consult Ministry of Finance before formulating monetary policy, particularly when it adopts contractionary monetary policy. Furthermore, in such situation, policy makers should not entirely focus on contractionary monetary policy to stop ruthless government spending and excessive government borrowing. Monetary policy needs to be accompanied by institutional arrangements to stop fiscal profligacy.

Our calibration reveals that another fiscal variable, tax revenue, also significantly and negatively responds to monetary policy shock. We find that government revenue from taxes substantially decrease when discount rates surge in the economy. Quantitative tightening increases the cost of doing business. Businesses find it harder to get easy and cheap loans. The reduced money supply or higher interest rate

crowds out private investment, discourage production and economic activities and government revenue from taxes ultimately diminishes. Another dimension of the higher interest rate is the discouragement of consumers spending and increased savings in the economy. This has also negative effects on government revenue from taxes. This is very important fiscal implication of contractionary monetary policy that reduces government revenues from taxes. The policy recommendation for monetary authority is to rationalize the behavior of interest rate as a policy instrument with great care, because discount rate plays a central role in altering the overall economic and business activities. The findings of this thesis explore that fiscal policy of treasury department in Pakistan responds to monetary policy and any act of the State Bank regarding altering policy instrument has significant repercussions and implications for the treasury.

Inflation also carries considerable implications for fiscal policy. We calibrate the response of tax revenue to inflation. In the beginning, tax revenue increases with price shock. This validates economic theory. Price shock maximizes producer's profit and they respond to it by increasing production in the short run. This increases tax revenue in the short run. But this rise in the revenue persists for a very short period. After the initial rise, tax revenue starts decline as cost of production increase with inflation that discourages output and ultimately shrink the economy's tax base. We also investigate the response of tax revenues to government spending shock. In our analysis, response of tax revenue is considerable and negative to government spending shocks. Tax revenues deviate from steady state when government spending shock hits the economy. We find that tax revenue decreases with higher government spending for some obvious reasons. In Pakistan, the federal government does not generate enough revenue from taxes, and excessive expenditures shrink the fiscal space causes budget deficit. In this situation, fiscal authority has limited options and its borrowing from

State Bank and other commercial banks increases. This drives the interest rate up which discourage capital accumulation and narrows down the tax base.

We know that neither producers nor consumers like inflation. Similarly policy makers and economic managers are also averse of high and volatile inflation. Besides other negatives, the main reason for such aversion is additional accumulation of government borrowing resulted from high inflation rates. We find that the response of government borrowing to inflation is positive. When there is inflation shock in the economy, government borrowing increases. Our calibration further reveals that government borrowing increases in response to a positive tax shock. There are two main reasons. First, tax erodes production activities. Secondly it discourages capital accumulation. Low economic activities shrink the tax base and reduce government revenue from taxes. This forces the federal government to borrow from the banking system in order to finance its expenditure. We also investigate the response of government borrowing from State Bank to fiscal shocks particularly government spending shock. We find that government borrowing from the State Bank of Pakistan shrinks with the increase in government spending. One possible reason for such a decline is the positive association of government spending and interest rate in Pakistan.

Similarly the response of government spending to inflation shock is positive. The presence of inflationary pressure in the economy exacerbates government expenditures. Just like individual consumers, higher prices also hurt purchasing power of the government because rising prices means paying more for the same amount of goods and services. This thesis also finds that government increases public spending in response to a positive tax shock. Additional resources are available to the government to increase its spending when government's revenue increases from taxes. This implies that a rise in tax revenue allows the government to free its arms and incur additional

public spending. It implies that government spending is elastic and responsive to inflation and tax shocks in Pakistan. Here the policy implication suggests that low and stable inflation is needed to keep the government spending low in order to ensure fiscal sustainability.

Besides investigating the response of fiscal and monetary policy to each others, we also examine the response of key economic variables to technology shocks and world output shocks. This thesis explores that our domestic output responses positively to technology shock. This is compatible with the existing literature as standard economic theory considers technological advancement as a positive supply shock. The response of our domestic output to world output shocks is positive. It is a well documented fact that no single country is cut off from the outside world in the current globalized world. Higher degree of financial integration and improved means of transportation and communication expose economies to external shocks. High price level damages the macroeconomic performance of the economy. Our calibration investigates the response of output to inflation and finds that output starts decline when inflation hits the economy. Advancement in technology has considerable impact on output and ultimately on inflation. We report a negative response of inflation to technology shock in Pakistan. This implies that inflation reduces with a positive technology shock. Contrary to technological shock, inflation in Pakistan positively responds to world output shock and the degree of responsiveness is considerably high. Government spending also responds to technology shock. A rise in total factor productivity or technology shock causes domestic output to increase. Tax base, government revenue and eventually spending increase with the increased in economic activities. This shows a pro-cyclical fiscal policy behavior in Pakistan. Earlier we notice that output respond significantly to technology shocks. When economic

activities stimulates in the country, government revenue also increases, enabling the government to spend more and more on the welfare of its public.

Fiscal policy also affects output in Pakistan. Our analysis uncovers a decline in output in response to fiscal shock in the form of higher taxes. Domestic output declines in the beginning and remain below its steady state for a short period. We also investigate the response of domestic output to government spending shocks. Government spending promotes economic activity and influences growth. In the beginning domestic output expands in response to government spending shock. But after some time, output starts decline. Treasury in Pakistan has not enough resources and its continuous spending undermines growth. This implies that fiscal shock; both higher spending and higher taxes bring considerable volatility to domestic output. These findings carry some very important policy implications. The impact of policy intervention is considerably low in the presence of high volatility and it reduces the impact of nominal variables on real variables. In this situation, the impact of financial sector of the economy, monetary policy, has lesser impact on the real sector of the economy, fiscal policy. The policy lesson is that government must rationalize its revenue and spending behavior in order to improve the policy environment. It is worth to mention here that we have differentiated our model from Cebi's model by incorporating government borrowing from the State Bank. Contrary to our findings, the impact of fiscal policy shock has a negligible influence over domestic output in Cebi's model. This implies that federal government borrowing in Pakistan is very crucial that affect macroeconomic variables and the overall performance of the economy.

State Bank considers the treasury as dominant and blames it for the sub-optimal outcomes of its monetary policy. Fiscal managers regularly ask State Bank to fill the shrinking fiscal space. State Bank of Pakistan has not many options on the table except

printing of money or to sell treasury bills through open market operation. In this case, we do believe that independency of the State Bank is important rather than the coordinated behavior of the bank. An independent central bank is the one that do not receive commands from fiscal authority and do not accommodate the federal government's demands for seigniorage to monetize the deficit. The autonomy of the State Bank of Pakistan also enables it not to carry out frequent open money market operation on behalf of the Ministry of Finance. Anti-inflationary monetary policy is quite enough to control inflation if State Bank gives a cool shoulder response and rejects the borrowing requirements of the government. Greater operational autonomy in carrying out monetary policy operation is needed to achieve and maintain price stability. Such a response from the State Bank of Pakistan can force the federal government to cut its coat according to the cloth. Furthermore, institutional arrangements are required that force the treasury to submit the annual budget plan, budget deficit, sources of financing and the required amount of seigniorage. Similarly the State Bank of Pakistan is supposed to submit monetary policy statement to the fiscal authority. The policy statement needs to contain the procedure and plan to achieve the targets. The fiscal and monetary policy statements require to specifically mentioning the rationale for adopting such targets and the means. The central bank needs also to brief the Ministry of Finance about the success or failure of monetary policy. Similarly the finance minister needs to brief the committee on the performance of the fiscal branch. This is instrumental in producing the cohesion between fiscal and monetary authority.

Findings of this thesis further reveal that there are significant negatives associated with indiscipline fiscal policy. Indiscipline fiscal policy makes it difficult for its monetary counterpart to formulate and execute monetary policy more freely and

independently. Similarly monetary policy also carries considerable fiscal implications. This implies that fiscal and monetary policy interacts with each other and this is high time to implement fiscal and monetary policy rules in its true spirit. Earlier we comment that standard models of interest rate are effective in the developed countries but are less effective in the developing countries like Pakistan. The main reason for this ineffectiveness is the absence of policy rules and its proper implementation in Pakistan. Institutional arrangements in the form of Fiscal Responsibility and Debt Limitation act, is also a kind of fiscal rules. The main objectives of the FRDL is to control fiscal deficit, stop the accumulation of public debt further and to reign in on the huge interest payments on debt servicing. The effectiveness of institutional arrangements in the form of Fiscal Responsibility and Debt Limitation act and Monetary and Fiscal Policy Coordination Board decreases in the presence of indiscipline treasury and fiscal profligacy. This further diminishes the efforts to reduce deficit in the future. Keeping in perspective the crippling economy of Pakistan, fiscal and monetary authority need to be more pragmatic and work on deficit and interest rate reduction. Fiscal and monetary managers with decisive powers are inevitable in order to achieve this objective. Fiscal consolidation is very much difficult in the absence of rule based policies. Strict anti fiscal deficit rules coupled with high degree of fiscal transparency is inevitable in reforming public finances in Pakistan. In the presence of legislation and fiscal responsibility law, it would be difficult for the politicians to take discretionary decisions regarding any government spending and tax cut. Similarly pre-determined fiscal targets for many years are inevitable to implement and achieve the objective of FRDL, DPCO, and MFPCB. In Pakistan, the impacts of these institutional arrangements are negligible. The main reasons for the ineffectiveness of these institutional arrangements are numerous. First, institutional arrangements for rules based fiscal policy are present in

Pakistan with the backup of legislative framework but their implementation is the actual issue. Second, politicians and fiscal managers frequently breach the rules set in the documents. Third, according to Monetary and Fiscal Coordination Board, monetary managers from State Bank and fiscal managers are supposed to meet on quarterly basis but they fail to do so and didn't meet regularly. If the federal government considers the State Bank of Pakistan is an agent of the government and not give full autonomy and independency, it may ask the State Bank to finance the fiscal deficits. In such situation, it is difficult for State Bank of Pakistan to force the government to ensure financial discipline and control inflation.

In many developed and developing countries, institutional arrangements are the most effective tools to stop government borrowing and contain fiscal profligacy. Institutional arrangements respond and limit the ability by specifying the fiscal deficit and debt to GDP ratio. Institutional arrangements are not effective in Pakistan and government usually borrows beyond limits mention in the Fiscal Responsibility and Debt Limitation act. Lack of the sense of urgency further deteriorates the fiscal position. This amplifies the implication for monetary policy and place more stringent constraints on monetary authority. Politicians and economic managers though committed and reaffirmed its commitment time and again to cut budget deficits and reduce the debt level but all these commitments are not materialized and prove just symbolic gestures. Lip services are not enough to address the grave economic issues. Tough regulations and institutional arrangements are needed in order to bring discipline into the ranks of fiscal and monetary manger besides politicians because fiscal indiscipline is a serious issue that matters. Furthermore, consequential legislations are also needed that make the government more responsible to stop it from borrowing behind limits. Such arrangements will definitely bring fiscal discipline and will hold accountable the

government responsible for spending beyond limits. Keeping in view the dismal and sorry state of Pakistan's economy, changes of some small parameters are not enough, fundamental changes are required by hook or by crook. We cannot afford wait and see policy. For economic revival, economic managers should focus on sustainable and long term solution rather than sticking to short term remedial measures. Further inaction is damaging and harmful for the economy.

At the end of this thesis, we want to write some general remarks that we observed during this thesis. Politics and politicians play an important role in Pakistan and are very crucial in the formulation of economic policies that determine the economic future of this country. Debt to GDP ratio is constantly raising in Pakistan as government fails to restraint its continuous fiscal slippages. Politicians protect their constituencies by adhering to indiscipline fiscal policy. The poor situation of public finances in Pakistan shows the worsening history of fiscal profligacy. The lavish spending of politicians and the lethargic attitude of politicians has an overwhelming effect on budget deficits. Fiscal profligacy is taking this country inexorably towards insolvency. Politicians do not have the knowledge of macroeconomic negatives of such expansionary fiscal policies. Similarly the fiscal managers extend funds because they do not respect the budget constraint and don't obey rules. Economists and policy makers consider fiscal indiscipline as the principal problem and State Bank shows grave concerns over the habitual monetization of fiscal deficit. Time and again it warns about the repercussions of fiscal deficit and its implications for the operation of monetary policy but all in vain.

It is commonly believed that an independent central bank is the pre-requisite for low and stable inflation. The central bank autonomy is necessary but not the sufficient condition for brining price stability. Prudently designed and rule based fiscal policy is instrumental for increasing monetary policy effectiveness and bringing price stability.

The optimality of monetary policy also increases when fiscal authority avoids inconsistent behavior. The timely information sharing from treasury about fiscal slippages facilitates the State Bank of Pakistan to formulate and executes its monetary policy more effectively. Such prudent fiscal practices yield material effects on the policy environment and economic situation. This will definitely facilitates the State Bank to attain its short as well as long term objectives. Specifying fiscal rules not only reduces fiscal deficits and provide space but also limit the behavior of the politicians and policy makers on the fiscal side. Institutional arrangements and rules create an environment in which there is a signed agreement between fiscal and monetary authority. Rules based policy forces both the fiscal and monetary authority to avoid inconsistent behavior. This not only works as a preventive arms but also guaranteed the autonomy and independency of the State Bank of Pakistan. Monitoring and accountability of public finances pose threats to the administrative discretion of the federal government and makes the financial managers more accountable. Policy makers need to avoid discretionary policy no matter whether the time is good or bad for the economy. Economy faces substantial damages when either fiscal or monetary authority breaches the rules.

We want to make an important comment before proceeding and taking this last chapter to its logical conclusion. From the findings of this thesis, we are not challenging the well entrenched economic thoughts and doctrines, but we surely questioning their validity believing the notion of one size does not fit all. This thesis also recommends some suggestions for making economic policies in the future. Realization of the interaction between fiscal and monetary policy by economic managers is the main issue that matters. Economic problems that Pakistan faces today are not insolvable. Drastic measures are needed to rescue the crippling economy. Keeping in perspective the

economic situation of the country, pragmatic approach with tough and hard decisions is required. Inherent flaws in fiscal policy needs to be removed besides bringing discipline into the rank and files of treasury. Fiscal and monetary authority needs to be more cohesive in order to overcome the economic problems in these difficult times and avoid any economic crisis. Similarly, economic managers should focus on sustainable and long term solution rather than sticking to short term remedial measures.

REFERENCES

Ahmad, S., Ahmed, W., Pasha, F., Khan, S., and Rehman, M., (2012). Pakistan Economy DSGE Model with informality. *SBP Working Paper* No. 47, State Bank of Pakistan.

Ahmed, W., Haider, A., and Iqbal, J., (2012). Estimation of Discount Factor β and Coefficient of Relative Risk Aversion γ in selected countries. *SBP Working Paper* No. 53, State Bank of Pakistan.

Acemoglu, D., Robinson, J., A., Querubín, P., and Johnson, S., (2008). When Does Policy Reform Work? The Case of Central Bank Independence. Brookings Papers on Economic Activity.

Adolfson, M., Laséen, S., Linde, J., and Villani, M., (2008). Evaluating an estimated new Keynesian small open economy model. *Journal of Economic Dynamics and Control*, 32: 2690 – 2721.

Alesina, A., Tabellini, G., (1987). Rules and Discretion with Non-coordinated Monetary and Fiscal Policies. *Economic Inquiry* 25(4), pp. 619-630.

Andersen, M., T. (2002). Fiscal Stabilization Policy in a Monetary Union with Inflation Targeting. *CEPR Discussion Paper No.3232, Social Science Research Network.*

An, S., and Schorfheide, F., (2007). Bayesian analysis of DSGE models, *Econometric Reviews*, 30: 889 - 920.

Arby, M. F., and Hanif, M. N., (2010). Monetary and Fiscal Policy Coordination: Pakistan's Experience, *SBP Research Bulletin*, 6: 3 – 13.

Aiyagari, R., S. and Gertler, M., (1985). The Backing of Government Bonds and Monetarism, *Journal of Monetary Economic, Elsevier,* Vol. 16(1), pages, 19-44.

Bahar, H. (2009) Interelationship aAmong Monetary, Fiscal, Exchange Rate and Debt Management Policies. *UNESCAP*, 27-30

Baldini, A. and Ribeiro. M. (2008). Fiscal and Monetary Anchors for Price Stability: Evidence from Sub-Saharan Africa. *IMF Working Paper /08/121*.

Blinder, J. S (1982), "Issues in the coordination of Monetary and fiscal policy" *NBER Working Paper Series*, Working Paper No. 982

Barro, R. J., and Gordon, B., D. (1983). Rules, Discretion and Reputation in a Model of Monetary Policy, *Journal of Monetary Economics*, pp. 101—21.

Bas, H. G., Van, A. and Niko G. (2001) Monetary and Fiscal Policy Transmission in the Euro-area: Evidence from a VAR Analysis. *Manuscript*

Benigno, G., and Benigno, P., (2004) Designing Targeting Rules for International Monetary Policy Cooperation. *Centre for Economic Performance, Discussion Paper* No. 666

Benigno, P., and Woodford, M. (2003) Optimal Monetary and Fiscal Policy: A linear Quadratic Approach. National Bureau of Economic Research , Inc, Working Paper 9905

Beetsma, R., Bovenberg, L. (1999). Does Monetary Unification Lead to Excessive Debt Accumulation?, *Journal of Public Economics,* 74(3), pp. 299-325.

Beetsma, R., and Uhlig, H. (1999). An Analysis of the Stability and Growth Pact, *Economic Journal,* Vol. 109, pp. 546–71.

Beetsma, R., and Jensen, H., (2004). Mark-up Fluctations and Fiscal Policy Stabilisation in a Monetary Union. *Journal of Macroeconomics*, 26(2): 357-376.

Benjamin Powell "Explaining Japan's recession" *The Quarterly Journal of Austrian Economics* vol. 5, no. 2 (Summer 2002): 35–50.

Bernanke, B., Gertler, M., and Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework, *Handbook of Macroeconomics Volume, Amsterdam: Elsevier Science, North-Holland.*

Bernard, L., Enrique G. and Piedra, d., l. Coordination of Monetary and Fiscal Policies. *International Monetary Fund Working Paper* WP/98/25, 1998.

Blanchard, O. and Perotti, R. (2002). An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output", *Quarterly Journal of Economics.*

Buti, M., Roeger W., and Init, V., (2001). Stabilising Output and Inflation in EMU: Policy Conflicts and Cooperation under the Stability Pact. *Journal of Common Market Studies*.

Canzoneri, M., Cumby, R., and Diba, B. (2001) Is the price level determined by the needs of fiscal solvency? *American Economic Review* 91 (5), pp 1221–38.

Canzoneri, M., Cumby, R., and Diba, B. (2002) Should The European Central Bank And The Federal Reserve Be Concerned About Fiscal Policy? *MIMEO*.

Calvo, G. A., (1983). Staggered Prices in a Utility Maximizing Framework. *Journal of Monetary Economics*, 12: 383 - 398.

Carlos A. V., Kaminsky, Graciela L., and Carmen M. Reinhart, (2004). "When it rains it pours: Procyclical capital áows and macroeconomic policies." *NBER Macroeconomics Annual 19*

Cebi, C., (2012). The interaction between monetary and fiscal policies in Turkey: An estimated New Keynesian DSGE Model. *Economic Modelling*, 29: 1258 - 1267.

Cespedes, L., Chang, R. and Velasco, A. (2004). Balance sheets and exchange rate policy. *The American Economic Review*, 94: 4.

Chari, V.V., L. J. Christiano and P. Kehoe (1991), Optimal monetary and fiscal policy, Some recent results, *Journal of Money, credit and banking*, 23: 519- 539.

Charles, W. (1999). Economic policy coordination in EMU, Strategies and Institutions, *mimeo*

Choudhri, E. U., and Malik, H. A., (2012). Monetary Policy in Pakistan: A Dynamic stochastic general equilibrium Analysis. IGC Working Paper 12/0389, International Growth Center (IGC), London School of Economics and Political Science, UK.

Christiano, L., M. Eichembaum, and Evans, C. (2005). Nominal rigidities and the dynamic effects to a shock of monetary policy, *Journal of Political Economy*, 113: 1 - 45.

Christiano, L., R. Motto and Rostagno, M. (2007). Financial factors in business cycles, *Mimeo, European Central Bank.*

Choi, W. G., and Cook, D. (2004). Liability Dollarization and the Bank Balance Sheet Channel. *Journal of International Economics,* 64: 247 – 282.

Clarida, R., Gali, J., and Gertler, M., (1999). The science of monetary policy: A new Keynesian perspective, *Journal of Economic Literature*, 37: 1661 – 1707

Coenen, G., and Straub, R., (2005). Does government spending crowd in private consumption? Theory and empirical evidence from the euro area. *International Finance*, 8(3): 435 – 470.

Cukierman, A., (1992) Central Bank Strategy, Credibility and Independence: Theory and Evidence, *MIT Press*, Cambridge, MA.

Cukierman, A., Webb, S., and Neyapti, B. (1992). Measuring the Independence of Central Banks and Its Effect on Policy Outcomes," *The World Bank Economic Review* 6-2:353-398

Dario Rukelj "Modelling Fiscal and Monetary Policy Interactions in Croatia Using Structural Vector Error Correction Model" *Research Paper* 121/2009.

Debt Policy Statement (2015-2016). *Debt Policy Coordination Office* (DPCO), Ministry of Finance.

Devereux, M. B., and Saito, M. (2005). A Portfolio Theory of International Capital Flows. *manuscript, University of British Columbia*.

Devereux, M. B., and A. Sutherland, (2006). Solving for country portfolios in an open economy macro model. *Manuscript, University of British Columbia*.

Dixit, A., and Lambertini, L., (2000). Fiscal Discretion Destroys Monetary Commitment. *Working Paper, Princeton and UCLA.*

Dixit, A., and Lambertini, L., (2001). Monetary-Fiscal Policy Interactions and Commitment versus Discretion in a Monetary Union. *Working Paper, Princeton and UCLA.*

Dixit, A., and Lambertini, L. (2001) Monetary-Fiscal Policy Interactions and Commitment versus Discretion in a Monetary Union, *European Economic Review* 45: 4-6, 977-87.

Dixit, A., and Lambertini, L. (2003a) Symbiosis of Monetary and Fiscal Policies in a Monetary Union, *Journal of International Economics* 60:2, 235-47.

Dixit, A., and Lambertini, L. (2003b) Interactions of Commitment and Discretion in Monetary and Fiscal Policies, *American Economic Review* 93:5, 1522-42.

Engel, C., and Matsumto, A. (2005). Portfolio choice in a monetary open-economy DSGE model. *University of Wisconsin and International Monetary Fund.*

Fabio, C., and Luca Sala, (2006). "Back to square one: identification issues in DSGE models," *Computing in Economics and Finance* Vol. *196*.

Fair, R. (1994) Is Monetary Policy Becoming Less Effective? *Cowles Foundation*. Discussion Paper No. 1071.

Farooq, A. and Hanif, M., N. (2007). Monetary and Fiscal Coordination. *SBP Research Bulletin*.

Farooq, A and M. N. Hanif (2010) Monetary and Fiscal Coordination: Pakistan's Experience. SBP Research Bulletin 6.

Favero, C., A. (2002). How do European Monetary and Fiscal Authorities Behave?. *CEPR Discussion Papers 3426*, C.E.P.R.

Favero, C. A., and Monacelli, T., (2005). Fiscal Policy Rules and Regime (In)Stability: Evidence from the US. *IGIER Working Paper 282*.

Fabio, C., and L. Sala, (2006). Back to square one: identification issues in DSGE models, *Computing in Economics and Finance,* Vol. *196*.

Fialho, M. M., and Portugal, M. S., (2005). Monetary and Fiscal Policy Interactions in Brazil: An Application of the Fiscal Theory of the Price Level. *Estudos Econômicos*, 35:657-685.

Forni, L., L. Monteforte, and L. Sessa (2009). The general equilibrium effects of fiscal policy: Estimates for the Euro area. *Journal of Public Economics*, 93: 559 – 585.

Fragetta, M., and Kirsanova, T., (2010). Strategic Monetary and Fiscal Policy Interactions: An Empirical Investigation, *European Economic Review*, 54(7): 855 – 879.

Galí, J., (2003). New Perspectives on Monetary Policy, Inflation, and the Business Cycle. In Advances in Economic Theory, *Applied Macroeconometrics, Oxford University press,* 3: 151 – 197.

Galí, J. and Gertler, M., (1999). Inflation Dynamics: A Structural Econometric Analysis, *Journal of Monetary Economics*, 44: 195 – 222.

Galí, J., and Monacelli, T., (2005). Monetary Policy and Exchange Rate Volatility in a Small Open Economy, *Review of Economic Studies*, 72(3): 707-734.

Grohe, S. S., and Uribe, M. (2001), Price-Level Determinacy and Monetary Policy Under a Balanced-Budget Requirement, J. Monet. Econ. 45, pp. 211-246

Gunther Schnabl "The Macroeconomic Policy Challenges of Balance Sheet Recession: Lessons from Japan for the European Crisis" *Cesifo Working Paper* NO. 4249.

Hagen, J. V., and Mundschenk, S., (2001). The political economy of policy coordination in the EMU, *Swedish Economic Policy Review*, 8: 107 – 137.

Haider, A. and Khan, S. U. (2008a). Does Volatility in Government Borrowing Lead to Higher Inflation? Evidence from Pakistan. *Journal of Applied Economic Sciences,* 4: 187 - 202.

Haider, A. and Khan, S. U., (2008b). A Small Open Economy DSGE Model for Pakistan. *Pakistan Development Review*, 47(4): 963 – 1008.

Hans F. Sennholz "Deficits Do Matter" *The Freeman* 2004.

Hemantha K.J. Ekanayake The Link Between Fiscal Deficit and Inflation" *ASARC Working Paper* 2012/14.

Herman Bennett & Norman Loayza, "Policy Biases when monetary and fiscal authorities have different objectives" *Central Bank of Chile* vol. 3(2)/2002.

"Impact of the current economic and financial crisis on potential output" *European Economy Occasional Papers49|June2009*.

Ireland, P., (2004). Technology Shocks in the New Keynesian Model. *The Review of Economics and Statistics*, MIT Press, 86: 923-936.

Jacques, M. (1997). Some Cross-Country Evidence about Debt, Deficits, and the Behavior of Monetary and Fiscal Authorities. *CEPR Discussion,* Paper No.1653.

Javid, M., and Munir, K., (2010). The Price Puzzle and Monetary Policy Transmission Mechanism in Pakistan: Structural Vector Autoregressive Approach. *The Pakistan Development Review*, Pakistan Institute of Development Economics, 49(4): 449 – 460.

Jean-Claude Chouraqui and Robert W.R. Price, "Medium-Term Financial Strategy: The Co-Ordination Of Fiscal And Monetary Policies" *Monetary and Fiscal Policy Division*, OECD Economics and Statistics Department.

John H. Cochrane "Understanding policy in the great recession: Some unpleasant fiscal arithmetic" *European Economic Review* 55 (2011) 2–30.

Kydland, F., and E. Prescott (1977) Rules Rather than Discretion: The Inconsistency of Optimal Plans. *Journal of Political Economy*, 88, pp.473-490

Kydland, F. E. and Edward, C. Prescott (1982): "Time to Build and Aggregate Fluctuations," *Econometrica* Vol. 50 Pp. 1345-1370.

Kirsanova, T., Satchi, M., Vines, D., and Wren-Lewis, S., (2007). Optimal fiscal policy rules in a monetary union. *Journal of Money, Credit, and Banking*, 39 (7): 1759–1784.

Klaus Adam and Roberto M. Billi, "Monetary Conservatism And Fiscal Policy" *Working Paper Series* No 663 / JULY 2006.

Kydland, F. E., and Prescott, E., (1982). Time to Build and Aggregate Fluctuations. *Econometrica,* 50: 1345 - 1370.

Kumhof, M and D Laxton (2007). A party without a hangover? On the effects of US government deficits, *mimeo IMF*.

Kumhof, M., R. Nunes, and I. Yakadina, (2008). Simple Monetary Rules under Fiscal Dominance. Board of Governors of the Federal Reserve System, *International Finance Discussion Papers* No. 937

Kuttner, K., and Posen, A. (2002). Fiscal Policy Effectiveness in Japan. Journal of the Japanese and International Economies 16, pp 538-558.

Lambertini, L., and Riccardo R. (2004), Independent or Coordinated? Monetary and Fiscal Policy in EMU", in Beetsma, Roel et al. (editors), Monetary Policy, Fiscal Policies and Labour Markets: Macroeconomic Policymaking in the EMU, *Cambridge: Cambridge University Press*, pp. 134-156.

Leeper, E. M. (1991). Equilibria under Active and Passive Monetary and Fiscal Policies. *Journal of Monetary Economics*, 27(1): 129-147.

Leith, C. and Lewis S., W. (2000). Interactions Between Monetary and Fiscal Policy Rules. *Economic Journal*, Vol. 110, No. 462, pp. 93-108.

Lowell M. Glenn and Abdus Samad "Fiscal and Monetary Policies Interrelation and Inflation over the Long Run: Testing Sargent and Wallace"s View for the United States" *The Journal of Business Inquiry* 2010.

Lubik, T. A., and Schorfheide, F., (2005). A Bayesian look at new open economy macroeconomics. *National Bureau of Economic Research* 20: 313 - 366.

Lubik, T. A., and Schorfheide, F., (2007). Do central bank responds to exchange rate movements? A structural investigation. *Journal of Monetary Economics,* 54: 1069 – 1087.

Malik, W. S., (2007). Monetary Policy Objectives in Pakistan: An Empirical Investigation, *Working Paper*. 35, Pakistan Institute of Development Economics, Islamabad, Pakistan.

Marco, R., Roeger, W., and Veld, J. (2001). Monetary and Fiscal Policy Interaction under a Stability Pact. *Economic Working Paper ECO 2001/08,* European University Institute.

Marco, R., Roeger, W., and Veld, J. (2009). QUEST III: An estimated open-economy DSGE model of the euro area with fiscal and monetary policy", *Economic Modelling,* Volume 26, Issue

Mélitz, J., (1997). Some Cross-Country Evidence about Debt, Deficits and the Behaviour of Monetary and Fiscal Authorities. *CEPR Discussion Papers* 1653, C.E.P.R. Discussion Papers.

Melitz, J., (2000). Some Cross-Country Evidence about Fiscal Policy Behavior and Consequences for EMU. *Unpublished manuscript*

Michal Franta, Jan Libich and Petr Stehlík: Tracking Monetary-Fiscal Interactions Across Time and Space" *CZECH National Bank, Working Paper Series* 6, 2012.

Milani, F. (2004). Adaptive Learning and Inflation Persistence. *Mimeo, Princeton University.*

Moses, O., and Nicola, V., (2009) How Does Fiscal Policy Affect Monetary Policy in the Southern Africa Community (SADC)? *MPRA Paper* No. 15372.

Muscatelli, A. M., P. Tirelli and C. Trecroci (2001). Monetary and Fiscal Policy interactions over the Cycles: Some empirical Evidence. *Cambridge University Press,* Cambridge, United Kingdom.

Muscatelli, A. M., P. Tirelli and C. Trecroci (2004). Fiscal And Monetary Policy Interactions In A New Keynesian Model With Liquidity Constraints. *Centre for Dynamic Macroeconomic Analysis*, CDMC 04/02.

Muscatelli, V.A., and Tirelli, P., (2005). Analyzing The Interaction Of Monetary And Fiscal Policy: Does Fiscal Policy Play A Valuable Role In Stabilisation*? CESifo Economic Studies*, 51 (4): 549–585.

Nasir, M., A. Ahmad, A. Ali, and Faiz-Ur-Rehman (2010) Fiscal and Monetary Policy coordination: Eviddence from Pakistan. *International Research Journal Of Finance And Economics* 35, 202-213

Neil H, Buchanan **"**Is it Sometimes Good to Run Budget Deficits? If so, Should We Admit it (Out Loud)**"** *The George Washington University Law School***,** *Public Law And Legal Theory Working Paper* Virginia Tax Review, Vol. 26 p. 325, 2006.

Nordhaus, W., M. (1994) Policy Games: Coordination and Independence in Monetary and Fiscal Policies," *Brookings Papers on Economic Activity*, Economic Studies Program, The Brookings Institution, Vol. 25(2), pp 139-216.

Ortiz, A., Ottonello, P., Sturzenegger, F. and Talvi, E. (2009). Monetary and Fiscal Policies in a Sudden Stop: Is Tighter Brighter? In Dealing with an International Credit Crunch: Policy Responses to Sudden Stops in Latin America, *Report Draft, Inter-American Development Bank*.

Pakistan Debt Policy Statement (2010-11),*Debt Policy Coordination Office, Ministry of Finance*.

Panagiotis Chronis "Monetary and fiscal policy interaction: what is the role of the transaction cost of the tax system in stabilization policies?" *Working Paper Bank of Greece.*

Persson, T. and Tabellini, G. (1993). Designing Institutions for Monetary Stability. *Carnegie-Rochester Conference Series on Public Policy*, vol. 39, pp. 53-84

Poterba, J. (1994). State Responses to Fiscal Crises: The Effects of Budgetary Institutions and Politics, *Journal of Political Economy*, vol. 102, no. 4.

Poterba, J. (1995). Balanced Budget Rules and Fiscal Policy: Evidence from the States, *National Tax Journal*, 48.

Rabanal, P., (2007). Does inflation increase after a monetary policy tightening? Answers based on an estimated DSGE model, *Journal of Economic Dynamics and Control*, 31(3): 906 – 937.

Ratto, M., Roeger, W., and Veld, J., (2009). Fiscal policy in an estimated open-economy model for the euro area. *Economic Modeling*, 26: 222 – 233.

Rogoff, K. (1985). The Optimal Degree of Commitment to an Intermediate Monetary Target, *Quarterly Journal of Economics*, Vol. 100. No. 4, pp. 1169-1189.

Sargent, T. J. and Wallace, N., (1981). "Some Unpleasant Monetarist Arithmetic", Federal Reserve Bank of Minneapolis Quarterly Review 5: pp 1-17.

Saeed Shafqat "Pakistani Bureaucracy: Crisis of Governance and Prospects of Reform", *The Pakistan Development Review* 38 : 4 Part II (Winter 1999) pp. 995–1017.

Sim, C., (1994). A simple model for the determination of the price level and the interaction of monetary and fiscal policy, *Economic Theory*, 4: 381-399.

Simons, H., C. (1936). Rules versus Authorities in Monetary Policy: *Journal of Political Economy*, pp. 1—30.

Smets, F., and Wouters, R., (2003). An estimated stochastic dynamic general equilibrium model of the euro area. *Journal of the European Economic Association*, 1: 1123 – 1175.

Smets, F., and Wouters, R., (2007). Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach. *American Economic Review*, 97(3): 586 – 606.

State Bank of Pakistan "Accountability Tools" Annual Performance Review (2002-03).

Stephanie, S. and Grohe, M. (2006). Optimal Simple and Implementable Monetary and Fiscal Rules: Expanded Version", *NBER Working Paper Series* 12402.

The State of Pakistan's Economy. *State Bank Of Pakistan*, Annual Report 2010 – 2011.

Tabellini, G., (1987), "Central Bank Reputation and Monetization of Deficits: The 1981 Italian Monetary Reforms", *Economic Inquiry*, 25, pp 185-200.

Tovar, C. E., (2009). DSGE models and central banks. *Economics - The Open-Access, Open-Assessment E-Journal*, Kiel Institute for the World Economy, 3(16):1 – 31.

Uhlig, H., and Ravn, M. O., (2002). On adjusting the Hodrick-Prescott filter for the frequency of observations, *Review of Economics and Statistics* 84(2), pp. 371-376.

Umbreen Javaid (2010) "Corruption and Its Deep Impact On Good Governance In Pakistan", *Pakistan Economic And Social Review* Volume 48, No. 1 (Summer 2010), pp. 123-134

Von, H., J., Hughes H., and Strauch, R., (2001) Budgetary Consolidation in EMU. *European Commission, Brussels Economic Papers* No. 148.

Woodford, M., (1990) Public Debt as Private Liquidity, *American Economic Review*, Vol.80, No.2, pp 382-388.

Woodford, M., (1990) Public Debt as Private Liquidity, *American Economic Review*, Vol.80, No.2, pp 382-388.

Woodford, M., (1994) Monetary Policy and Price Level Determinacy in a Cash-in-Advance Economy, *Economic Theory 4*: Page 345-380.

Woodford, M., (1995) Price level Determinacy Without Control of a Monetary Aggregate. National Bureau of Economic Research , Inc, Working Paper 5204

Woodford, M., (1996) Control of the Public Debt: A requirement for Price Stability? National Bureau of Economic Research , Inc, Working Paper 5684

Woodford, M. (1998) Doing Without Money: Controlling Inflation in a Post-Monetary World. *Review of Economic Dynamics, Elsevier for the Society fir Economic Dynamics*, Vol. 1(1), pp. 173-219

Woodford, M., “Fiscal Requirements for Price Stability” *Princeton University October* 2000.

Woodford, M. (2001) Fiscal Requirement for Price Stability. National Bureau of Economic Research , Inc, Working Paper 8072

Wyplosz, C., (1999). Economic Policy Coordination in EMU: Strategies and Institutions. *ZEI Policy Paper B11*

Zoli, E., (2005) How Does Fiscal Policy Affect Monetary Policy in Emerging Market Economies? *BIS Working Paper*, No. 174.

APPENDIX

Table A1: Variance Decomposition

	Specification 1: without government borrowing					
	μ_π	μ_r	μ_g	μ_τ	μ_a	μ_{c^*}
$\pi_{H,t}$	99.21	0.23	0.50	0.05	0.00	0.00
r_t	99.02	0.65	0.21	0.06	0.02	0.03
y_t	31.43	1.36	0.49	0.01	66.70	0.00
g_t	0.01	0.01	99.83	0.08	0.08	0.00
τ_t	0.46	0.03	3.01	96.50	0.01	0.00
b_t	0.08	0.10	98.42	1.01	0.38	0.00

	Specification 2: with government borrowing					
	μ_π	μ_r	μ_g	μ_τ	μ_a	μ_{c^*}
$\pi_{H,t}$	81.43	0.29	17.98	0.31	0.00	0.00
r_t	64.91	0.14	33.37	1.56	0.01	0.01
y_t	25.14	0.93	19.03	0.50	54.41	0.00
g_t	0.01	0.01	99.82	0.09	0.08	0.00
τ_t	0.44	0.02	2.92	96.60	0.01	0.00
b_t	0.08	0.09	98.52	0.92	0.38	0.00

Table A2: Matrix of Correlation

	Specification 1: without government borrowing					
	μ_π	μ_r	μ_g	μ_τ	μ_a	μ_{c^*}
$\pi_{H,t}$	1.00	0.99	-0.55	-0.06	-0.03	0.08
r_t	0.99	1.00	-0.57	-0.03	-0.34	0.06
y_t	-0.55	-0.57	1.00	0.08	0.03	0.00
g_t	-0.06	-0.03	0.08	1.00	-0.15	-0.96
τ_t	-0.03	-0.03	0.03	-0.15	1.00	0.27
b_t	0.08	0.06	0.00	-0.96	0.27	1.00

	Specification 2: with government borrowing					
	μ_π	μ_r	μ_g	μ_τ	μ_a	μ_{c^*}
$\pi_{H,t}$	1.00	0.86	-0.41	-0.24	0.02	0.27
r_t	0.86	1.00	-0.58	-0.46	0.15	0.51
y_t	-0.41	-0.58	1.00	0.08	0.01	-0.05
g_t	-0.24	-0.46	0.08	1.00	-0.14	-0.99
τ_t	0.02	0.15	0.01	-0.14	1.00	0.25
b_t	0.27	0.51	-0.05	-0.99	0.25	1.00

Table A3: Autocorrelations

	Specification 1: without government borrowing				
Order	1	2	3	4	5
$\pi_{H,t}$	0.922	0.792	0.655	0.530	0.424
r_t	0.925	0.796	0.660	0.535	0.429
y_t	0.967	0.919	0.868	0.822	0.780
g_t	0.931	0.810	0.678	0.554	0.446
τ_t	0.438	0.158	0.058	0.026	0.015
b_t	0.844	0.694	0.562	0.451	0.358
	Specification 2: with government borrowing				
Order	1	2	3	4	5
$\pi_{H,t}$	0.933	0.816	0.690	0.572	0.468
r_t	0.814	0.688	0.589	0.504	0.430
y_t	0.824	0.730	0.676	0.640	0.614
g_t	0.923	0.793	0.655	0.530	0.422
τ_t	0.438	0.168	0.068	0.032	0.018
b_t	0.904	0.771	0.636	0.515	0.412

B1: Descriptive Statistics:

In this section we describe our data, which we use in empirical analysis. Here we specifically mention variable of our interest. All the concerned test and treatment is carried out in this section. We use yearly data covering a time period from 1960 to 2010. The data on fiscal and monetary variables are taken from the State Bank of Pakistan statistical hand book and International Financial Statistic (IFS). We have consumer price index as well as inflation to counter check our results. We also use budget deficit as a percentage of gross domestic product. Total public debt as a percentage of GDP is also used in this thesis to counter check the findings of DSGE with conventional techniques of ARDL. It is important to mention here that variables used in the dynamic stochastic general equilibrium model do not need to be test for the problem of unit root or stationarity. So we investigate only those variables that are used in autoregressive distributed lag model while estimating the cointegration or long run association between variables.

B1.1: Unit Root Testing

It is a standard practice in the research to check time series for unit root problem or stationarity before going to estimation of any kind of equation. Before checking the cointegrating relationship or association among the variables of our interest, we need to determine the order of integration of variables. The series is non stationary if it contains unit root problem. If we proceed and estimate variables that are not stationary and have the problem of unit root, then it produces some spurious regression or meaningless relationship. Following standard protocol, this study checks whether the variables under consideration are stationary or non-stationary. Literature on time series suggests several methods and procedures for investigation the problem of unit root tests

that broadly includes the augmented Dickey-Fuller (ADF) tests and Phillips-Perron **(**PP) Tests besides other methods.

ADF test assume that the errors are statistically independent and have a constant variance. Thus, an error term should be uncorrelated with the others, and has constant variance. PP developed a unit root test as a generalized of the ADF test that allow for a weaker set of assumptions concerning the error process. Their test differs from the ADF test mainly on the detection and removal of potential autocorrelation in the errors. For example, ADF test includes the lag of dependent variable to correct the problem of autocorrelation in errors. The PP test corrects for any *serial correlation* and *Heteroscedasticity* in the errors of the test regression by directly modifying the test statistics. PP test statistics have the same asymptotic distribution as the ADF statistics. ADF and PP test is used to test the stationary proprieties of the data.

Normally error terms are expected not to be white noise. ADF the test is significantly helpful in order to remove the problem of autocorrelation. The lag length on these extra terms is either determined by the Akaike Information Criterion (AIC) or Schwartz Bayesian Criterion (SBC). This is critical and productive in order to whiten the residuals.

The three possible forms of the Augmented Dickey Fuller (ADF) test are given by the following equations.

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \mu_t \qquad \text{(A)}$$

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \mu_t \qquad \text{(B)}$$

$$\Delta y_t = \alpha_0 + \alpha_2 t + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \mu_t \qquad \text{(C)}$$

In the process of investigation of unit root problem, we have null hypothesis that states that variable has a unit root problem. The alternative hypothesis states that variable is stationary. The criterion for rejecting null hypothesis is that when *P* value is less than 5 percent which implies that our variable is stationary. But if the *P* value is not less than 5 percent then we accept our null hypothesis and conclude that our variable has a unit root problem.

Table B1: Results of Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) Tests

Variable	ADF		PP		Order of Integration
	Level	First Difference	Level	First Difference	
INF	-3.3397*	-6.6242***	-3.4642*	-7.4842***	I(0)
MMR	-2.5762*	-7.0968***	-2.5882*	-7.1021***	I(1)
BD	-4.0547**	-9.0353***	-3.9727**	-11.3302***	I(0)
DB	-3.4679*	-8.6191***	-3.4463*	-11.7580***	I(1)
DBg	-7.2840***	____	-7.3144***	____	I(0)
M2	-3.2382*	-5.0858***	-2.7716	-5.1278***	I(1)
DR	-3.5620**	-5.8701***	-2.4691	-5.9545***	I(0)
LCPI	-3.4853*	-3.2536**	-2.7096	-3.3843*	I(1)

** Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level*

Test for stationarity suggests that variables of our interest are not integrated of the same order. The above table shows that consumer price index is not stationary and become stationary at first difference. We also investigate the problem of unit root for inflation and find that inflation is stationary at level. There is no need to take first difference of inflation. Money market rate is non-stationary at level and has the problem of unit root. It becomes stationary when we take first difference. This implies it is integrated of order

one, I(1). Budget deficit and discount rate are stationary at level. They are integrated of order zero, I (0). On the other hand total public debt is non stationary at level. We take first difference to remove the problem of unit root and it becomes stationary. So it is integrated of order one, I (1). The growth rate of public debt is stationary and integrated of order zero, I(0). None of the variable is integrated of order two i.e. I(2). The different order of integration of the variable provide the logical justification for using Autoregressive Distributed Lag Model (ARDL) for investigating the cointegrating or long run association and short relationship among these variable for further empirical analysis and policy prescription.

C1: Correlation:

Before starting the detail estimation, we are going to have a quick look on the correlation among these variables. This is important to do such an exercise because it allows us to get a wild idea of the direction and strength of the association between these variables. This provides an important piece of information in a row. The following table elaborates correlation among different variables used in this thesis.

Table C1: Correlation between the variables

Variables	**INF**	**MMR**
INF	1	0.6075
MMR	0.6075	1

Figure C1: Schematic Presentation of Correlation between inflation & money market Rate

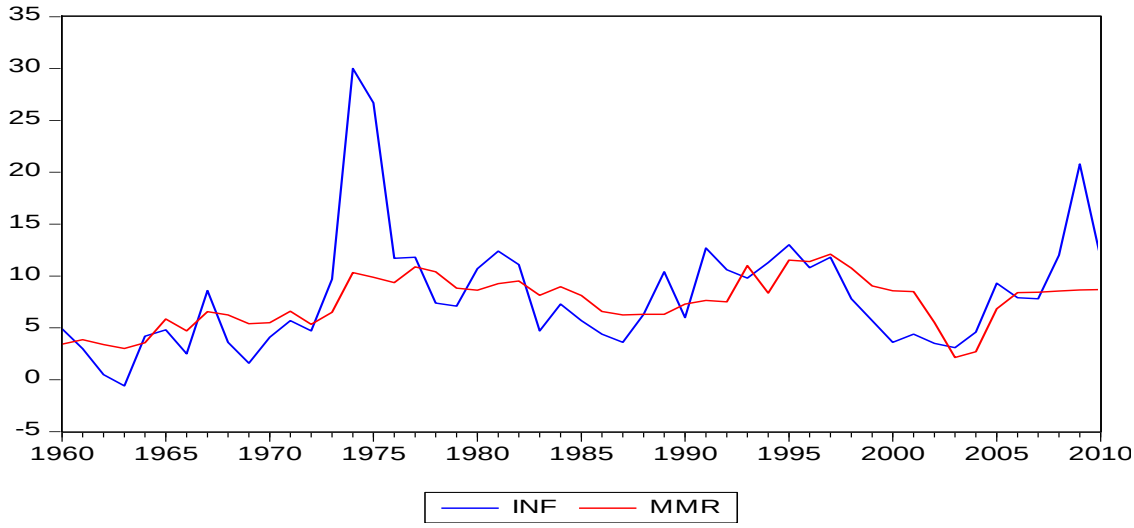
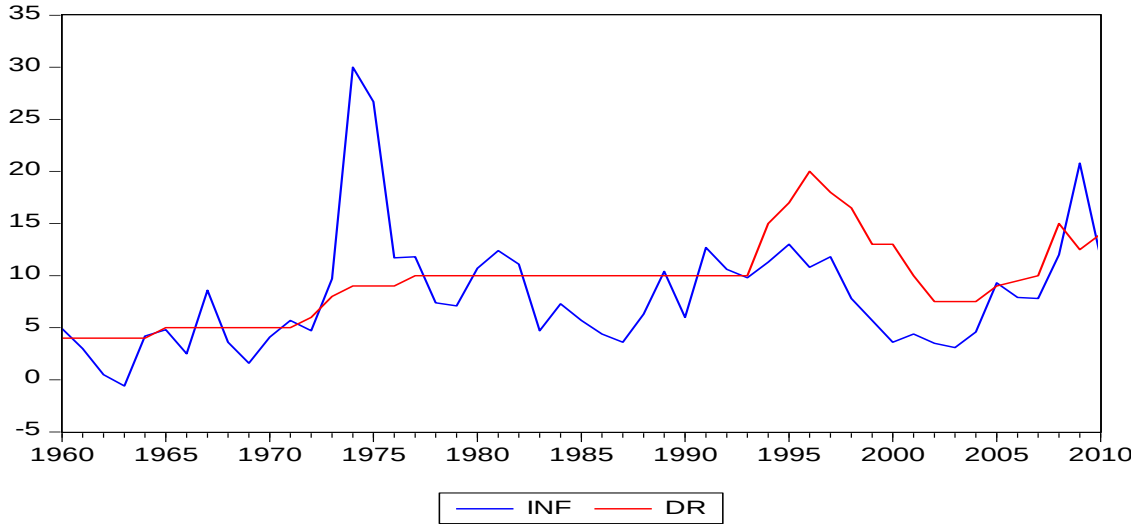


Table C2: Schematic Presentation of Correlation between Inflation & Discount Rate

Variables	INF	DR
INF	1	0.4144
DR	0.4144	1

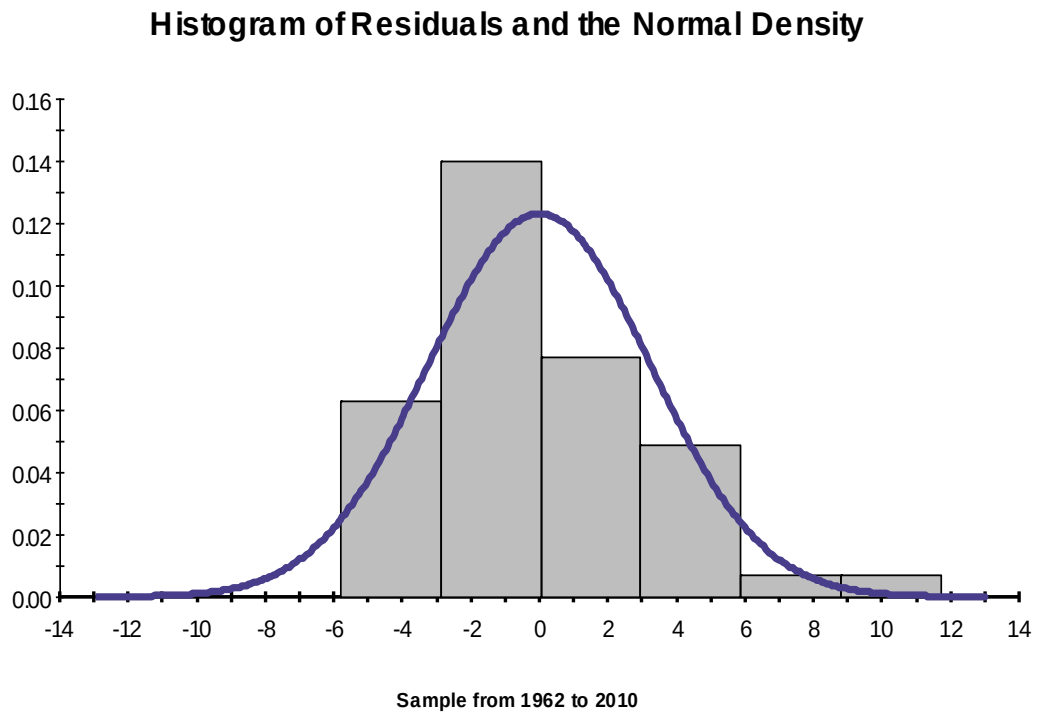
Figure C2: Schematic Presentation of Correlation between the variables



Contrary to the fundamental theory of negative correlation between inflation and discount rate, here the sign of correlation between the interest rate and inflation is

positive. The correlation between inflation and money market rate as well as with the discount rate is positive. Both price level and interest rate move in the same direction. From here we can also get a wild idea about the existence of the price puzzle phenomenon in Pakistan.

Figure D3: Histogram of Residuals and the Normal Density:



The following table shows six different shocks and its specification in MATLAB.

Table D1: Shocks and its Specification in MATLAB

Shocks	MATLAB Specification
$\varepsilon_t^g = \rho_{\varepsilon_t^g}\varepsilon_{t-1}^g + \mu_t^g$	$e\_g = roh\_e\_g * e\_g(-1) + mu\_g;$
$\varepsilon_t^T = \rho_{\varepsilon_t^T}\varepsilon_{t-1}^T + \mu_t^T$	$e\_tau = roh\_e\_tau * e\_tau(-1) + mu\_tau;$
$\varepsilon_t^r = \rho_{\varepsilon_t^r}\varepsilon_{t-1}^r + \mu_t^r$	$e\_r = roh\_e\_r * e\_r(-1) + mu\_r;$
$\varepsilon_t^\Pi = \rho_{\varepsilon_t^\Pi}\varepsilon_{t-1}^\Pi + \mu_t^\Pi$	$e\_pi = roh\_e\_pi * e\_pi(-1) + mu\_pi;$
$\varepsilon_t^a = \rho_{\varepsilon_t^a}\varepsilon_{t-1}^a + \mu_t^a$	$e\_a = roh\_e\_a * e\_a(-1) + mu\_a;$
$\varepsilon_t^{C^*} = \rho_{\varepsilon_t^{C^*}}\varepsilon_{t-1}^{C^*} + \mu_t^{C^*}$	$e\_cf = roh\_e\_cf * e\_cf(-1) + mu\_cf;$

Table D2: Parameters Calculations in MATLAB

Parameters	MATLAB
$\delta_\alpha = \frac{\delta}{(1-\alpha)+\alpha\varpi}$	sigma_alpha = sigma / ((1 - alpha) + alpha * omega));
$\varpi = \delta\gamma + (1-\alpha)(\delta\eta - 1)$	omega=sigma*gamma+(1-alpha)*(sigma*eta-1);
$\lambda^b = \frac{\xi}{\theta + \xi(1-\theta)(1-\beta))}$	lambdab = zeta / (theta + zeta * (1 - theta * (1 - beta)));
$\lambda^f = \frac{\beta\theta}{\theta + \xi(1-\theta)(1-\beta))}$	lambdaf = (beta * theta) / (theta + zeta * (1 - theta * (1 - beta)));
$\kappa = \frac{(1-\beta\theta)(1-\theta)(1-\xi)}{\theta + \xi(1-\theta)(1-\beta))}$	kappa = ((1 - beta * theta) * (1 - theta) * (1 - zeta)) / (theta + zeta * (1 - theta * (1 - beta)));

Table D3: Model (Linear) in MATLAB

1. $\hat{y}_t = E_t\left(\hat{y}_{t+1}\right) - E_t(\Delta g_{t+1}) + \alpha(\varpi - 1)(\rho_{c^*} - 1)\hat{c^*}_t - \frac{1}{\sigma_\alpha}\left[\hat{r}_t - E_t\left(\hat{\Pi}_{H,t+1}\right)\right]$

MATLAB Representation:

y = y(+1)-(g(+1)-g)+alpha*(omega-1)*(rhoc-1)*cf-(1/sigma_alpha)*(r-pih(+1));

2. $\hat{y}_t^n = \frac{(1+\varphi)}{(\delta_\alpha + \varphi)}\hat{a}_t - \frac{(\delta - \delta_\alpha)}{(\delta_\alpha + \varphi)}\hat{c}_t^*$

MATLAB Representation:

yn= ((1+phi)/(sigma_alpha+phi))*e_a-((sigma-sigma_alpha)/(sigma_alpha+phi))*cf;

3. $\hat{\Pi}_{H,t} = \lambda^b \hat{\Pi}_{H,t-1} + \lambda^b E_t\left\{\hat{\Pi}_{H,t+1}\right\} + K\hat{mc} + \varepsilon_t^\Pi$

MATLAB Representation:

pih=lambdab*pih(-1)+lambdaf*pih(+1)+kappa*mc+e_pi;

4. $\hat{mc}_t = (\delta_\alpha + \varphi)\left(\hat{y}_t - \hat{y}_t^n\right) - \delta_\alpha g_t + \hat{T}_t$

MATLAB Representation:

mc=(sigma_alpha+phi)*(y-yn)-sigma_alpha*g+tau;

5. $\hat{b}_{t+1} = \hat{r}_t + \frac{1}{\beta}\left[\hat{b}_t - \hat{\Pi}_{H,t} + (1-\beta)\left(\hat{T}_t - \hat{Y}_t\right) + \frac{\overline{C}}{\overline{B}}\left(\hat{g}_t - \hat{T}_t\right)\right]$

MATLAB Representation:

b(+1)=r+(1/beta)*(b-pih+(1-beta)*(tau-y)+(Cbar/Bbar)*(g-tau));

6. $\hat{r}_t = \rho_r\left(\hat{r}_{t-1} - \hat{r}^n_{t-1}\right) + (1-\rho_r)\left[r_\Pi \hat{\Pi}_{H,t} + r_y\left(\hat{y}_t - \hat{y}^n_t\right)\right] + \hat{r}^n_t + \varepsilon^T_t$

MATLAB Representation:

r=rhor*(r(-1)-rn(-1))+(1-rhor)*(r_pi*pih+r_y*(y-yn)+r_b*(b-b(-1)))+rn+e_r;

7. $\hat{g}_t = \rho\,\hat{g}_{t-1} + (1-\rho_g)\left[g_y\left(\hat{y}_{t-1} - \hat{y}^n_{t-1}\right) + g_b\,\hat{b}_t\right] + \varepsilon^g_t$

MATLAB Representation:

g=rhog*g(-1)+(1-rhog)*(g_y*(y(-1)-yn(-1))+g_b*b)+e_g;

8. $\tau_t = \rho_\tau \tau_{t-1} + (1-\rho_t)\left[\tau_y\left(\hat{y}_{t-1} - \hat{y}^n_{t-1}\right) + \tau_b b_t\right] + \varepsilon^\tau_t$

MATLAB Representation:

tau=rho_tau*tau(-1)+(1-rho_tau)*(tau_y*(y(-1)-yn(-1))+tau_b*b)+e_tau;

9. $\hat{r}^n_t = \delta_\alpha\left[E_t\left\{\hat{y}^n_{t+1}\right\} - \hat{y}^n_t\right] + \delta_\alpha\alpha(\varpi - 1)(\rho_{C^*} - 1)\hat{c}^*_t$

MATLAB Representation:

rn=sigma_alpha*(yn(+1)-yn)+sigma_alpha*alpha*(omega-1)*(rhoc-1)*cf;

Table D4: Symbols/Notations used in this thesis and their Names

Letter Name	Upper Case	Lower Case
Alpha	A	α
Beta	B	β
Gamma	Γ	γ
Sigma/Delta	Δ	δ
Epsilon	E	ε
Zeta	Z	ζ
Eta	H	η
Theta	Θ	θ
Pi	Π	π
Kappa	K	κ

Lambda	Λ	λ
Xi	Ξ	ξ
Rho	P	ρ
Sigma	Σ	σ
Tau	T	τ
Upsilon	Y	υ
Phi	Φ	φ
Psi	Ψ	ψ
Omega	Ω	ω
Mu	M	μ

Detailed Derivation Of The Model.

We start with government budget constraint which plays an important role in linking fiscal and monetary policy. Treasury budget constraint is given by

$$G_{t-i} + i_{t-1}B_{t-1}^{T} = T_t + \left(B_t^T - B_{t-1}^T\right) + CB_t^R \qquad (1)$$

We have also a constraint for the central bank. The budgetary identity for the monetary management is

$$\left(B_t^M - B_{t-1}^M\right) + CB_t^R = i_{t-1}B_{t-1}^M + \left(H_t - H_{t-1}\right) \qquad (2)$$

Let $B = B^T - B^M$ is the stock of government interest bearing debt held by the public. To get the consolidated government budget constraint, we combine equ (1) and equ (2)

$$G_t + i_{t-1}B_{t-1} = T_t + \left(B_t - B_{t-1}\right) + \left(H_t - H_{t-1}\right) \qquad (3)$$

Dividing the consolidated budget constraint by P_tY_t

$$\frac{G_t}{P_tY_t} + i_{t-1}\left[\frac{B_{t-1}}{P_tY_t}\right] = \frac{T_t}{P_tY_t} + \frac{B_t - B_{t-1}}{P_tY_t} + \frac{H_t - H_{t-1}}{P_tY_t}$$

Divide and multiply the term $\frac{B_{t-1}}{P_tY_t}$ by $P_{t-1}Y_{t-1}$, we get

$$\frac{B_{t-1}}{P_t Y_t} = \left(\frac{B_{t-1}}{P_{t-1} Y_{t-1}}\right)\left(\frac{P_{t-1} Y_{t-1}}{P_t Y_t}\right)$$

Let

$$\frac{B_{t-1}}{P_{t-1} Y_{t-1}} = b_{t-1}$$

So $$\frac{B_{t-1}}{P_t Y_t} = b_{t-1}\left(\frac{1}{(1+\pi_t)(1+\mu_t)}\right)$$

Where b_{t-1} represents real debt relative to income. π_t is the inflation rate in the economy and μ_t is the growth rate of real output.

Lets us define $\bar{r}_{t-1} = \frac{1+i_{t-1}}{(1+\pi_t)(1+\mu_t)} - 1$ as the ex post real rate of return on capital from $t-1 \text{to} t$. Incorporating the above equation in equation (3), the consolidated budget constraint of government becomes

$$g_t + \bar{r}_{t-1} b_{t-1} = \tau_t + (b_t - b_{t-1}) + h_t - \frac{h_{t-1}}{(1+\pi_t)(1+\mu_t)} \qquad (4)$$

To investigate the role of anticipated and unanticipated inflation for the fiscal and monetary policy operation and effectiveness, let π_t^e is expected inflation and r_t is ex ante real rate of return.

So $$1 + i_{t-1} = (1 + r_{t-1})(1 + \pi^e) \qquad (a)$$

Now we add $$\left(\frac{r_{t-1} - \bar{r}_{t-1}}{b_{t-1}}\right) = \left(\frac{(\pi - \pi_t^e)(1 + r_{t-1})b_{t-1}}{(1+\pi_t)}\right)$$

to both sides of the consolidated government budget constraint to get

$$g_t + r_{t-1}b_{t-1} = \tau_t + (b_t - b_{t-1}) + \left[\frac{\pi - \pi^e}{1+\pi_t}\right](1+r_{t-1})b_{t-1} + \left[h_t - \left(\frac{1}{1+\pi_t}\right)h_{t-1}\right] \quad (5)$$

In equation (5) $(\pi - \pi^e)b_{t-1}$ represents revenue from unanticipated inflation. The last term of the above equation represent seigniorage.

$$S_t = \frac{H_t - H_{t-1}}{P_t Y_t}$$

Dividing both sides by $P_t Y_t$ and doing some small manipulation

$$s_t = h_t - h_{t-1} + \left(\frac{\pi_t}{1+\pi_t}\right)h_{t-1} \quad (6)$$

Where $h_t - h_{t-1}$ show the changing position of high powered money.

The growth rate of nominal monetary base holds a prominent position in this scheme of things. Let $\phi = H$ and it indicates the growth rate of the nominal monetary base.

The growth rate of h_t will be

$$\left(\frac{\phi - \pi}{1+\pi}\right) \approx \phi - \pi \quad \text{And}$$

$$d = b + h \quad (7)$$

The total government liability d is composed of interest bearing debt, b and non-interest bearing debt h.

Add $r_{t-1}h_{t-1}$ and incorporate total liabilities of the government to the consolidated budget equation (5)

$$g_t + r_{t-1}d_{t-1} = \tau_t + (d_t - d_{t-1}) + \left(\frac{\pi - \pi^e}{1+\pi_t}\right)(1+r_{t-1})d_{t-1} + \left(\frac{i_{t-1}}{1+\pi_t}\right)h_{t-1} \quad (8)$$

$\left(\frac{i}{1+\pi}\right)h = \bar{s}$ is seigniorage. (9)

Ignore surprise inflation for a while, the single period budget identity becomes

$$g_t + r_{t-1}b_{t-1} = \tau_t + (b_t - b_{t-1}) + s_t$$

Assuming r to be constant and solving one period forward, we get

$$(1+r)b_{t-1} + \sum_{i=0}^{\infty}\frac{g_{t+1}}{(1+r)^i} = \sum_{i=0}^{\infty}\frac{\tau_{t+1}}{(1+r)^i} + \sum_{i=0}^{\infty}\frac{s_{t+i}}{(1+r)^i} + \lim_{i\to\infty}\frac{b_{t+i}}{(1+r)^t} \quad (10)$$

If $\lim_{i\to\infty}\frac{b_{t+i}}{(1+r)^t} = 0$

This implies that inter-temporal budget constraint of the government is satisfied.

$$(1+r)b_{t-1} + \sum_{i=0}^{\infty}\frac{g_{t+1}}{(1+r)^i} = \sum_{i=0}^{\infty}\frac{\tau_{t+1}}{(1+r)^i} + \sum_{i=0}^{\infty}\frac{s_{t+i}}{(1+r)^i} \quad (11)$$

Let Δ is primary government deficit and is equal to

$$\Delta = g - t - s$$

The inter-temporal budget constraint becomes

$$(1+r)b_{t-1} = \sum_{i=0}^{\infty}\frac{g-t-s}{(1+r)^i} = \sum_{i=0}^{\infty}\frac{\Delta_{t+1}}{(1+r)^i} \quad (12)$$

Let R indicates gross real interest rate and is equal to

$R = 1 + r$ then equation (12) implies

$$Rb_{t-1} = \sum_{i=0}^{\infty} \frac{\Delta_{t+i}}{R^i}$$

$$= \sum_{i=0}^{\infty} \frac{g_{t+1} - t_{t+i} - s_{t+1}}{R^i} \quad \text{as } \Delta_{t+i} = g_{t+i} - t_{t+i} - s_{t+i}$$

$$b_{t-1} = \frac{1}{R} \sum_{i=0}^{\infty} \frac{g_{t+1} - t_{t+i} - s_{t+1}}{R^i}$$

$$= -R^{-1} \sum_{i=0}^{\infty} R^{-i} \left(g_{t+i} - \tau_{t+i} - s_{t+i} \right) \tag{13}$$

Let $g_t - \tau_t - s_t$ is the primary government deficit and s_t represents seigniorage revenue. And let

S_t^f represents primary government surpluses and is equal to

$$S_t^f = \tau_t - g_t$$

Then

$$b_{t-1} = -R^{-1} \sum_{i=0}^{\infty} R^{-i} S_{t+i}^f + R^{-i} \sum_{i=0}^{\infty} R^{-i} S_{t+i} \tag{14}$$

For checking the relationship between public debt, tax revenue and seigniorage, we set

$$g_t = 0$$

The government budget constraint becomes

$$\left(1 + r_{t-1}\right) = \tau_t + b_t + s_t \tag{15}$$

The economic agent or the household receives income y_t and he/she pays taxes denoted by τ_t, household also receives real interest on holding government debt and that is

$$(1+i_{t-1})\frac{B_{t-1}}{P_t} = (1+r_{t-1})b_{t-1}$$

Where i represents interest rate, B show the amount of debt held by the household and P_t shows price level. We know that

$$(1+r_{t-1})b_t = \left(\frac{1+i_{t-1}}{1+\pi_t}\right)-1$$

And the demand for real cash balances is

$$\frac{M_{t-1}}{P_t} = \frac{m_{t-1}}{1+\pi_t}$$

$$= (1+\pi_t)^{-1} m_{t-1}$$

So the household budget constraint can be written as

$$c_t + m_t + b_t = y + (1+r_{t-1})b_{t-1} + \frac{m_{t-1}}{1+\pi_t} - \tau_t$$

$$c_t + m_t + b_t = y + (1+r_{t-1})b_{t-1} + (1+\pi_t)^{-1} m_{t-1} - \tau_t \qquad (16)$$

Assume that ψ represents the share of interest bearing debt of the total liabilities of the government and this lies between zero and one. If the government debt is not entirely financed by revenue from taxes then revenue from seigniorage must be adjusted.

Now

$$T_t = \psi(1 + r_{t-1})b_{t-1} \tag{17}$$

T_t denotes the present discounted value of taxes. Where $(1 + r_{t-1})b_{t-1}$ are government liabilities including interest payments on debt

$$T_{t+1} = \psi(1 + r_{t-1+1})b_{t-1+1}$$

$$T_{t+1} = \psi(1 + r_t)b_t$$

$$= \tau_t + E_t\left[\frac{T_{t+1}}{1 + r_t}\right]$$

Substituting T_{t+1} we get

$$= \tau_t + E_t\left[\frac{\psi(1 + r_t)b_t}{1 + r_t}\right]$$

$$T_t = \tau_t + \psi b_t$$

$$T_t - \psi b_t = \tau_t$$

$$\tau_t = T_t - \psi b_t$$

Substituting T_t

$$t_t = \psi(1 + r_{t-1})b_{t-1} - \psi b_t \tag{18}$$

We Know that

$$1 + r = R$$

$$1 + r_{t-1} = R_{t-1}$$

Substituting in (18), we get

$$t_t = \psi\left(R_{t-1}b_{t-1}\right) - \psi b_t$$

$$t_t = \psi\left[R_{t-1}b_{t-1} - b_t\right]$$

We also know that

$$\left(1 + r_{t-1}\right)b_{t-1} = \tau_t + b_t + s_t$$

$1 + r = R$ and $1 + r_{t-1} = R_{t-1}$

$$R_{t-1}b_{t-1} = \tau_t + b_t + s_t$$

$$R_{t-1}b_{t-1} - b_t = \tau_t + s_t$$

We know that

$$t_t = \psi\left[R_{t-1}b_{t-1} - b_t\right]$$

Substituting t_t in $R_{t-1}b_{t-1} - b_t = \tau_t + s_t$

$$R_{t-1}b_{t-1} - b_t = \psi\left[R_{t-1}b_{t-1} - b_t\right] + s_t$$

$$s_t = R_{t-1}b_{t-1} - b_t - \psi\left[R_{t-1}b_{t-1} - b_t\right]$$

$$s_t = \left(1 - \psi\right)\left[R_{t-1}b_{t-1} - b_t\right] \qquad (19)$$

According to equation (16), we know that household budget constraint is

$$c_t + m_t + b_t = y + \left(1 + r_{t-1}\right)b_{t-1} + \frac{m_t}{1 + \pi_t} - \tau_t$$

$$t_t = \psi\left[R_{t-1}b_{t-1} - b_t\right]$$

$$c_t + m_t + b_t + \tau_t = y + (1 + r_{t-1})b_{t-1} + \frac{m_t}{1+\pi_t}$$

$$c_t + m_t + b_t + \tau_t = y + (1 + r_{t-1})b_{t-1} + \frac{m_t}{1+\pi_t}$$

We also know that

$$1 + r_{t-1} = R_{t-1}$$

So

$$c_t + m_t + b_t + \tau_t = y + R_{t-1}b_{t-1} + \frac{m_t}{1+\pi_t}$$

$$y + R_{t-1}b_{t-1} + \frac{m_t}{1+\pi_t} = c_t + m_t + b_t + \tau$$

We also know that

$$t_t = \psi\left[R_{t-1}b_{t-1} - b_t\right]$$

And

$$y + R_{t-1}b_{t-1} + \frac{m_t}{1+\pi_t} = c_t + m_t + b_t + \psi\left[R_{t-1}b_{t-1} - b_t\right]$$

$$y + R_{t-1}b_{t-1} + \frac{m_t}{1+\pi_t} = c_t + m_t + b_t + \psi R_{t-1} - \psi b_t$$

$$y + R_{t-1}b_{t-1} - \psi R_{t-1}b_{t-1} = c_t + m_t + (1-\psi)b_t$$

$$y + (1-\psi)R_{t-1}b_{t-1} - \psi R_{t-1}b_{t-1} = c_t + m_t + (1-\psi)b_t$$

(20)

This equation has very important implications. When ψ =1, then

$$(1-\psi)b_t = 0$$

$$(1-\psi)R_{t-1}b_{t-1} = 0$$

This implies that the term representing government debt vanishes. It means that only the level of stock of money matters. When ψ <1 it implies that both the level of government debt and money stock matters. Let

$$w = m + (1-\psi)b$$

$$w_t = m_t + (1-\psi)b_t$$

$$m_t = w_t - (1-\psi)b_t$$

$$m_t + (1-\psi)b_t = w_t$$

$$w_t = m_t + (1-\psi)b_t$$

$$w_{t-1} = m_{t-1} + (1-\psi)b_{t-1}$$

$$m_{t-1} = w_{t-1} - (1-\psi)b_{t-1}$$

We know that

$$y + (1-\psi)R_{t-1}b_{t-1} + \frac{m_{t-1}}{1+\pi_t} = c_t + m_t + (1-\psi)b_t$$

And

$$m_t = w_t - (1-\psi)b_t$$

So

$$y+(1-\psi)R_{t-1}b_{t-1}+\frac{m_{t-1}}{1+\pi_t}=c_t+w_t-(1-\psi)b_t+(1-\psi)b_t$$

$$y+(1-\psi)R_{t-1}b_{t-1}+\frac{m_{t-1}}{1+\pi_t}=c_t+w_t$$

$$y+(1-\psi)b_{t-1}R_{t-1}+\frac{m_{t-1}}{1+\pi_t}=c_t+w_t$$

We know that

$$w_{t-1}=m_{t-1}+(1-\psi)b_{t-1}$$

$$w_{t-1}-m_{t-1}=(1-\psi)b_{t-1}$$

$$(1-\psi)b_{t-1}=w_{t-1}-m_{t-1}$$

$$y+w_{t-1}R_{t-1}-m_{t-1}+\frac{m_{t-1}}{1+\pi_t}=c_t+w_t$$

$$y+w_{t-1}R_{t-1}=c_t+w_t+m_{t-1}-\frac{m_{t-1}}{1+\pi_t}$$

$$y+R_{t-1}w_{t-1}=c_t+w_t+\frac{(1+\pi_t)m_{t-1}-m_{t-1}}{(1+\pi_t)}$$

$$y+R_{t-1}w_{t-1}=c_t+w_t+m_{t-1}\left[\frac{(1+\pi_t)-1}{(1+\pi_t)}\right]$$

$$y+R_{t-1}w_{t-1}=c_t+w_t+\frac{i_{t-1}m_{t-1}}{(1+\pi_t)} \qquad (21)$$

This equation implies that individual can now use income for consumption, for making financial assets or can hold money. The opportunity cost of holding money is

$$\frac{i_t}{(1+\pi_t)}$$

Government debt policy is also critical in the determination of price level but the transmission is not a direct one. To investigate the role of debt policy, lets us assume that the household has a separable utility function

$$\ln C_t + \delta \ln m_t$$

$$MRS_{c,m} = \frac{i_t}{1+i_t}$$

&

$$m_t = \delta c_t \left(\frac{1+i_t}{i_t} \right)$$

The Euler's equation for optimal consumption path is

$$c_{t+1} = \beta(1+r_t)c_t$$

Household budget constraint is

$$y + R_{t-1}w_{t-1} = c_t + w_t + \frac{i_{t-1}}{(1+\pi_t)} m_{t-1}$$

We know that

$$m_t = \delta c_t \left(\frac{1+i_t}{i_t} \right) \qquad \text{(a)}$$

$$m_{t-1} = \delta c_{t-1}\left(\frac{1+i_{t-1}}{i_{t-1}}\right)$$

$$m_{t-1} = \delta\left(\frac{1+i_{t-1}}{i_{t-1}}\right)c_{t-1} \qquad \text{(b)}$$

And we also know that

$$c_{t+1} = \beta(1+r_t)c_t$$

$$c_{t+1-1} = \beta(1+r_t)c_{t-1}$$

$$c_t = \beta(1+r_t)c_{t-1}$$

$$\frac{c_t}{\beta(1+r_t)} = c_{t-1} \qquad \text{(c)}$$

Substituting (c) into (b), we get

$$m_{t-1} = \delta\left(\frac{1+i_{t-1}}{i_{t-1}}\right)c_{t-1}$$

$$m_{t-1} = \delta\left(\frac{1+i_{t-1}}{i_{t-1}}\right)\frac{c_t}{\beta(1+r_t)} \qquad \text{(d)}$$

Now we substitute (d) in the household budget constraint

$$y + R_{t-1}w_{t-1} = c_t + w_t + \frac{i_{t-1}}{(1+\pi_t)}m_{t-1}$$

$$y + R_{t-1}w_{t-1} = c_t + w_t + \frac{i_{t-1}}{(1+\pi_t)}\left[\delta\left(\frac{1+i_{t-1}}{i_{t-1}}\right)\frac{c_t}{\beta(1+r_t)}\right]$$

$$y + R_{t-1}w_{t-1} = c_t + w_t + \frac{i_{t-1}}{(1+\pi_t)}\delta\left(\frac{1+i_{t-1}}{i_{t-1}}\right)\frac{c_t}{\beta(1+r_t)}$$

$$y + R_{t-1}w_{t-1} = c_t + \frac{i_{t-1}}{(1+\pi_t)}\delta\left(\frac{1+i_{t-1}}{i_{t-1}}\right)\frac{c_t}{\beta(1+r_t)} + w_t$$

$$y + R_{t-1}w_{t-1} = c_t\left[1+\frac{\delta}{\beta}\right]\left(\frac{i_{t-1}}{(1+\pi_t)}\left(\frac{1+i_{t-1}}{i_{t-1}}\right)\frac{c_t}{(1+r_t)}\right) + w_t$$

We know that in steady state and in equilibrium

$$c_t = y_t$$

$$y + R_{t-1}w_{t-1} = y_t\left[1+\frac{\delta}{\beta}\right] + w_t$$

$$y + R_{t-1}w_{t-1} = y_t + y_t\left(\frac{\delta}{\beta}\right) + w_t$$

$$y - y + R_{t-1}w_{t-1} = y_t\left(\frac{\delta}{\beta}\right) + w_t$$

$$R_{t-1}w_{t-1} = \left(\frac{\delta}{\beta}\right)y_t + w_t$$

In steady state we have

$$w = w_{t-1} = w^{ss}$$

$$R_{t-1}w_t = \left(\frac{\delta}{\beta}\right)y_t + w_t$$

$$R_{t-1}w_t - w_t = \left(\frac{\delta}{\beta}\right)y_t$$

$$w_t\left[R_{t-1}-1\right]=\left(\frac{\delta}{\beta}\right)y_t$$

$$w_t=\frac{1}{\left[R_{t-1}-1\right]}\left(\frac{\delta}{\beta}\right)y_t$$

$$w_t=\frac{\delta y_t}{\beta\left(R_{t-1}-1\right)}$$

We know that

$$W=\left[\frac{M+(1+\psi)B}{P}\right]$$

Substituting in

$$w_t=\frac{\delta y_t}{\beta\left(R_{t-1}-1\right)}$$

$$\left[\frac{M+(1-\psi)B}{P}\right]=\frac{\delta y_t}{\beta\left(R_{t-1}-1\right)}$$

$$\frac{\delta y_t}{\beta\left(R_{t-1}-1\right)}=\left[\frac{M+(1-\psi)B}{P}\right]$$

$$P.\frac{\delta y_t}{\beta\left(R_{t-1}-1\right)}=M+(1-\psi)B$$

$$P=\frac{M+(1-\psi)B}{\frac{\delta y_t}{\beta\left(R_{t-1}-1\right)}}$$

$$P=M+(1-\psi)B\frac{\beta\left(R_{t-1}-1\right)}{\delta y_t}$$

Let in the steady state

$$R-1=r^{ss}$$

Substituting in the above equation

$$P^{ss}=\frac{\beta r^{ss}}{\delta y}\left[M+(1-\psi)B\right] \qquad (22)$$

When ψ =1 then

$$P^{ss}=\frac{\beta r^{ss}}{\delta y}M \qquad (23)$$

This implies that price level determination in the economy entirely depend on money stock in the economy. In this case, government finances its spending by imposing taxes. It means that the level of government budget deficits and level of public debt has no role to play in the determination of price level and inflation is independent of it.

But we know that most of the time government faces budget deficits. It means the value of ψ is different from zero. When $0<\psi<1$, we have

$$P^{ss}=\frac{\beta r^{ss}}{\delta y}\left[M+(1-\psi)B\right] \qquad (24)$$

Above equation indicates that both the level of government debt and money stock are critical for the determination of price level. Changes in the stock of money and the changing level and pattern of fiscal deficits and the level of government debt affect the price level.

As we early discussed that composition of government liabilities plays very important role in the determination of price level. Let λ represents noninterest-bearing debt and a fraction of government liabilities and equals

$$\lambda = \frac{M}{M+B}$$

The value of λ depends on the open market operation by the central bank particularly the level of funds or liquidity in the market. As the open market operation changes, the fraction of money stocks and debt in total government liabilities changes.

$$\lambda(M+B) = M$$

Substitute M in equation (4.22)

$$P^{ss} = \frac{\beta r^{ss}}{\delta y}\left[M + (1-\psi)B\right]$$

$$P^{ss} = \frac{\beta r^{ss}}{\delta y}\left[\lambda(M+B) + (1-\psi)B\right]$$

$$P^{ss} = \frac{\beta r^{ss}}{\delta y}\left[(1-\psi)(1-\lambda)(M+B)\right] \qquad (25)$$

Consider the household budget constraint

$$D_t + P_t Y_t - T_T \geq P_t C_t + M_t^d + B_t^d$$

Let D represent household wealth and is equal to

$$D_{t+1}^d = (1+i_t)B_t^d + M_t^d$$

Divide both sides by P_t

$$\frac{D_t}{P_t}+\frac{P_tY_t}{P_t}-\frac{T_T}{P_t}\geq\frac{P_tC_t}{P_t}+\frac{M_t^d}{P_t}+\frac{D_{t+1}^d}{P_t}+\frac{B_t^d}{P_t}$$

$$d_t+y_t-\tau_t\geq c_t+m_t^d+b_t^d$$

$$d_t+y_t-\tau_t=c_t+\left(\frac{i_t}{1+i_t}\right)m_t^d+\left(\frac{1}{1+r_t}\right)b_{t+1}^d$$

Let λ indicates the discount factor and is equal to

$$\lambda_{t,t+i}=\prod_{j=1}^{i}\left(\frac{1}{1+r_{t+j}}\right)$$

And

$$d_t+\sum_{i=0}^{\infty}\lambda_{t,t+i}(y_{t+i}-\tau_{t+i})=\sum_{i=0}^{\infty}\lambda_{t,t+i}\left[c_{t+i}\left(\frac{i_{t+1}}{1+i_{t+1}}\right)m_{t+1}^d\right]$$

We also know that government budget constraint in nominal term is

$$P_tg_t+(1+i_{t-1})B_{t-1}=T_t+M_t-M_{t-1}+B_t$$

Divide both sides by P_t

$$\frac{P_tg_t}{P_t}+(1+i_{t-1})\frac{B_{t-1}}{P_t}=\frac{T_t}{P_t}+\frac{M_t}{P_t}-\frac{M_{t-1}}{P_t}+\frac{B_t}{P_t}$$

$$g_t+d_t=\tau_t+\left(\frac{i_t}{1+i_t}\right)m_t+\left(\frac{1}{1+r_t}\right)d_{t+1}$$

$$d_t+\sum_{i=0}^{\infty}\lambda_{t,t+i}\left[g_{t+1}-\tau_{t+1}-\bar{s}_{t+1}\right]=\lim_{T-\infty}\lambda_{t,t+T}d_t \qquad (26)$$

Where s represent government revenue generated through seigniorage and is equilibrium and is equal

$$\bar{s} = \left(\frac{i_t}{1+i_t} \right) m_t$$

$$\frac{\bar{s}}{\left(\frac{i_t}{1+i_t} \right)} = m_t$$

Equilibrium in goods market means that

$$y_t = c_t + g_t$$

$$c_t = y_t - g_t$$

And supply of money equals demand for money

$$m_t^d = m_t^s$$

Substituting c_t and m_t

$$d_t + \sum_{i=0}^{\infty} \lambda_{t,t+i} \left[g_{t+1} - \tau_{t+1} - \left(\frac{i_{t+i}}{1+i_{t+i}} \right) m_{t+i} \right] = 0$$

$$D_t + \sum_{i=0}^{\infty} \lambda_{t,t+i} \left[g_{t+1} - \tau_{t+1} - \bar{s}_{t+1} \right] = 0$$

$$D_t = \sum_{i=0}^{\infty} \lambda_{t,t+i} \left[\tau_{t+1} + \bar{s}_{t+1} - g_{t+1} \right]$$

Dividing by P_t

$$\frac{D_t}{P_t} = \sum_{i=0}^{\infty} \lambda_{t,t+i} \left[\tau_{t+1} + \bar{s}_{t+1} - g_{t+1} \right]$$

Now

$$D_t = P_t \sum_{i=0}^{\infty} \lambda_{t,t+i} \left[\tau_{t+1} + \bar{s}_{t+1} - g_{t+1} \right]$$

$$D_t \frac{1}{\sum_{i=0}^{\infty} \lambda_{t,t+i} \left[\tau_{t+1} + \bar{s}_{t+1} - g_{t+1} \right]} = P_t$$

$$P_t^* = \frac{D_t}{\sum_{i=0}^{\infty} \lambda_{t,t+i} \left[\tau_{t+1} + \bar{s}_{t+1} - g_{t+1} \right]} \qquad (27)$$

Detailed Derivation of the General Form of ARDL Model:

The general form of the error correction model is derived using the two variables Y_t and X_t.Consider the following two-variables Y_t and X_t with n-lags of both variables.

$$Y_t = \delta_0 + \sum_{i=0}^{n} \delta_i Y_{t-i} + \sum_{j=0}^{n} \lambda_j X_{t-j} \qquad (1)$$

$$Y_t = \delta_0 + \delta_1 Y_{t-1} + \delta_2 Y_{t-2} + ... + \delta_n Y_{tt-n} + \lambda_0 X_t + \lambda_1 X_{t-1} + \lambda_2 X_{t-2} + ... + \lambda_n X_{t-m} + u_t$$

(2)

Here, the short run impact of the variable X_t on Y_t is captured by λ_0.

The long run association or coefficients are

$$Y_t = Y_{t-1} = Y_{t-2} = ... = Y_{t-n} = Y_t^* \qquad (3)$$

$$X_t = X_{t-1} = X_{t-2} = ... = X_{t-n} = X_t^* \quad (4)$$

. Substituting (3) and (4) into equation (2), we get

$$Y_t^* = \delta_0 + \delta_1 Y_t^* + \delta_2 Y_t^* + ... + \delta_n Y_t^* + \lambda_0 X_t^* + \lambda_1 X_t^* + \lambda_2 X_t^* + ... + \lambda_n X_t^* + u_t$$

We do some little manipulation

$$Y_t^* - \delta_1 Y_t^* - \delta_2 Y_t^* - .... - \delta_n Y_t^* = \delta_0 + \lambda_0 X_t^* + \lambda_1 X_t^* + \lambda_2 X_t^* + ... + \lambda_n X_t^* + u_t$$

$$Y_t^* (1 - \delta_1 - \delta_2 - .... + \delta_n) = \delta_0 + (\lambda_0 + \lambda_1 + \lambda_2 + ... + \lambda_n) X_t^* + u_t$$

Rearranging

$$Y_t^* = \frac{\delta_0}{(1 - \delta_1 - \delta_2 - .... + \delta_n)} + \frac{(\lambda_0 + \lambda_1 + \lambda_2 + ... + \lambda_n)}{(1 - \delta_1 - \delta_2 - .... + \delta_n)} X_t^* + u_t \quad (5)$$

Let

$$A = \frac{\delta_0}{(1 - \delta_1 - \delta_2 - .... + \delta_n)}$$

$$B = \frac{(\lambda_0 + \lambda_1 + \lambda_2 + ... + \lambda_n)}{(1 - \delta_1 - \delta_2 - .... + \delta_n)}$$

So equation 5 becomes

$$Y_t^* = A + BX_t^* + u_t$$

We derive Error Correction Model (ECM) from equation (2)

$$Y_t = \delta_0 + \delta_1 Y_{t-1} + \delta_2 Y_{t-2} + ... + \delta_n Y_{tt-n} + \lambda_0 X_t + \lambda_1 X_{t-1} + \lambda_2 X_{t-2} + ... + \lambda_n X_{t-m} + \varepsilon_t$$

We can write Y_t as

$$Y_t = Y_t - Y_{t-1} + Y_{t-1}$$

$$Y_t = \Delta Y_t + Y_{t-1} \quad \text{(a)}$$

And we can also write X_t as

$$X_t = X_t - X_{t-1} + X_{t-1}$$

$$X_t = \Delta X_t + X_{t-1} \quad \text{(b)}$$

Substituting, value of Y_t and X_t from (a) and (b) into equation (2)

$$\Delta Y_t + Y_{t-1} = \delta_0 + \delta_1 Y_{t-1} + \delta_2 Y_{t-2} + ... + \delta_n Y_{tt-n} + \lambda_0 \left[\Delta X_t + X_{t-1}\right] + \lambda_1 X_{t-1} + \lambda_2 X_{t-2} + ... + \lambda_n X_{t-m} + \varepsilon_t$$

$$\Delta Y_t + Y_{t-1} = \delta_0 + \delta_1 Y_{t-1} + \delta_2 Y_{t-2} + ... + \delta_n Y_{tt-n} + \lambda_0 \Delta X_t + \lambda_0 X_{t-1} + \lambda_1 X_{t-1} + \lambda_2 X_{t-2} + ... + \lambda_n X_{t-m} + \varepsilon_t$$

Rearranging

$$\Delta Y_t = \delta_0 + \delta_1 Y_{t-1} - Y_{t-1} + \delta_2 Y_{t-2} + ... + \delta_n Y_{tt-n} + \lambda_0 \Delta X_t + \lambda_0 X_{t-1} + \lambda_1 X_{t-1} + \lambda_2 X_{t-2} + ... + \lambda_n X_{t-m} + \varepsilon_t$$

$$\Delta Y_t = \delta_0 + (\delta_1 - 1) Y_{t-1} + \delta_2 Y_{t-2} + ... + \delta_n Y_{tt-n} + \lambda_0 \Delta X_t + \lambda_0 X_{t-1}$$

$$+ \lambda_1 X_{t-1} + \lambda_2 X_{t-2} + ... + \lambda_n X_{t-m} + \varepsilon_t \quad \text{(6)}$$

We can also write Y_{t-1} as

$$Y_{t-1} = Y_{t-1} - Y_{t-2} + Y_{t-2}$$

$$Y_{t-1} = \Delta Y_{t-1} + Y_{t-2}$$

$$Y_{t-1} - Y_{t-2} = \Delta Y_{t-1}$$

$$\Delta Y_{t-1} = Y_{t-1} - Y_{t-2} \qquad \text{(c)}$$

Similarly

$$X_{t-1} = X_{t-1} - X_{t-2} + X_{t-2}$$

$$X_{t-1} = \Delta X_{t-1} + X_{t-2}$$

$$X_{t-1} - X_{t-2} = \Delta X_{t-1}$$

$$\Delta X_{t-1} = X_{t-1} - X_{t-2} \qquad \text{(d)}$$

Substituting (c) and (d) into equation (6)

$$\Delta Y_t = \delta_0 + (\delta_1 - 1)\left[\Delta Y_{t-1} + Y_{t-2}\right] + \delta_2 Y_{t-2} + ... + \delta_n Y_{t-n} + \lambda_0 \Delta X_t + \lambda_0 X_{t-1}$$

$$+ \lambda_1 \left(\Delta X_{t-1} + X_{t-2}\right) + \lambda_2 X_{t-2} + ... + \lambda_n X_{t-m} + \varepsilon_t$$

$$\Delta Y_t = \delta_0 + (\delta_1 - 1)\Delta Y_{t-1} + (\delta_1 - 1)Y_{t-2} + \delta_2 Y_{t-2} + ... + \delta_n Y_{t-n} + \lambda_0 \Delta X_t + \lambda_0 X_{t-1}$$

$$+ \lambda_1 \Delta X_{t-1} + \lambda_1 X_{t-2} + \lambda_2 X_{t-2} + ... + \lambda_n X_{t-m} + \varepsilon_t$$

Now we re-arrange the terms Y_{t-2}

$$\Delta Y_t = \delta_0 + (\delta_1 - 1)\Delta Y_{t-1} + \delta_2 Y_{t-2} + (\delta_1 - 1)Y_{t-2} + ... + \delta_n Y_{t-n} + \lambda_0 \Delta X_t + \lambda_0 X_{t-1}$$

$$+\lambda_1 \Delta X_{t-1} + \lambda_1 X_{t-2} + \lambda_2 X_{t-2} + ... + \lambda_n X_{t-m} + \varepsilon_t$$

On the same lines, Y_{t-2} can be written as

$$Y_{t-2} = Y_{t-2} - Y_{t-3} + Y_{t-3}$$

$$Y_{t-2} = \Delta Y_{t-2} + Y_{t-3}$$

And similarly X_{t-2} is equal to

$$X_{t-2} = X_{t-2} - X_{t-3} + X_{t-3}$$

$$X_{t-2} = \Delta X_{t-2} + X_{t-3}$$

Substituting the values of Y_{t-2} and X_{t-2} in equation

$$\Delta Y_t = \delta_0 + (\delta_1 - 1)\Delta Y_{t-1} + \delta_2 Y_{t-2} + (\delta_1 - 1)\left[\Delta Y_{t-2} + Y_{t-3}\right] + ... + \delta_n Y_{t-n} + \lambda_0 \Delta X_t$$

$$+\lambda_0 X_{t-1} + +\lambda_1 \Delta X_{t-1} + \lambda_1 X_{t-2} + \lambda_2\left[\Delta X_{t-2} + X_{t-3}\right] + ... + \lambda_n X_{t-m} + \varepsilon_t \qquad (7)$$

$$\Delta Y_t = \delta_0 + (\delta_1 - 1)\Delta Y_{t-1} + \delta_2 Y_{t-2} + (\delta_1 - 1)\Delta Y_{t-2} + (\delta_1 - 1)Y_{t-3} + ... + \delta_n Y_{t-n} +$$

$$\lambda_0 \Delta X_t + \lambda_0 X_{t-1} + \lambda_1 \Delta X_{t-1} + \lambda_1 X_{t-2} + \lambda_2 \Delta X_{t-2} + \lambda_2 X_{t-3} + ... + \lambda_n X_{t-m} + \varepsilon_t \qquad (8)$$

Following the same procedure we need to change the values of *X* and *Y* till X_{t-n} and Y_{t-n}, we get.

$$\Delta Y_t = \delta_0 + (\delta_1 - 1)\Delta Y_{t-1} + (\delta_2 - 1)\Delta Y_{t-2} + ... + (\delta_{n-1} - 1)\Delta Y_{t-n-1} + \lambda_0 \Delta X_t + \lambda_1 \Delta X_{t-1}$$

$$+\lambda_2 \Delta X_{t-2} + ... + \lambda_{m-1} \Delta X_{t-n-1} + \delta_1 Y_{t-2} + \delta_2 Y_{t-3} + ...$$

$$+\delta_n Y_{t-(n+1)} + \lambda_0 X_{t-1} + \lambda_1 X_{t-2} + \lambda_2 X_{t-3} + ... + \lambda_n X_{t-(m+1)} + \varepsilon_t \quad (9)$$

In the long run we have

$$Y_t = Y_{t-1} = Y_{t-2} = ... = Y_{t-n}$$

And

$$X_t = X_{t-1} = X_{t-2} = ... = X_{t-n}$$

Now we replace the terms Y_{t-2}, $Y_{t-3} \ldots . Y_{t-n}$ with Y_{t-1} and X_{t-2}, X_{t-3},..... X_{t-n} Within the above equation (9)

$$\Delta Y_t = \delta_0 + (\delta_1 - 1)\Delta Y_{t-1} + (\delta_2 - 1)\Delta Y_{t-2} + ... + (\delta_{n-1} - 1)\Delta Y_{t-n-1} + \lambda_0 \Delta X_t + \lambda_1 \Delta X_{t-1}$$

$$+ \lambda_2 \Delta X_{t-2} + ... + \lambda_{m-1} \Delta X_{t-n-1} + \delta_1 Y_{t-1} + \delta_2 Y_{t-1} + ...$$

$$+ \delta_n Y_{t-1} + \lambda_0 X_{t-1} + \lambda_1 X_{t-1} + \lambda_2 X_{t-1} + ... + \lambda_n X_{t-1} + \varepsilon_t \quad (10)$$

By setting

$$b_i = (\delta_i - 1)$$

We have

$$\Delta Y_t = \delta_0 + b_1 \Delta Y_{t-1} + b_2 \Delta Y_{t-2} + ... + b_{n-1} \Delta Y_{t-n-1} + \lambda_0 \Delta X_t + \lambda_1 \Delta X_{t-1}$$

$$+ \lambda_2 \Delta X_{t-2} + ... + \lambda_{m-1} \Delta X_{t-n-1} + \delta_1 Y_{t-1} + \delta_2 Y_{t-1} + ...$$

$$+ \delta_n Y_{t-1} + \lambda_0 X_{t-1} + \lambda_1 X_{t-1} + \lambda_2 X_{t-1} + ... + \lambda_n X_{t-1} + \varepsilon_t \quad (11)$$

Now we take the terms Y_{t-1} and X_{t-1} common and Apply Summation

$$\Delta Y_t = \delta_0 + \sum_{i=1}^{n-1} b_i \Delta Y_{t-i} + \sum_{j=1}^{m-1} b_j \Delta X_{t-j} + \left(\delta_1 + \delta_2 + ...\delta_n - 1\right) Y_{t-1} +$$

$$+ \left(\lambda_0 + \lambda_1 + \lambda_2 + ... + \lambda_n\right) X_{t-1} + \varepsilon_t \qquad (12)$$

Let

$$\chi_1 = \left(\delta_1 + \delta_2 + ...\delta_n - 1\right) \ (e)$$

And

$$\chi_2 = \left(\lambda_0 + \lambda_1 + \lambda_2 + ... + \lambda_n\right) \ (f)$$

Substituting (*e*) and (*f*) in the above equation (12)

$$\Delta Y_t = \delta_0 + \sum_{i=1}^{n-1} b_i \Delta Y_{t-i} + \sum_{j=1}^{m-1} b_j \Delta X_{t-j} + \chi_1 Y_{t-1} + \chi_2 X_{t-1} + \varepsilon_t \qquad (13)$$