AN OPEN ECONOMY MODEL OF PAKISTAN: RELATIVE EFFECTIVENESS OF MONETARY AND FISCAL POLICY

THESIS

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

By

Abid Hameed, B.A.
Denton, Texas
August, 1995
AN OPEN ECONOMY MODEL OF PAKISTAN: RELATIVE EFFECTIVENESS OF MONETARY AND FISCAL POLICY

THESIS

Presented to the Graduate Council of the
University of North Texas in Partial Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

By

Abid Hameed, B.A.

Denton, Texas

August, 1995

This thesis examines the relative effectiveness of monetary and fiscal policy in Pakistan by utilizing an open economy framework. There is a great need for research about the effectiveness of macroeconomic policies as the knowledge of the relative importance of monetary and fiscal policy could prove useful to policymakers and help them understand the macroeconomic adjustment processes of these policy measures.

The dynamics of the open economy are analyzed with the help of innovative Vector Autoregression methodology (VAR). Specifically, impulse response functions and variance decompositions are generated to study the dynamics. Granger-Causality test are also performed. The results from this thesis show that fiscal policy is more effective than monetary policy in Pakistan. Evidence is also found that monetary authorities accommodate fiscal policies.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF TABLES</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF ILLUSTRATIONS</td>
<td>vi</td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2. PAKISTAN'S POLITICAL AND ECONOMIC TRENDS</td>
<td>4</td>
</tr>
<tr>
<td>Political History</td>
<td></td>
</tr>
<tr>
<td>Economic History</td>
<td></td>
</tr>
<tr>
<td>Economic Structure</td>
<td></td>
</tr>
<tr>
<td>Objectives and Tools of Monetary and Fiscal Policy in Pakistan</td>
<td></td>
</tr>
<tr>
<td>Transmission Mechanism of Monetary and Fiscal Policy in Pakistan</td>
<td></td>
</tr>
<tr>
<td>3. VECTOR AUTOREGRESSION METHODOLOGY</td>
<td>21</td>
</tr>
<tr>
<td>Granger-Causality</td>
<td></td>
</tr>
<tr>
<td>Stationarity in VAR Modeling</td>
<td></td>
</tr>
<tr>
<td>Unit Roots</td>
<td></td>
</tr>
<tr>
<td>Cointegration and Error Correction Modeling</td>
<td></td>
</tr>
<tr>
<td>Johansen Procedure</td>
<td></td>
</tr>
<tr>
<td>4. ESTIMATION AND RESULTS</td>
<td>37</td>
</tr>
<tr>
<td>Test for Unit Roots</td>
<td></td>
</tr>
<tr>
<td>Lag Length</td>
<td></td>
</tr>
<tr>
<td>Granger-Causality Test</td>
<td></td>
</tr>
<tr>
<td>Johansen Cointegration Test</td>
<td></td>
</tr>
<tr>
<td>Error Correction Model</td>
<td></td>
</tr>
<tr>
<td>Impulse Response Functions</td>
<td></td>
</tr>
<tr>
<td>Monetary Shocks</td>
<td></td>
</tr>
</tbody>
</table>
Fiscal Shocks
Variance Decompositions

5. CONCLUSION .................................................................................. 53

ILLUSTRATIONS ................................................................................. 56

TABLES ................................................................................................. 69

REFERENCE LIST ................................................................................. 78
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Data in Levels</td>
<td>70</td>
</tr>
<tr>
<td>2. Identification of Data Generating Process</td>
<td>71</td>
</tr>
<tr>
<td>3. Augumented Dickey-Fuller Unit Root Test</td>
<td>72</td>
</tr>
<tr>
<td>4. Pairwise Granger-Causality Tests</td>
<td>73</td>
</tr>
<tr>
<td>5. Johansen's Cointegration Test</td>
<td>74</td>
</tr>
<tr>
<td>6. Ljung-Box Q Statistic</td>
<td>75</td>
</tr>
<tr>
<td>7. Variance Decompositions</td>
<td>76</td>
</tr>
</tbody>
</table>
LIST OF ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figures</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Plot of Time Series</td>
<td>57</td>
</tr>
<tr>
<td>2. Plot of Residuals</td>
<td>58</td>
</tr>
<tr>
<td>3. Responses to a Shock in GXRL-Version 1</td>
<td>59</td>
</tr>
<tr>
<td>4. Responses to a Shock in MYRL-Version 1</td>
<td>60</td>
</tr>
<tr>
<td>5. Responses to a Shock in GXRL-Version 2</td>
<td>61</td>
</tr>
<tr>
<td>6. Responses to a Shock in MYRL-Version 2</td>
<td>62</td>
</tr>
<tr>
<td>7. Responses to a Shock in GXRL-Version 3</td>
<td>63</td>
</tr>
<tr>
<td>8. Responses to a Shock in MYRL-Version 3</td>
<td>64</td>
</tr>
<tr>
<td>9. Responses to a Shock in GXRL-Version 4</td>
<td>65</td>
</tr>
<tr>
<td>10. Responses to a Shock in MYRL-Version 4</td>
<td>66</td>
</tr>
<tr>
<td>11. Responses to a Shock in GXRL-Version 5</td>
<td>67</td>
</tr>
<tr>
<td>12. Responses to a Shock in MYRL-Version 5</td>
<td>68</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

Stabilization policy refers to a program of economic policy measures designed to achieve broad macroeconomic objectives such as an improvement in the growth of real output, a low rate of inflation and sustainable balance of payments position. Many developing countries have experienced very serious problems in each of these three areas and as a result have been required to design and implement comprehensive stabilization programs aimed at restoring macroeconomic equilibrium in the economy. Over the years, Pakistan has faced similar difficulties in achieving its macroeconomic objectives. Government stabilization policies play an important part in achieving macroeconomic equilibrium in Pakistan. However, there is little known with authenticity, about the channels through which changes in the policies percolate through the system. A few studies have attempted to address these issues in context of Pakistan by using both large and medium-sized structural models. Saqib and Yasmin (1987) use Anderson-Jordon type equation to evaluate the relative importance of fiscal and monetary policies in effecting real output (Anderson and Jordon, 1968). Their results imply that monetary impulses have greater leverage in explaining changes in the GNP. Hussain (1992) also using an Anderson-Jordan type model tests for the relative effectiveness of monetary and fiscal policies in Pakistan by performing Granger and
Sims causality test. His results detect a unidirectional causality running from monetary variables to nominal GNP and from nominal GNP to government expenditure. The results provide evidence that changes in government expenditure, rather than causing changes in the nominal GNP, are influenced by changes in nominal GNP and that monetary policy is more effective than fiscal policy in influencing nominal GNP.

Naqvi, Khilji and Ahmed (1983) have built a 56 equation macroeconomic structural model for Pakistan. The policy simulation from this model provides some highly counter-intuitive results. They argue that deficit-financing does not contribute to monetary expansion and that monetary expansion does not explain changes in the general price level. Masood, K. and Ahmed, E (1980) analyze the relative effectiveness of monetary and fiscal policy and conclude that fiscal innovations are relatively more important in explaining the variations in real output. Recently, Chisti, Hasan and Mahmud (1992) have studied the macroeconomic behavior of Pakistan by building a ten variable open economy model. Their study finds a weak response of fiscal policy shocks on real GDP in the short-run and strong response of monetary shocks on real GDP in the long-run. However, some of these studies have reached contradictory and at times even counter-intuitive results. One of the aims of this thesis is to broaden existing perspectives on transmission mechanism of fiscal and monetary shocks in impacting real output, in the context of Pakistan.
This thesis is divided into five chapters. Chapter 2 presents the structural characteristics of Pakistan’s economy. Chapter 3 discusses the specification issues involved in VAR modeling. Chapter 4 presents estimation results and finally chapter 5 sums up the conclusion.
CHAPTER 2

PAKISTAN'S POLITICAL AND ECONOMIC TRENDS

Policy formulation in many less developed countries (LDC's) is subject to many social, political, and economic influences. Pakistan, one such less developed country, has faced many challenges on political, economic and social fronts since its inception in 1947. In order to address the policy question in the context of Pakistan's economy, some of the institutional and structural characteristics of this economy are described below.

Political History

Pakistan's political history can be divided into five periods. The first lasted for over eleven years (1947-1958) and was characterized as a competitive parliamentary democracy. Governments changed rapidly during this period as the indigenous leaders of the areas that constituted Pakistan began the process of recapturing political power from the migrant community.

The second period of Pakistan's political history lasted for a little over thirteen years (1958-1971) and saw two military dictatorships - the first under General Ayub Khan (1958-1969) and the second under General Yahya Khan (1969-1971). During this period, the military and the civilian bureaucracies forged a strong political alliance with a number of middle-class urban and rural groups. Also in 1971, the separatist
movement in East Pakistan led to the breakdown of the eastern wing of Pakistan. This breakdown led to severe revenue shortages as the economy of the former East Pakistan (Bangladesh) was a major source of revenue for Pakistan.

The third period of Pakistan's political history represented a brief interregnum in the rule by the military; during the years (1972-1977), Zulfikhar Ali Bhutto managed to retain political power with populist support. This period is characterized by Pakistan's experimentation with the socialist democracy.

The fourth period of Pakistan's political history began in 1977 with the establishment of Pakistan's third military dictatorship and lasted for eight and a half years. During this period of martial law, the military sought to broaden its political constituency by instituting a number of reforms aimed at introducing Islam into economics and politics.

The fifth period of Pakistan's political history (1988-1995) was characterized by parliamentary democracy but governments changed rapidly. During this period, three elections were held and governments were dissolved as a result of political instability and corruption charges.

Pakistan's political history thus reflects a constant struggle among social groups for participation in or control of the political process. It is interesting to speculate as how these political conflicts may have affected economic decision making and economic performance in the economy. Such an analysis is best done in the context of the five periods identified above (Kennedy, 1993).
Economic History

1949 was the first turning point for Pakistan's economy. The country was still struggling to handle the chaos created by the partition of British India when India dealt a further blow by halting trade with its neighbor, thus bringing to an end the custom union that had tied together the two nation's economies since independence. The Indian action was prompted by Pakistan's decision not to follow the 'sterling area' and devalue its currency with respect to U.S dollar. This decision changed the rate of exchange for parity to 144 Indian rupees per 100 Pakistani rupees. India refused to accept the rate and halted the flow of goods and services between the two countries (Burki, 1986).

The economy of Pakistan is primarily agricultural with agricultural goods being its principal asset, output, and its only export. The series of decisions that emanated from the Indian action had great significance for Pakistan's economic history. These decisions established the private sector as the leading sector of the economy. The policymakers turned to the industrial sector to lead the economy out of the difficulties created by the trauma of partition. The policy framework was based on "trickle down economics". The assumption was that the rapid economic growth would first help those who possessed physical assets by returning large profits to them. The rich, in turn, would allow incomes to "trickle down" to the less privileged segment of the population by providing increased employment to the poor and by increasing the consumption of daily necessities that the poor produced. The poor would use the additions to their incomes not only for increasing the consumption of daily necessities
but also for buying education, health care and better shelter for their families.

The second important year for the Pakistani economy was 1958, when General Ayub Khan established the first military government and introduced new ways of conducting economic business. Although the model of economic development adopted by Ayub Khan allowed the state a much more important role in economic management, and although Ayub Khan instituted central planning for allocating public sector resources, he did not abandon the two guiding principles for economic development that were adopted in 1949: that the private sector would lead the economy, and that the market would be allowed to take care of poverty alleviation and social development. The following statement by chief economist of Planning Commission, Mahbubul Haq, outlines the strategy adopted by Pakistan in the second Five Year Plan (1960-1965): "There exists functional justification for inequality of income that raises production for all and consumption for few. The road to eventual equalities may inevitably lie through initial inequalities." (Haq, 1976).

In 1972 Zulfikhar Bhutto, elected on the socialist platform, nationalized a number of economic enterprises redefining the role of the state in economic management. Nationalization of a number of economic enterprises in the sectors of industry, finance, trade, and communication was one of the important manifestations of this structural change. The resulting expansion of the public sector was in line with the populist politics advocated by Bhutto. Not unexpectedly, this sudden shift in priorities caused major disruptions. Private capital moved out of industry and went into construction and commerce, two sectors in which returns were high; a great deal of
private capital also left the country for the security offered in the Middle East, Europe and United States. This was the only period in Pakistan's economic history in which the growth of output in both agriculture and industry was less than the rate of growth in GNP.

When the military forced Zulfikar Ali Bhutto out of office in July 1977, it also abandoned his socialist economic policies. These policies had previously alienated the social groups that were important for the military: the large landlords of Sind; the middle-sized farmers of the Punjab and Northwest Frontier Province; and the merchants and the industrialists of Karachi, Lahore and Multan. Together all of these groups formed the constituency that had supported Ayub Khan in the 1960s. Under General Zia-ul-Haq, the military instinctively went back for support to the same social groups. Accordingly, further development of public sector was constrained and private entrepreneurs were invited back to invest in all sectors of the economy. Agriculture, once again received a great deal of government attention and resources. Small industries, in particular those that provided inputs for the agricultural sector and processed agricultural output, came to be especially favored (Burki, 1986).

The economy responded quickly to these changes in policy. The rate of growth of output in the agricultural sector changed from slightly higher than 2 per cent per year during the Bhutto period to 4.6 per cent. The rate of growth of manufacturing output nearly doubled, from 5.2 per cent to 9.1 per cent. The GDP increased at the annual rate of 6.1 per cent, which was made possible not by expansion of non-productive sectors of the economy, as had happened during the period of Zulfikar Ali
Bhutto, but by the impressive increases in output of the agricultural and industrial sectors.

After nearly eight years of military rule, a parliamentary democracy with a civilian prime minister was reinstalled in December 1985. But former military dictator and President Zia-ul-Haq remained pre-eminent and showed it in May 1988 when he removed Prime Minister Mohammed Khan Junejo, dissolved the Parliament and formed a caretaker government without a prime minister. Elections were to be held in 90 days but skeptics doubted they would be held, especially since Zia declared his intention of turning Pakistan into a completely Islamic State. The influence of the military remained strong.

New general elections on a party basis were allowed in November 1988 after President Zia lost his life in an air crash. It marked end of an era and a hopeful rebuilding of democracy on firmer foundations. Benazir Bhutto’s Pakistan People’s Party won the elections overall. A new government emerged in Pakistan along with an essentially new pattern of national politics, headed by a younger generation of leaders. In a strenuous series of foreign trips through 1989, Benazir Bhutto presented an attractive image of Pakistan which earned respect in the West and in Asia. But a serious economic crisis faced the Bhutto government, and underlying political tensions threatened to upset the country’s surface stability. The two pressing economic problems facing the new government were the ever-increasing budget deficit and the current account balance. Pakistan’s budget deficit for 1989 was approximately 5.3% of GDP. The government’s first budget, presented in June 1989, was well received by
the IMF as signaling a seriousness of economic intent which had been lacking under the previous regime. The budget had three goals: cutting the budget deficit, controlling inflation (currently around 20% per cent), and improving the inadequate infrastructure. In August 1990, President Ghulam Ishaq dissolved the parliament and formed a caretaker government. Benazir Bhutto's government was accused of corruption and nepotism and a judicial commission was set up to look into the corruption charges (Hayman, 1990).

General elections were held in October 1990. The Islamic Democratic Alliance received the majority vote. Prime Minister Nawaz Sharif took office announcing his agenda of economic reforms. During this period, the newly elected government of Nawaz Sharif launched an ambitious program of privatization, deregulation and economic reform aimed at reducing the structural impediments to sound economic development. Announcing this structural reform, the government gave top priority to denationalizing 115 public enterprises, abolishing the government's monopoly in the financial sector, and selling key utilities to private interest groups. Nawaz Sharif's government further liberalized the economy by lifting all controls on foreign currency entering the country and proposed new policies to encourage foreign investment. The government's new economic policy underlaid a belief in the market system to allocate resources. Pakistan's economy sustained an impressive rate of growth in the GDP during the 1980's and 1990's, averaging 6.2 per cent per year in real terms, but rapid growth exacerbated structural flaws in the economy that caused the federal budget and the country's current account to slide deeply into deficit by the decade's end. With
IMF help, the government attempted to restore fiscal balance through a multilayer structural adjustment program designed to increase revenues, control spending and stabilize monetary growth. IMF-supported structural adjustment measures implemented in 1989 and 1990 improved the fiscal situation somewhat, but an unexpected revenue shortfall in 1991 plunged the deficit even further into the red. In addition, government borrowed heavily from the central bank, the State Bank of Pakistan (SBP), to cover that part of the budget gap not financed by foreign assistance or domestic public debt, promoting an inflationary expansion of the money supply. Nawaz Sharif's government is credited with revitalizing Pakistan's economy through its economic reforms. The government faced strong political opposition led by former Prime Minister Benazir Bhutto which further destabilized the economic and political structure of the country. The government was also accused of corruption and in 1993 the parliament was again dissolved and a caretaker government was established (U.S Department of Commerce, 1992).

General elections were held again in 1994. Benazir Bhutto was able to regain the office of prime minister. The new government embarked on broader economic reform. To attract more private capital from abroad, the government has liberalized regulations governing foreign investment and foreign exchange. Governments sanctions for new investments are no longer required except for investment in restricted industries. Exchange rate reforms made it possible for non-resident foreigners and Pakistanis to invest in shares of companies in Pakistan on a fully repatriable basis. Foreign repatriation of profits and capital was now possible without prior approval.
from the central bank. In addition, foreign owned firms in Pakistan may now freely issue equity shares and have better access to local currency credit facilities. Foreign banks can compete on equal bases with Pakistani banks in underwriting equity securities in Pakistan. Furthermore, Pakistan residents can open foreign currency bank accounts and more easily purchase foreign exchange for travel, education, etc. In addition, the central bank has been granted more autonomy in managing the money supply. Credit rationing, price controls, and interest rate ceilings have been lifted. The State Bank of Pakistan has for the first time in 1994, used open market operations to control the money supply in the economy (Dawn, 1994).

Economic Structure

Pakistan is a relatively poor country with annual per capita income of less than $400 and an adult literacy rate of about 24 percent. Pakistan’s economy is dependent on agriculture and has suffered set-backs from warfare, political upheaval and poor weather conditions reducing crops and continuing rapid population growth. Although still agrarian in character, the economy has undergone significant transformation in terms of growth, patterns of production and consumption, employment structure, composition and direction of foreign trade, and the relative roles of public and private sector. The share of agriculture in GDP has declined from 53 per cent in 1949-1950 to 26 per cent in 1987-1988 with a corresponding rise over this period in the share of industry from 9.6 per cent to 25 per cent. Over the last few years, Pakistan has managed a self sustained broad-based growth rate of GDP of about 6 per cent per annum. The investment rate (16 per cent of GNP) and saving rate (12 per cent of GNP)
in Pakistan are low in absolute terms as well as in comparison with the levels attained by other less developed countries. The Consumer Price Index (CPI) was up 13 per cent during 1991. Heavy government borrowing from the central bank, prompting rapid expansion of money supply, coupled with government's removal of agricultural and utility subsidies has kept inflation at double-digit levels. Over the past few years, the government has liberalized the economy by encouraging the private sector and welcoming foreign private investment (U.S Department of Commerce, 1992).

Objectives and Tools of Monetary and Fiscal Policy in Pakistan

The Planning Commission in Pakistan has the primary authority to formulate the monetary and fiscal policies of the government. The commission formulates five year plans which broadly outline the growth rates desired in different sectors, declare the budget and project revenues and expenditure outlays. As such, the objectives of the monetary and fiscal authorities are often intertwined since their primary focus is on economic growth and development. The objectives of the monetary and fiscal authorities can be classified under four broad categories: (1) to promote economic growth and development by fostering higher levels of production and employment in all sectors; (2) to serve as a source to supplement current government revenue and to provide development finance to all sectors, especially the public sector; (3) to promote confidence in the domestic currency through measures that stabilize domestic wages and prices; and, (4) to maintain a healthy external reserves and balance of payments position.

With respect to the promotion of economic growth and development,
policymakers in Pakistan have used monetary policies as an easy source of money to finance private domestic investment. The emphasis on domestic investment is based on economic studies in the literature, especially growth models, that stress the importance of investments as one of the major conduits for economic growth and development. In addition to using monetary policies to encourage domestic investment initiatives, the government views fiscal policies as crucial in attracting all kinds of investment. In its attempt to attract both domestic and foreign investment, the government has made conscious efforts to attract industries with backward and forward linkages by granting tax concessions, relief from import duties to industries with growth potential, and the imposition of tariffs barriers in order to protect infant industries. It is noted that the tax system in Pakistan is neither well structured nor as effective as a source of revenue as those in more developed countries.

On many occasions revenue shortfalls have contributed to many unplanned and excessive monetary expansions which the central bank (SBP) had to sustain in order to meet the financial requirements of the government. The easy money policies generally create inflationary pressure. Many analysts have indicated that some of the macroeconomic problems of Pakistan are self-inflicted arising from mismanagement characterized by unsustainable levels of government expenditures, and also from a lack of information about the appropriate dose of monetary-fiscal stimulus necessary for economic growth and stability.

The policy of easy money by the central bank is also extended to the priority sectors, that is, those sectors that are involved in agricultural exports, manufacturing.
mining and other export-related activities. The policy of easy money is accomplished by commercial banks through rediscounting facilities\(^1\). The objective of rediscounting policy is to insulate bank rates from market forces in the interest of government financing. Since these rates are insulated from the forces of demand and supply, they are insensitive to changes in the availability of loanable funds in financial markets. Through this mechanism, commercial banks are able to keep the bank rates relatively low for both the public and private sector of the economy. From this analysis it may be concluded that monetary policy in Pakistan follows the financial requirements of the government. On the other hand, fiscal incentives in the form of loans for agricultural and rural development projects are usually provided by the government. The aim of direct government loans is usually to reach those in the rural areas that may not otherwise have access to bank credit (Owoye, 1994).

As for the promotion of confidence in a strong and stable domestic currency, the monetary and fiscal authorities view stable currency as essential for price stability;

\(^1\)Rediscounting amounts to discounting a bill of exchange that already has been discounted with another person. This usually happens when a shortage of funds compels the commercial banks to rediscount bills that they have already discounted with the central bank acting as a lender of last resort.
both authorities cooperate in the maintenance of a strong and stable currency through different control mechanisms. One example of these control mechanisms is the fixed exchange rate policy followed by Pakistan prior to mid-1980s, even though it contributed to real exchange rate misalignment and a current account deficit. As the balance of payments position worsened during the 1980s as a result of external shocks, external reserves were drawn to finance the deficits, thus weakening the position of reserves as a source of funds for development. Generally, these policy actions were based on a perception that market forces may not achieve the equilibrium that is consistent with economic growth. This skepticism may help explain why the government plays a significant role in wage and price determination domestically. These market interventions have caused various market distortions and severe macroeconomic imbalance.

Finally, it should be noted that the task of maintaining a healthy external-reserves and balance-of-payments position in Pakistan has not been easy because of the rapid expansion of purchasing power which has created excess demand for goods and services beyond the production and supply capabilities. As a result, imports rose and continued to rise in order to supplement the insufficient domestic supply; thus the available external reserves have been persistently run down to pay for the external deficits. To correct for the external imbalances, monetary authorities have been used via the reduction in the money supply and volume of domestic credit. In some cases, foreign exchange authorizations for import and foreign travel have been severely curtailed to ease the pressure on foreign exchange earnings. On the other side of this
policy issue, fiscal policies have been used to restrain consumer demand in an effort to control balance of payments pressures. The government has sometimes adopted tougher fiscal measures, which included higher import duties or a total ban on importation of certain goods (Oluwole, 1994).

Given the above discussion of the objectives of the monetary and fiscal authorities in Pakistan, the obvious question is what are the tools that are used to achieve these objectives. The central bank in Pakistan, SBP, has traditionally used the following tools: (1) bank rediscount rate; (2) liquidity ratio requirements; (3) cash requirements; (4) domestic credit control; and (5) open market operations. Open market operations, used for the first time in 1994, is a relatively new tool for SBP.

For fiscal policies, the conventional tools are government spending and taxes. Here a question can be raised with respect to the significance of government spending and tax policies in aggregate demand fine tuning in Pakistan's economy. Given the inefficient tax structure, it is easily conjectured which of the fiscal variables will have a significant impact on the economy.

Transmission Mechanism of Monetary and Fiscal Policy in Pakistan

In the case of a less developed country like Pakistan, the analysis of the monetary transmission mechanism is relevant because it would provide some useful insights as to the differences, if any, in the relative importance of monetary and fiscal policy. Generally, the traditional Keynesian view of the monetary transmission mechanism can be classified into three categories: (1) those operating through investment spending; that is, a shock in the money supply decreases the interest rate
which in turn boosts investment and causes output to increase; (2) those operating through consumer durables expenditure; and, (3) those operating through international trade. What these categories have in common, apart from aggregate output, is the interest rate. From previous discussion it is noted that interest rates do not represent the cost of financing investment spending in Pakistan because they are fixed by government policies. This has been well documented in the development literature.

On the basis of this knowledge, the traditional Keynesian view of transmission is not applicable. Fixed interest rate policies explain why the demand and supply of loanable funds is insensitive to interest rates in Pakistan. It is therefore safe to conclude that the effects of expansionary monetary policies are not transmitted through interest rates.

Rather, the effects of monetary policies are channeled to the economy through the level of domestic credit that goes to the priority sectors such as agriculture, manufacturing, mining and services. As investment rises in these sectors due to readily available credit, aggregate output rises. That is, the money supply increases lead to an increase in quantity of loanable funds, causing investment spending to rise, and thus causing aggregate demand and aggregate output to rise. On the other hand, a restrictive monetary policy works in the opposite direction (Cook and Kirkpatrick, 1990).

Money and capital markets are relatively underdeveloped in Pakistan. But the three existing stock exchanges act as an important conduit for meeting the financing needs of the business community. It is also possible to have a relatively powerful monetary transmission mechanism because of a link between money and stock exchanges. Modigliani (1971) indicated that when stock prices increase, the value of
financial wealth increases thus increasing the lifetime resources available for consumers, and therefore, consumption should rise. Similarly, Mishkin (1977) pointed out that an expansionary monetary policy can lead to an increase in stock prices which in turn increases the value of financial assets, thus leading to a rise in consumer durable expenditures as consumers become more financially secure, given the low probability of financial distress. If an assumption is made that the efficient-markets theory applies to the stock market in Pakistan, the Modigliani (1971) and Mishkin (1977) analysis should hold in transmitting the effects of monetary policy on the economy (Oluwole, 1994).

With respect to fiscal policy actions in Pakistan, an expansionary fiscal policy (an increase in government spending) increases aggregate demand directly. That is, an increase in government spending increases aggregate demand which results in an increase in aggregate output. Restrictive fiscal policy works in the opposite direction. However, it is important to note that the transmission mechanism in the case of an expansionary or restrictive fiscal policy caused by changes in taxes may be ambiguous not only because of the small and ill-structured tax base, but also because of the pervasive problem of tax evasion.

Based on the above discussion, it can be argued that the government may have a free hand in macroeconomic fine-tuning by implementing any one of these policies; that is by changing the money supply or government spending (or taxes) as deemed appropriate. But the central question is how effective is the monetary or fiscal policy as a stabilization tool. There is no clear-cut answer to this question. The purpose of
this thesis is to address the above question by providing empirical evidence on the effectiveness of monetary and fiscal policy in context of Pakistan's economy. The policy-makers decision to choose the appropriate policy would be greatly enhanced by the results of this empirical investigation.
CHAPTER 3

VECTOR AUTOREGRESSION METHODOLOGY

Traditionally, macroeconometric research begins with the use of theory to construct a highly restricted structural econometric model. The determination of the nature of those restrictions is fraught with difficulty and thus many specification decisions turn out to be largely ad hoc and of dubious validity.

Recently, an alternative approach to modeling macroeconomic time series has come into wide use. This alternative introduced by Sims (1980) suggests the use of vector autoregression (VAR) models to analyze time series relationships among macroeconomic variables. The user of the VAR approach imposes a few restrictions and can generally use ordinary-least-squares estimation. As opposed to conventional structural macroeconomic models, the VAR technique does not require any explicit economic theory to estimate a model. It also allows one to capture empirical regularities in the data using fewer key macroeconomic variables and thereby providing the channels through which the different policy variables operate. The following discussion presents the specification issues involved in VAR methodology. Specifically, this section discusses impulse response function, variance decomposition and Granger-Causality in the context of VAR setting.

The starting point of vector autoregression methodology is the formulation of a
general unrestricted vector autoregressive model. As it name implies, this consists of regressing each current (non-lagged) variable in the model on all the variables in the model lagged a certain number of times. The VAR model represents the dynamic interactions among a set of variables collected in an \((n \times 1)\) vector \(y_t\). For example, for the model estimated in this paper, the vector \(y_t\) consists of five variables listed as follows: real output (YRL), real investment (IRL), real money (MYRL), real government expenditure (GXRL) and real trade balance (TR). A \(p\)th-order vector autoregression, denoted as \(\text{VAR}(p)\) can be represented as follows:

\[
y_t = c + \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \cdots + \Phi_p y_{t-p} + \epsilon_t \tag{1}
\]

Here 'c' denotes an \((n \times 1)\) vector of constants and \(\Phi_j\) an \((n \times n)\) matrix of autoregressive coefficients for \(j=1,2,\ldots,p\). The \((n \times 1)\) vector \(\epsilon_t\) is a vector of random variables each of which is serially uncorrelated:

\[
E(\epsilon_t \epsilon_t^\top) = \begin{cases} 
\Omega & \text{for } t = 1 \\
0 & \text{otherwise}
\end{cases}
\]

\[
E(\epsilon_t) = 0
\]

where \(\Omega\) is \((n \times n)\) contemporaneous covariance matrix.

Let \(c_i\) denote the \(i\)th element of the vector 'c' and let \(\Phi_{ij}\) denote the row \(i\), column \(j\) element of the matrix \(\Phi_j\). Then the first row of the vector system in equation (1) specifies that
Thus a vector autoregression is a system of equations in which each variable is regressed on a constant and p lags of itself and on p lags of each of the other variables in the VAR. Note that each regression has the same explanatory variables.

Using the lag operator, equation (1) can be written in compact form as follows

\[ \Phi(L) y_t = \epsilon_t \]

Here \( \Phi(L) \) indicates an \( (n \times n) \) matrix polynomial in the lag operator \( L \). The row i, column j element of \( \Phi(L) \) is a scalar polynomial in \( L \), where \( \delta_{ij} \) is unity if \( i = j \) and zero otherwise. In order to analyze the impact of policy shocks on the macroeconomic variables, Sims (1980) proposed the use of impulse response functions (IRF) and variance decomposition (VDC) that are obtained from the moving average
representations of the VAR model. Impulse response functions permit examining the
timing as well as the magnitude of response of one of the variables in the VAR model
to a shock in other variables in the VAR model. The impulse response functions can
be thought as dynamic elasticities. The impulse response function technique involves
perturbing the estimated system on an equation-by-equation basis with a shock equal to
one standard deviation of the estimated standard error term. Shocks of this size can be
viewed as representative of the magnitude of shocks which have occurred during the
sample period used to estimate the model. The response over time of the dependent
variables to these standardized shocks is monitored, creating an overview of the
dynamic working of the system of equations.

On a technical level, impulse response functions are obtained from the moving
average representation as follows.

\[ y_t = \mu + \varepsilon_t + \Psi_1 \varepsilon_{t-1} + \Psi_2 \varepsilon_{t-2} + \ldots \quad (6) \]

Thus the matrix \( \Psi \) has the interpretation

\[ \frac{\partial y_{t+s}}{\partial \varepsilon_t} = \Psi_s \quad (7) \]

that is, the row i, column j element of \( \Psi \) identifies the consequences of a one-unit
increase in the jth variable's innovation at time t for the value of the ith variable at time
\( (t+s) \), holding all other innovations at all dates constant. It is noted that in equation (1)
the vector of residuals may not necessarily be contemporaneously uncorrelated. In
applied literature the recommended procedure is to carry out the Choleski
decomposition method, as suggested by Doan (1989), to orthogonolize the variance-covariance matrix of innovations. Choleski decomposition is not unique with respect to the ordering of the variables except in cases where the VAR covariance matrix is diagonal. The recommended way to overcome this non-uniqueness is to triangularize the system (Sims (1980) and Doan (1989)).

Having derived the variance-covariance matrix from the moving average representation, one can then construct the VDCs. The variance decomposition shows the portion of the variance in the prediction for each variable in the system that is attributable to its own innovations and shocks to other variables in the system.

Atheoretical VAR models, however, have generated considerable controversy. Most of the controversy has dealt with the limitations of the VAR approach (Sims, 1982, 1986, Sargent, 1984, Cooley and Leroy, 1985). Despite these sharp criticisms of the usefulness of the VAR approach to macroeconomic model building, there are important uses of a VAR model. For instance, McMillin (p. 320, 1988) pointed out that these models are particularly useful in the case of, "forecasting, analyzing the cyclical behavior of the economy, the generation of stylized facts about the behavior of the elements of the system which can be compared with existing theories or can be used in formulating new theories, and testing of theories that generate Granger-Causality implications." As suggested by Litterman (1979), the VAR procedure not only provides greater forecast accuracy than earlier standard structural models but it can also be suitable in analyzing the impacts of policy shocks on the target variables.
Another important issue that deserves discussion in the context of VAR is the problem of robustness of the results of the estimated VAR models. Runkle (1987) and Spencer (1989) have argued that the empirical results from VAR models are nonrobust and that changing the model slightly can produce significantly different results. In a recent paper, Todd (1990) examined both sides of the debate and concludes that nonrobustness is not a general property of VAR results and that even simple VAR models can sometimes provide useful evidence on economic issues. He recommends that researchers using a VAR should check their results for robustness.

Granger-Causality

Granger (1969) has defined the concept of causality which, under suitable conditions, is fairly easy to deal within context of VAR models. The idea is that a cause cannot come after the effect. Thus if a variable $y$ affects $x$, the former should help improve the predictions of the latter variable. Causality tests can be used to determine, for example, whether the effect of monetary and fiscal policy on real output are statistically significant and vice versa.

More formally, let $x_i$ and $y_i$ contain all the information up to time $t$: $x_i = \{x_s | s \leq t\}$, $y_i = \{y_s | s \leq t\}$; let $u_t$ denote all the information in the universe up to time $t$ and define $\sigma(y_{t+1} | u_t)$ to be the one-step-ahead expected quadratic forecast error matrix when all the information in $y_i$ is used in predicting $y_{t+1}$. If

$$\sigma(y_{t+1} | u_t) > \sigma(y_{t+1} | u_t - \{x_s | s \leq t\})$$

then $x_i$ is said to cause $y_i$ (Granger sense). In other words one is better able to predict $y_{t+1}$ using $u_t$ than using $u_t - \{x_s | s \leq t\}$, if $x_i$ causes $y_i$. 
Allowing for possible unidirectional causality between \( x \) and \( y \), equation (4) maybe rewritten as

\[
y_t = C_t + B_1 y_{t-1} + \ldots + B_p y_{t-p} + A_1 x_{t-1} + \ldots + A_q x_{t-q} + u_t
\]

\[
= C_t + B(L) Y_t + A(L) X_t + U_t
\]

(8)

where \( B(L) \) and \( A(L) \) are polynomial matrices in the backshift operator \( L \). Testing that \( y_t \) is not caused by \( x_t \) is equivalent to testing the restriction \( A(L) = 0 \).

**Stationarity in VAR Modeling**

Macroeconomic theory often deals with equilibrium relationships. Most empirical econometric studies are an attempt to evaluate such relationships by summarizing economic time series using statistical analysis. To apply standard inference procedures in a dynamic time series model one needs the various variables to be stationary since the majority of econometric theory is built upon the assumption of stationarity. The Vector Autoregression (VAR) specification employed in this paper theoretically requires the processes that are being modeled to be Gaussian jointly covariant stationary. Although a model could forecast well even in the presence of nonstationarity, the precise calculation of impulse response functions requires a necessary and sufficient condition of stationarity. In the section below, a discussion is presented on the concept of stationarity and nonstationarity and its implication for economic modeling.

**Unit Roots**

A stochastic process is said to be stationary (or, more precisely, is stationary in a strict sense), if the joint and conditional probability distributions of the process are
unchanged if displaced in time. In practice, it is more usual to deal with weak sense stationarity, restricting attention to the means, variances and covariances of the process. A stochastic process is said to be weak stationary if:

$$E(X_t) = \text{constant} = \mu; \ Var(X_t) = \text{constant} = \sigma^2,$$

and $$\text{Cov}(X_t, X_{t+j}) = \sigma_j$$

Thus the means and the variances of the process are constant over time, while the value of the covariance between two periods depends only on gap between the periods and not the actual time at which this covariance is considered. If one or more of the conditions above are not fulfilled, the process is nonstationary (Charemza and Deadman, 1992).

Nonstationarity of time series is regarded as a problem in econometric analysis. It has been shown in a number of theoretical works that, in general, statistical properties of regression analysis using nonstationary time series are dubious. In applied literature, transformation of the data is performed to alleviate the problem of nonstationarity. One transformation method employed is that of differencing. A nonstationary series which can be transformed to a stationary series by differencing $$d$$ times is said to be integrated of order $$d$$, denoted as: $$X_t \sim I(d)$$. Besides, the traditional technique of visual inspection to confirm that the series is stationary, some empirical tests for the univariate case have been developed to examine the random walk or unit root hypothesis. Dickey and Fuller (1979, 1981) have developed a simple method of testing the order of integration of a series. The tests are described below.

Suppose one wishes to test the hypothesis that a stochastic variable is integrated
of order one, that is \( y_t \) is generated with \( a_t = 1 \) by:

\[
y_t = a_t y_{t-1} + \epsilon_t \quad \text{(9)}
\]

where \( \epsilon_t \) represents a series of identically distributed stationary variables with zero means. Begin by subtracting \( y_{t-1} \) from each side of the equation (9) in order to write the equivalent form: \( \Delta y_t = \delta y_{t-1} + \epsilon_t \), where \( \delta = a-1 \). Testing the hypothesis \( a_t = 1 \) is equivalent to testing the hypothesis \( \delta = 0 \). Dickey and Fuller (1979) actually consider three different regression equations that can be used to test for the presence of a unit root:

\[
\Delta y_t = \delta y_{t-1} + \epsilon_t \quad \text{(10)}
\]

\[
\Delta y_t = a_0 + \delta y_{t-1} + \epsilon_t \quad \text{(11)}
\]

\[
\Delta y_t = a_0 + \delta y_{t-1} + a_2 t + \epsilon_t \quad \text{(12)}
\]

The difference between the three regressions concerns the presence of the deterministic elements \( a_0 \) and \( a_2 t \). The first is pure random walk model, the second random walk with drift, and the third includes both a constant and a linear time trend (Enders, 1995).

For the purpose of testing for a unit root, the parameter of interest in equations (10) through (12) is \( \delta \); if \( \delta = 0 \), the \( \{y_t\} \) sequence contains a unit root. The test involves estimating one of these equations using ordinary least squares in order to
obtain the estimated value of $\delta$ and the associated standard error. Comparing the resulting $t$-statistic with the appropriate value reported in MacKinnon (1991) allows one to determine whether it is possible to reject the null hypothesis that $\delta = 0$.

A weakness of the original Dickey-Fuller test is it does not take account of possible autocorrelation in the error process $\epsilon_t$. If $\epsilon_t$ is autocorrelated then the ordinary least squares estimates of the equations (10-12) are not efficient. A simple solution, advocated by Dickey and Fuller (1981), is to use $K$-period lagged left-hand side variables as additional explanatory variables to approximate the autocorrelation. This test, called the Augmented Dickey-Fuller test (ADF), is widely regarded as being the most efficient test from among the simple tests for integration (Charemza and Deadman, 1992).

The ADF test posits the following equations:

$$\Delta y_t = \delta y_{t-1} + \sum_{i=2}^{k} \beta_i \Delta y_{t-i} + \epsilon_t \quad (13)$$

$$\Delta y_t = a_0 + \delta y_{t-1} + \sum_{i=2}^{k} \beta_i \Delta y_{t-i} + \epsilon_t \quad (14)$$

$$\Delta y_t = a_0 + \delta y_{t-1} + a_2 t + \sum_{i=2}^{k} \beta_i \Delta y_{t-i} + \epsilon_t \quad (15)$$

The practical rule for establishing the value of $K$ (the number of lags) is that it should be relatively small in order to save the degrees of freedom but large enough to allow
for the existence of autocorrelation. The testing procedure is as described previously for the standard Dickey-Fuller test, with an examination of student-t ratio for \( \delta \). The critical values of the tests are same as for Dickey-Fuller test.

Dickey and Fuller (1981) provide three additional F-statistics \((\phi_1, \phi_2, \phi_3)\) to test joint hypotheses on the coefficients of equations (13) through (15). These statistics can be used to test the significance of the drift and trend terms. With equation (14) the null hypothesis \( \delta = a_0 = 0 \) is tested using the \( \phi_1 \) statistic. With equation (15) the joint hypothesis \( a_0 = \delta = a_2 = 0 \) is tested using the \( \phi_2 \) statistic, and the joint hypothesis \( \delta = a_2 = 0 \) is tested using the \( \phi_3 \) statistic (Enders, 1995).

Cointegration and Error Correction Modeling

Engle and Granger (1987) show how the concept of cointegration relates to stationarity. In general, if two variables, \( a \) and \( b \), are integrated of order one, denoted as \( I_a(1) \) and \( I_b(1) \), then they are cointegrated if there exists a linear combination of two variables that is stationary. Consider two time series \( y_t \) and \( x_t \) which are both \( I(d) \); that is they have compatible long-run properties. In general, any linear combination of \( y_t \) and \( x_t \) will also be \( I(d) \). If, however, there exists a vector \((1, -\beta)\), such that the combination

\[
\mathbf{z}_t = y_t - \alpha - \beta x_t
\]

(16)

is \( I(d-b) \), \( b > 0 \), then Engle and Granger (1987) define \( y_t \) and \( x_t \) as cointegrated of order \((d, b)\), with \((1, -\beta)\) called the cointegrating vector.

The concept of cointegration tries to mimic the existence of a long-run
equilibrium to which an economic system converges over time. If, for example, economic theory suggests the following long-run relationship between $y_t$ and $x_t$,

$$y_t = \alpha + \beta x_t$$  \hspace{1cm} (17)

then $z_t$ can be interpreted as the equilibrium error or the distance that the system is away from the equilibrium at any point in time.

Engle and Granger also show that if $y_t$ and $x_t$ are cointegrated CI(1,1), then, there must exist an error correction model (ECM) representation of the following form

$$\Delta y_t = \theta_0 + \theta_1 z_{t-1} + \sum \theta_{2i} \Delta x_{t-i} + \sum \theta_{3i} \Delta y_{t-i} + \epsilon_t$$  \hspace{1cm} (18)

where $\Delta$ denotes the first-order time difference and where the error term is a sequence of independent and identically distributed random variables with mean zero and variance $\sigma^2$. Furthermore, they prove the converse result that an ECM generates cointegrated series (Charemza and Deadmen, 1992).

Note that the term $z_{t-1}$ in equation (18) represents the extent of the disequilibrium between levels of $y$ and $x$ in the previous period. The ECM states that changes in $y_t$ depend not only the changes in $x_t$, but also on the extent of disequilibrium between the levels of $x$ and $y$. The appeal of the ECM formulation is that it combines the flexibility of a dynamic specification with desirable long-run properties. It could be seen as capturing the dynamics of the system whilst incorporating the equilibrium condition as suggested by economic theory.

Based on the concept of cointegration, Engle and Granger suggest a two-step procedure for dynamic modelling which has become very popular in applied research.
Let us assume that $y_t$ and $x_t$ are both $I(1)$; then, the procedure is as follows: (1) In order to test whether the series are cointegrated, the 'cointegrating regression'

$$y_t = \alpha + \beta x_t + z_t$$  \hspace{1cm} (19)

is estimated by ordinary least squares and it is tested whether the cointegrating residuals

$$\hat{z}_t = y_t - \hat{\alpha} - \hat{\beta} x_t$$  \hspace{1cm} (20)

are $I(0)$. Stock (1987) has shown that if two $I(1)$ series are cointegrated, then the OLS estimates from the equation (20) provide 'super-consistent' estimates of the cointegrating vector in the sense that they converge to the true parameter at a rate proportional to the inverse of sample size, $T^{-1}$, rather than at $T^{-1/2}$ as in the ordinary stationary case; (2) The residuals $\hat{z}_t$ are entered into the error correction formulation.

The idea of cointegration introduces an important constraint in VAR modeling that can be specified in the form of error correction model (ECM). Engle and Granger (1987) point out that "vector autoregressions estimated with cointegrated data will be misspecified if the data are differenced, and, will have omitted important constraints if the data are used in levels." Thus, to overcome this problem, the Granger Representation theorem allows a VAR model in first differences to be specified with a constraint of an error correction variable included. The premise of this theorem, however, is that the components of vector $y_t$ are integrated of order one, $I(1)$, which implies a random walk vector. This in turn implies that each variable of $x_t$ is a random
walk. Cointegration can exhibit higher orders than unity, thus error correction models can be estimated given those higher orders (Cromwell and Hannan, 1993).

Johansen Procedure

The Engle and Granger (1987) estimation procedure for cointegration has come under criticism for one main reason. In the multivariate case this procedure may be used to test the null of non-cointegration against the alternative of only one cointegrating vector. However, there can be more than one cointegrating relation present and, hence, another testing strategy should be applied. In this paper, a test for cointegration among the variables is carried out within the framework provided by the maximum likelihood estimation technique of cointegrating vectors suggested by Johansen (1988). The test is described below.

Consider an unrestricted VAR model:

\[ Z_t = \sum_{i=1}^{r} A_i Z_{t-i} + \epsilon_t \]  (21)

where \( Z_t \) contains all \( n \) variables of the model and \( \epsilon_t \) is a vector of random errors. The VAR model in equation (21) can also be represented in the form:

\[ \Delta Z_t = \sum_{i=1}^{k=1} \Gamma_i \Delta Z_{t-i}^* + \Pi_{k+1} Z_{t-k} + \epsilon_t \]  (22)

where:

\[ \Gamma_i = I + A_1 + A_2 + \ldots + A_i \]

\[ \Pi_{k+1} = (I-A_1-A_2-\ldots-A_k) \]

The equality of models in equation (21) and (22) may be confirmed by adding \( Z_{t-1} \),
Z_{t-2}, \ldots, Z_{tk} and A_1 Z_{t-2}, A_2 Z_{t-3}, \ldots, A_k Z_{tk} to both sides of Equation (21) and rearranging. This transformation of the VAR model into the form of equation (22) is called the cointegration transformation. Also, in equation (22) the rank of matrix $\Pi_{k+1}$ gives the dimension of the cointegrating vector. If this rank is $r$, $\Pi_{k+1}$ can be decomposed into
\[ -\Pi_{k+1} = \alpha \beta' \]  
where both $\alpha$ and $\beta$ are $p \times r$ matrices. The rows of $\beta'$ form the $r$ distinct cointegrating vectors and if one thinks of the elements of the $r \times 1$ vector $\beta'X_{tk}$ as "error correction" terms, the elements of matrix $(-\alpha)$ express the speed of adjustment of the dependent variables towards the equilibrium state (Georgoutsos and Kouretas, 1992).

Johansen (1988) has suggested the following procedure for estimating the basis for cointegrating space: regress $\Delta X_t$ and $X_{tk}$ on the lagged differences of $\Delta X_t$ and a constant and derive a set of residuals $R_u$ and $R_w$, respectively. Then find the eigenvalues $\lambda$ of $S_{kk}^{-1}S_{ok}$ in the metric $S_{kk}$, that is, solve the following equation:
\[ |\lambda S_{kk}^{-1}S_{ko}S_{cc}^{-1}S_{ok}| = 0 \]  
where $S_{kk} = T^{-1} \sum_{t=1}^{T} R_{tl}R_{tl}'$  
where $i = l = 0$, $T$ is the number of observations. The likelihood ratio test statistic, the
trace test for the hypothesis that there are at most $r$ cointegrating vectors, is given by:

$$-2 \ln Q = -T \sum_{j=r+1}^{p} \ln(1-\hat{\lambda}_j)$$  \hspace{1cm} (26)$$

where $\hat{\lambda}$ correspond to the $p-r$ smallest eigenvalues. The $p \times r$ matrix of cointegrating vectors, $\beta$, can be obtained as the $p$-element eigenvectors corresponding to the largest eigenvalues. The LR statistic for testing that there are $r$ versus $r+1$ cointegrating vectors, the maximal eigenvalue test is given by:

$$-2 \ln (Q; r/r+1) = -T (1-\hat{\lambda}_{r+1})$$  \hspace{1cm} (27)$$

For both the trace and the maximal eigenvalue tests, critical values have been tabulated by Osterwald-Lenum (1992). Trace test statistic is employed in this paper.
CHAPTER 4

ESTIMATION AND RESULTS

The model estimated in this thesis includes five key macroeconomic variables that are common to most small open economy models. The data source is various issues of International Financial Statistics. The variables included in the open economy model are as follows: real GNP (YRL), real government expenditure (GXRL), real investment (IRL), real trade balance (TR) and real money (MYRL). All data are logged, except the real trade balance variable. Real trade balance is available in U.S dollars, conversion to rupees was carried out by multiplying this series with the bilateral exchange rate. A list of the data and time series plots of the logs of series are presented in Table 1 and Figure 1, respectively. The model is estimated over the period 1963 to 1993.

Test for Unit Roots

Dickey and Fuller (1979) present three regressions equations that can be used to test for the presence of unit root. The difference between the regressions is the inclusion of a deterministic trend and time trend. The first step in the testing for unit root is to specify the correct data generating process. One can test whether a time trend or a drift term be included in the regression equation being posited for testing the unit root hypothesis. A simple procedure is to carry out a unit root test with an unrestricted
model by employing equation (15). A restricted model given by equation (14) is also estimated. An F-test is employed to calculate the joint hypothesis $a_2 = \delta = 0$. This hypothesis is tested using the $\phi_3$ statistic. It is given as follows:

$$
\phi_3 = \frac{[\text{RSS}(\text{restricted}) - \text{RSS}(\text{unrestricted})]}{r}
$$

where

$$
\frac{\text{RSS}(\text{unrestricted})}{(T-K)}
$$

where $\text{RSS (restricted)}$ and $\text{RSS (unrestricted)} = \text{the sums of the squared residual from the restricted and unrestricted models respectively and}$

$$
r = \text{number of restrictions}
$$

$$
T = \text{number of usable observations}
$$

$$
k = \text{number of parameters estimated in the unrestricted model}
$$

Hence, $T-K = \text{degrees of freedom in the unrestricted model}$. Comparing the calculated value of $\phi_3$ to the appropriate value reported in Dickey and Fuller (1981) allows one to determine the significance level at which the restriction is binding. The null hypothesis is that data are generated by the restricted model and the alternative hypothesis is that the data are generated by the unrestricted model. If the restriction is not binding, $\text{RSS (restricted)}$ should be close to $\text{RSS (unrestricted)}$ and $\phi_3$ should be small; hence, large values of $\phi_3$ suggest a binding restriction and rejection of null hypothesis. Thus if the calculated value of $\phi_3$ is smaller than the critical values reported in Dickey and Fuller (1981), one cannot reject the restricted model. If the calculated value of $\phi_3$ is larger than the critical values reported in Dickey and Fuller, one can reject the null hypothesis and conclude that the restriction is binding (Enders, 1995).
Before unit root test are performed, one must identify the data generating process (DGP). For each variable in the analysis, equations (14) and (15) are estimated and the null hypothesis of $a_2 = \delta = 0$ is tested against the alternative given by equation (15). Viewing equation (14) as the restricted model and equation (15) as unrestricted model, the $\phi_3$ statistic is calculated. Table 2 presents the results from this analysis. Looking at the table one sees that for all the variables except MYRL (real money) the computed $\phi_3$ statistic is smaller than the critical value at 5% and 1% significance level. It is noted that one cannot reject the null hypothesis and it is was decided to use equation (14) to test for the unit root null hypothesis $\delta = 0$. In case of MYRL, the computed $\phi_3$ statistic is greater than the critical value. The null hypothesis is rejected, implying that the data generating process contains a unit root and/or a deterministic time trend. For this series, equation (15) was used to test for the null hypothesis of a unit root.

The five series labeled YRL (real output), TR (real trade balance), IRL (real investment), GXRL (real government expenditure) and MYRL (real money balances) were tested for unit root. The tests carried out above for the identification of DGP indicate a process without a trend for the first four series, and deterministic time trend for the last series. Equation (14) is employed to test for unit root in the first four series and equation (15) is used for the last series labeled MYRL. Table 3 lists the results from the unit root analysis. For the five series the computed t-statistic (in absolute value) is lower than the critical values tabulated in MacKinnon (1991). Thus the null hypothesis of unit root $\delta = 0$ is not rejected at the 5% significance level. In order to test
if the above series contain multiple roots, unit root test were conducted on the first differences of the above series. The results tabulated in Table 3 indicate that the null hypothesis of a unit root can be easily rejected at the 5% significance level for the series labeled MYRL, GXRL and TR whereas for the series labeled YRL and IRL the null hypothesis of unit root cannot be rejected. The second differences of the above two series were tested to determine if there was a third root. The results from this exercise indicated that the null hypothesis of a unit root could be easily rejected. Based on the above analysis it is concluded that all the five series are non-stationary. MYRL, GXRL, TR are integrated of order 1, that is, I(1) and the series labeled YRL and IRL are integrated of order 2, that is, I(2).

Lag Length

To determine alternative lag lengths, a variety of statistical procedures are available; some conflict arises between the alternatives due to differences in sample properties. In this paper, a likelihood ratio statistic, modified by Sims (1980), is employed. This statistic has a correction for sample size. The statistic for testing a vector AR(p) against a vector AR(m) is

\[ LR = (T-c)(\ln|\sigma_i| - \ln|\sigma_m|), \quad p < m \tag{28} \]

where \(\sigma\) is the covariance matrix of residuals of AR(i), T is the number of observations and c is correction factor which is equal to the number of regressors in each equation in the AR(m). Actually, the AR(m) can be viewed as an unrestricted model with AR(p) as the restricted one. The statistic LR is asymptotically distributed under the null with
\[ k^2(m-1) \] degrees of freedom, where \( k \) is the number of equations. To address the issue of lag length, a VAR system is estimated with lag length arbitrarily equal to 3. This unrestricted model was then tested against a restricted model with lag=2. The calculated Sims test statistic is 13.3 which is distributed as \( \chi^2(18) \) and is insignificant at the 5\% level. These results indicate that the restriction of \( p=2 \) is not rejected and a model with \( p=2 \) was tested against a model with \( p=1 \). The result show that the restriction can be rejected. The calculated test statistic is 2174 which is distributed as \( \chi^2(9) \) and is significant at the 5\% level. Based on these results, a lag length of 2 was adopted.

**Granger-Causality Tests**

Bivariate Granger Causality tests are performed on real output, real government expenditure and real money. Based on the discussion on unit roots earlier section, Granger tests are performed on the stationary variables. The three variables are differenced to achieve stationarity. Specifically, real output is differenced twice to achieve stationarity as it is integrated of order 2, real government expenditure and real money are each differenced once to achieve stationarity as they are integrated of order 1. As mentioned earlier, causality test can be used to determine whether the effect of monetary and fiscal policy on real output are statistically significant. Moreover, the discussion of Pakistan's economy in an earlier section leads one to believe that there is a possibility of endogeneity of monetary growth with respect to real output growth. On the basis of this debate about the possible exogeneity or endogeneity of the policy variables, bivariate causality tests are performed between real money and real
government expenditure, real money and real output, and real government expenditure and real output. It is expected that real government expenditure Granger causes real money. The Pakistani government periodically resorts to deficit financing in order to meet the shortages in budget revenues. Looking at the results of bivariate causality (Table 4) between real government expenditure and real money, one surprisingly finds that real government expenditure does not Granger-cause real money. It is also seen that real government expenditure Granger causes real output.

**Johansen Test**

The next stage in estimation involves testing the series for a cointegrating relationship. Johansen's (1988) multivariate procedure without deterministic trend is adopted. The choice of no deterministic trend in the DGP is based on the earlier results from identifying the DGP processes for time series. For four of the series, the null hypothesis of $a_2=\delta=0$ could not be rejected at the 5% critical level, implying absence of deterministic time trend. The Johansen procedure requires that all the variables in the system be integrated of same order. If some variables are integrated of order higher than one, one may consider their appropriate differences, which themselves are integrated of order one. Two of the series, YRL and IRL, are integrated of order two (I(2)) whereas the rest of the series are integrated of order one (I(1)). The Johansen procedure is applied to the first difference of YRL and IRL and the remaining series enter in levels. Table 5 presents the results from the Johansen test. The likelihood ratio statistic in the form of equation (26) for testing the hypothesis that there are at most $r$ cointegrating vectors is presented in the table. The calculated LR statistic is
compared with the critical values tabulated by Osterwald-Lenum (1992). Looking at
the table it is seen that the null hypothesis of no cointegration, that is, \( r = 0 \), should be
rejected since the computed LR is greater than the 5% critical value. Similarly, the
hypothesis \( r \leq 1, r \leq 2, r \leq 3 \) can be rejected. Consequently, it is assumed that there are
four cointegrating vectors. Cointegrating vectors can be thought of as representing
constraints that an economic system imposes on the movement of the variables in the
system in the long run. Consequently, the more cointegrating vectors there are, the
more stable the system. Other things the same, it is desirable for an economic system
to be stationary in as many directions as possible. The problem with multiple
cointegration relationships is that it may preclude easy interpretation of the results. It
is noted that a cointegrating vector merely represents a long-run, stable relationship
among jointly endogenous variables, in general, they cannot be interpreted as structural
equations (Dickey et al 1991). This certainly is the case of the four cointegrating
vectors at hand. Neither of the four cointegrating vectors necessarily represent any
meaningful structural equation. All that can be said is that there are four combinations
for which variance is bounded.

Error Correction Model

In order to capture the constraints represented by the cointegrating vectors, an
error correction model is formulated. Error correction formulation requires that all the
variables in the system be integrated of same order. If some variables are integrated of
order higher than one, one may consider their appropriate differences, which
themselves are integrated of order one. Two of the series labeled YRL and IRL are I(2)
whereas the rest of the series are I(1). First differences of YRL and IRL labeled YRLD and IRLD are I(1). The ECM is formulated as follows:

\[
\Delta YRLD_t = \alpha_1 + \sum_{j=1}^{\phi} \beta_1 j \Delta YRLD_{t-j} + \sum_{j=1}^{\rho} \alpha_1 j \Delta YRLD_{t-j} + \sum_{j=1}^{\rho} \beta_2 j \Delta GXRL_{t-j} + \sum_{j=1}^{\rho} \beta_3 j \Delta IRLD_{t-j} + \sum_{j=1}^{\rho} \beta_4 j \Delta TR_{t-j} + \sum_{j=1}^{\rho} \beta_5 j \Delta MYRL_{t-j} + \epsilon_{1t}
\]  

(29)

\[
\Delta MYRL_t = \alpha_2 + \sum_{j=1}^{\phi} \beta_1 j \Delta MYRL_{t-j} + \sum_{j=1}^{\rho} \alpha_1 j \Delta MYRL_{t-j} + \sum_{j=1}^{\rho} \beta_2 j \Delta GXRL_{t-j} + \sum_{j=1}^{\rho} \beta_3 j \Delta IRLD_{t-j} + \sum_{j=1}^{\rho} \beta_4 j \Delta TR_{t-j} + \sum_{j=1}^{\rho} \beta_5 j \Delta YRLD_{t-j} + \epsilon_{2t}
\]  

(30)

\[
\Delta GXRL_t = \alpha_3 + \sum_{j=1}^{\phi} \beta_1 j \Delta GXRL_{t-j} + \sum_{j=1}^{\rho} \alpha_1 j \Delta GXRL_{t-j} + \sum_{j=1}^{\rho} \beta_2 j \Delta MYRL_{t-j} + \sum_{j=1}^{\rho} \beta_3 j \Delta IRLD_{t-j} + \sum_{j=1}^{\rho} \beta_4 j \Delta TR_{t-j} + \sum_{j=1}^{\rho} \beta_5 j \Delta YRLD_{t-j} + \epsilon_{3t}
\]  

(31)

\[
\Delta IRLD_t = \alpha_4 + \sum_{j=1}^{\phi} \beta_1 j \Delta IRLD_{t-j} + \sum_{j=1}^{\rho} \alpha_1 j \Delta IRLD_{t-j} + \sum_{j=1}^{\rho} \beta_2 j \Delta YRLD_{t-j} + \sum_{j=1}^{\rho} \beta_3 j \Delta GXRL_{t-j} + \sum_{j=1}^{\rho} \beta_4 j \Delta TR_{t-j} + \sum_{j=1}^{\rho} \beta_5 j \Delta MYRL_{t-j} + \epsilon_{4t}
\]  

(32)
\[ \Delta TR_t = \alpha_5 + \sum_{j=1}^{p} \beta_{1j} \Delta Z_{j,t-2} + \sum_{j=1}^{p} \alpha_{j} \Delta TR_{t-j} + \sum_{j=1}^{p} \beta_{2j} \Delta GXRL_{t-j} + \sum_{j=1}^{p} \beta_{3j} \Delta YRLD_{t-j} + \sum_{j=1}^{p} \beta_{4j} \Delta MYRL_{t-j} + \sum_{j=1}^{p} \beta_{5j} \Delta IRLD_{t-j} + \epsilon_{t} \]  

In the above equations the term "\(Z_{j,t-1}\)" refers to the four cointegrating relationship and represents the long-run constraints. Lag length \(p\) is 2 and \(\Delta\) is the first-order time difference.

Other than the error-correction term \(Z_{j,t-1}\) equations (29-33) constitute a VAR in first differences. This near VAR can be estimated by ordinary least squares. OLS is an efficient strategy since each equation contains the same set of regressors. Since all terms in the equations (29-33) are stationary, the usual test statistics are appropriate. Adequacy of the model can be assessed by performing diagnostic checks to determine whether the residuals of the VAR approximate white noise.

The estimated ECM is listed below.
\[ \Delta \text{GXRL} = -0.188z_{t-1} + 0.185z_{t-1} + 0.348z_{t-1} + 0.404z_{t-1}; \]

\[ \begin{array}{c}
(-1.039) \\
(1.08) \\
(.554) \\
(.901)
\end{array} \]

\[-.373\Delta \text{GXRL}(-1) - .173\Delta \text{GXRL}(-2) -.167\Delta \text{MYRL}(-1) + .159\Delta \text{MYRL}(-2) \]

\[ \begin{array}{c}
(-1.64) \\
(-1.03) \\
(-.696) \\
(.560)
\end{array} \]

\[-.762\Delta \text{YRLD}(-1) -.19\Delta \text{YRLD}(-2) + .175\Delta \text{IRLD}(-1) -.07\Delta \text{IRLD}(-2) \]

\[ \begin{array}{c}
(-1.65) \\
(-.575) \\
(.516) \\
(-.306)
\end{array} \]

\[+1.05E-07\Delta \text{TR}(-1) +2.66E-07\Delta \text{TR}(-2) \]

\[ \begin{array}{c}
(.341) \\
(1.00) \\
(34)
\end{array} \]

\[ \Delta \text{IRLD} = -0.402z_{t-1} + 0.379z_{t-1} - 1.13z_{t-1} + 0.057z_{t-1}; \]

\[ \begin{array}{c}
(-1.67) \\
(1.66) \\
(-1.35) \\
(.097)
\end{array} \]

\[+0.226\Delta \text{GXRL}(-1) - .277\Delta \text{GXRL}(-2) - .927\Delta \text{MYRL}(-1) - .629\Delta \text{MYRL}(-2) \]

\[ \begin{array}{c}
(.748) \\
(-1.227) \\
(-2.88) \\
(-1.657)
\end{array} \]

\[+.685\Delta \text{YRLD}(-1) + .476\Delta \text{YRLD}(-2) -.725\Delta \text{IRLD}(-1) - .448\Delta \text{IRLD}(-2) \]

\[ \begin{array}{c}
(1.115) \\
(1.08) \\
(1.60) \\
(-1.338)
\end{array} \]

\[+3.63E-07\Delta \text{TR}(-1) + 2.45E-07\Delta \text{TR}(-2) \]

\[ \begin{array}{c}
(.37) \\
(.694)
\end{array} \]
\[ \Delta TR = -127254.9 Z_{t-1} + 118579.4 Z_{t-2} - 630945 Z_{t-3} \]
\[ (-0.824) \quad (1.806) \quad (-1.16) \]
\[ + 65449.2 Z_{t-1} - 152233.5 AGXRL(-1) + 125996.2 AGXRL(-2) \]
\[ (1.171) \quad (-0.781) \quad (0.864) \]
\[ + 204900.5 MYRL(-1) - 646802.4 MYRL(-2) + 297448.1 YRLD(-1) \]
\[ (1.989) \quad (-2.64) \quad (0.751) \]
\[ + 101899.5 YRLD(-2) - 81345.2 YRLD(-1) - 49608.7 YRLD(-2) \]
\[ (0.358) \quad (-0.278) \quad (-0.229) \]
\[ - 0.35 \Delta TR(-1) + 0.308 \Delta TR(-2) \quad (36) \]
\[ (-1.132) \quad (1.35) \]
\[ \Delta MYRL = 0.180 Z_{t-1} - 0.169 Z_{t-2} - 0.620 Z_{t-3} + 0.527 Z_{t-4} \]
\[ (0.858) \quad (-0.848) \quad (-0.845) \quad (1.01) \]
\[ - 0.067 AGXRL(-1) + 0.017 AGXRL(-2) + 0.133 MYRL(-1) - 0.439 MYRL(-2) \]
\[ (-0.253) \quad (0.086) \quad (0.473) \quad (-1.31) \]
\[ + 0.307 YRLD(-1) + 0.0267 YRLD(-2) - 0.450 YRLD(-1) - 0.282 YRLD(-2) \]
\[ (0.570) \quad (0.069) \quad (-1.13) \quad (-0.961) \]
\[ - 5.3E-08 \Delta TR(-1) - 1.21E-07 \Delta TR(-2) \quad (38) \]
\[ (-1.147) \quad (-3.390) \]
\[ \Delta YRLD = -0.544 Z_{t-1} + 0.514 Z_{t-2} - 2.592 Z_{t-3} + 1.222 Z_{t-4} \]
\[ (2.56) \quad (2.53) \quad (-3.48) \quad (2.32) \]
\[ + 0.325 AGXRL(-1) - 0.405 AGXRL(-2) - 0.599 MYRL(-1) - 0.109 MYRL(-2) \]
\[ (1.21) \quad (-2.02) \quad (2.1) \quad (-0.325) \]
\[ + 1.035 YRLD(-1) + 0.586 YRLD(-2) - 0.749 YRLD(-1) - 0.366 YRLD(-2) \]
\[ (1.89) \quad (1.49) \quad (-1.86) \quad (-1.23) \]
\[ + 2.98E-07 \Delta TR(-1) + 4.55E-07 \Delta TR(-2) \quad (37) \]
\[ (-0.816) \quad (0.145) \]
The number in parenthesis represent t-statistics.

The speed of adjustment coefficients $\beta_t$ are of particular interest in that they have important implication for the dynamics of the system. Looking at the above equations one sees that only in the equation for YRLD are the four cointegrating constraints significant at the 5% level. Also, the point estimates of the $Z_{t+k}$ imply that YRLD converges to a long run equilibrium. It is noted that out of the four cointegrating constraints two imply a positive feedback while the other two imply a negative feedback toward the long-run equilibrium. Diagnostic checks were performed on the residuals from the ECM system estimated above. Residuals plots and Ljung-Box Q-statistics confirm the whiteness of the residuals. These are presented in Figure 2 and Table 6, respectively.

Lutkepohl and Reimers (1992) show that innovation accounting (i.e, impulse responses and variance decomposition analysis) can be obtained from a system of cointegrated variables. In order to study the impact of monetary and fiscal policy shocks on real output, impulse response function and variance decompositions were generated from the above ECM formulation. The results from the impulse response functions and variance decompositions are presented below.

Impulse Response Analysis

As mentioned earlier, the impulse response functions allow one to analyze the dynamic behavior of a variable due to random shocks to other variables. The graphs of the impulse response functions provide a way to analyze the shocks. As the focus of this analysis is to study the relative importance of fiscal and monetary policy, the shock
of one standard deviation to real money and real government expenditure is considered and the response of the other variables in the system over a period of ten years is traced. The following is a summary of the results from the impulse response functions.

Monetary Shocks

Figure 3 reveals that a one standard deviation shock to MYRL (real money balances) produces a positive delayed impact on YRLD (real output) with a lag of two years, and the response decays over the long-run. GXRL (real government expenditure) shows a very weak response to the one standard deviation shock in MYRL. IRLD (real Investment) shows a strong positive impact after a lag of 3 years and decays over the long-run. Finally, TR (real trade balance) shows a strong negative impact after a lag of 2 years, and after 4 years it seems to have a permanent positive effect.

One can provide the following economic explanation for the above results. Given a shock to real money, initially the aggregate demand of the economy is stimulated, causing output to increase. Interest rates are insensitive to changes in the money supply in Pakistan, and the effect of an expansionary monetary policy is channeled through level of domestic credit that goes to the priority sectors such as agriculture export processing zones and manufacturing. As investment rises in these sectors due to readily available credit, aggregate output rises. One can speculate that increases in investment channel into increases in exports, which results in an improvement in the trade balance.
Fiscal Shocks

Figure 4 reveals that a one standard deviation shock to GXRL (real government expenditure) produces a strong delayed impact on YRLD (real output) with a lag of 3 years and the response decays over the long-run. MYRL (real money balances) shows a positive response to a shock in GXRL (real government expenditure) over the first two years and shows a decaying pattern up until 7 years and then seems to acquire a permanent trend over the long-run. IRLD (real investment) series shows a depressed impact over the first three years and acquires a positive impact which seems to be permanent in the long-run. TR (real trade balance) seems to respond strongly to a shock in GXRL (government expenditure) and portrays a permanent effect.

One can provide the following economic justification for the dynamics of real fiscal shocks to the system. As before, a real fiscal shock leads to an increase in real output due to governments expenditure on infrastructure and development programs. Increases in fiscal expenditure encourage investment in the economy. As the interest rates are fixed and priority sector's credit quota fixed, there is an increase in investment which translates into more exports, and consequently, the real trade balance improves.

Taken together the results from the monetary and fiscal policy shocks point out that real shocks in government expenditure are relatively more influential in affecting real output as compared to real shocks to money supply. The results from IRFs (impulse response functions) support the results obtained by Granger-causality tests.

As mentioned earlier, VDCs (variance decompositions) can provide further insight into the effectiveness of monetary and fiscal policies on real output. Also,
Doan (1989) recommends analyzing impulse response functions and variance decomposition together when interpreting the results from IRFs. One can find an interesting and unexpected response by looking at the IRFs, but examining respective VDCs might show only a trivial effect. Below is a discussion of the summary results of the variance decompositions.

Variance Decompositions

The results of the VDCs for all the variables in baseline ordering are reported in Table 7. Both direct and indirect effects are captured by VDCs. Given that the main focus of this thesis is to analyze the impact of monetary and fiscal policies on YRL (real output), particular interest is focused on the portion of YRL explained by shocks to MYRL (real money) and GXRL (real government expenditure). As expected, the direct effects of MYRL and GXRL on itself are very high, 81.6% and 100% respectively. This confirms the exogenous nature of these policy variables.

On the other hand, a further inspection of Table 7 indicates that a very small portion of the variance in YRL within a year is explained by innovations to either MYRL (.8%) or GXRL (4.8%). In fact, innovations to YRL itself explain most of the variation in YRL in that time period. However, within three years, innovations to MYRL explain only 3.49% of the variance in YRL. Innovations to GXRL explain 31% of the variance in YRL. Finally, within a span of ten years, innovations to GXRL and MYRL explain 28% and 4.39% of the variance in YRL respectively.

Finally, in order to check the robustness of the model, IRFs are generated with four different orderings of the variables in the system. Denoting the baseline ordering
as version 1, the five alternative versions are as follows:

Version 1. GXRL, MYRL, YRLD, IRLD and TR (Figure 3, 4)
Version 2. MYRL, GXRL, YRL, IRLD and TR (Figure 5, 6)
Version 3. IRLD, YRLD, TR, MYRL and GXRL (Figure 7, 8)
Version 4. IRLD, MYRL, GXRL, YRLD and TR (Figure 9, 10)
Version 5. IRLD, GXRL, MYRL, TR and YRLD (Figure 11, 12)

Figures 3-12 present the impulse response functions for the respective versions. It is seen that changing the ordering does not change the results significantly overall. However, it is noted that if MYRL comes before GXRL in a given ordering, the IRFs for a real shock in government expenditure seem to show a stronger positive response on real money. If GXRL comes before MYRL in an ordering, the IRFs due to a real shock in government expenditure show a moderate positive response on real money. It seems that innovations in GXRL and MYRL are most probably highly correlated. Care should be exercised in interpreting the responses of MYRL to a real shock in GXRL. The best that can be said is that there is evidence that a shock to GXRL has a positive impact on MYRL.
CHAPTER 5

CONCLUSION

Stabilization policy refers to a program of economic policy measures which are designed to achieve broad macroeconomic objectives such as an improvement in the growth of real output, a low rate of inflation and a sustainable balance of payments position. Stabilization policies play an important part in the macroeconomic performance of developing countries, including Pakistan. It is important that the channels through which monetary and fiscal policy percolate through the economic system be identified. This identification will help the government to achieve its stabilization measures by using policies that are known to affect the relevant macroeconomic variables. The relative importance of monetary and fiscal policy is still a controversial issue. In light of this controversy the purpose of this paper was to broaden the existing perspective on the above issue.

Following, Chisti et al (1992), it is believed that in absence of any knowledge of true macroeconomic relations between variables, the recent application of the Vector Autoregression(VAR), pioneered by Sims (1980,1986) is a possible alternatives. This approach seems more flexible than macroeconometric modeling. This thesis develops and estimates a five-variable open-economy model for Pakistan.

The VAR methodology used in this thesis involved the following steps: Unit
roots test were carried out on the five variables to check for stationarity; all of the variables turned out to be non-stationary; the system was tested for cointegration and four long-run cointegrating constraints were found; an error correction model, which represents a restricted VAR with cointegrating restrictions, was formulated; impulse response functions and variance decompositions were generated; Granger-Causality test were also performed to find statistical significance of the monetary and fiscal variables in explaining real output growth.

The primary focus of this study was to evaluate the relative importance of monetary and fiscal policy. Looking at impulse response functions and variance decompositions evidence is found that fiscal policy is relatively more effective in influencing real output. Bivariate Granger-Causality tests also support the above hypothesis. Also, evidence is found that shocks to real government expenditure have a positive impact on real money. This can simply be interpreted as an indication that monetary policies accommodate fiscal policies through debt monetization. Further, it is noted that the system is estimated with all real variables and shocks in real variables can have permanent effects. Looking at impulse response functions, one can see that most of the variables respond in a permanent manner to a monetary or fiscal shock.

It is noted that the behavioral response of Pakistan's economy to a given policy measure diverges from the predictions derived from the analysis directed at industrialized economies. The impulse response functions generated in this thesis are not consistent with the traditional view of dynamic effects of a shock to fiscal or monetary variable on output. Traditionally, shocks to monetary or fiscal variables
builds up until the adjustment of price and wage leads the economy back to equilibrium. In case of Pakistan, a shock to real money or government expenditure seems to have permanent effect on real variables. These permanent responses can be explained by focusing on the structural characteristics of Pakistan which are very different from industrialized countries. Underdeveloped money and capital markets, restrictions on imports and exports in the form of tariffs and quotas, and indirect channels for the transmission of monetary and fiscal policy (e.g. insensitivity of the interest rates) all act to slow the adjustment process which leads the system back to its steady-state equilibrium.

Lastly, it can be conjectured that the monetary authorities will continue to finance government spending in Pakistan in the spirit of economic growth and development. This means there would be lack of objectivity from the monetary authorities and that this would continue to contribute to the inability to formulate prudent and effective monetary policy in Pakistan.
ILLUSTRATIONS
Fig. 1. Time Series Plots
Fig. 2. Residuals Plots
Fig. 3. Responses to a shock in GXRL - Version 1
Fig. 4. Responses to a shock in MYRL-Version 1
Fig. 5. Responses to a shock in GXRL-Version 2
Fig. 6. Responses to a shock in MYRL-Version 2
Fig. 7. Responses to a shock in GXRL-Version 3
Fig. 8. Responses to a shock in MYRL-Version 3
Fig. 9. Responses to a shock in GXRL-Version 4
Fig. 10. Responses to a shock in MYRL-Version 4
Fig. 11. Responses to a shock in GXRL-Version 5
Fig. 12. Responses to a shock in MYRL-Version 5
### TABLE 1

**DATA IN LEVELS**

<table>
<thead>
<tr>
<th>OBS</th>
<th>GXR</th>
<th>MYR</th>
<th>YR</th>
<th>IR</th>
<th>TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td>143029.5</td>
<td>465147.5</td>
<td>2712466</td>
<td>378686.3</td>
<td>-634707.7</td>
</tr>
<tr>
<td>1964</td>
<td>182816.5</td>
<td>532687.3</td>
<td>2980852</td>
<td>393410.4</td>
<td>-119379.8</td>
</tr>
<tr>
<td>1965</td>
<td>221371.2</td>
<td>556639.9</td>
<td>2989853</td>
<td>378686.3</td>
<td>-149559.0</td>
</tr>
<tr>
<td>1966</td>
<td>297237.9</td>
<td>591488.2</td>
<td>394024.8</td>
<td>-80631.3</td>
<td></td>
</tr>
<tr>
<td>1967</td>
<td>248041.4</td>
<td>532532.6</td>
<td>3259008</td>
<td>41253.3</td>
<td>-133759.8</td>
</tr>
<tr>
<td>1968</td>
<td>349387.1</td>
<td>561287.0</td>
<td>3330439</td>
<td>468845.8</td>
<td>-79427.9</td>
</tr>
<tr>
<td>1969</td>
<td>367589.3</td>
<td>635128.3</td>
<td>3587318</td>
<td>468042.3</td>
<td>-77864.6</td>
</tr>
<tr>
<td>1970</td>
<td>380915.7</td>
<td>675469.9</td>
<td>3284819</td>
<td>314847.9</td>
<td>-90187.3</td>
</tr>
<tr>
<td>1971</td>
<td>360887.4</td>
<td>819186.5</td>
<td>2284819</td>
<td>314847.9</td>
<td>-106493.4</td>
</tr>
<tr>
<td>1972</td>
<td>371552.6</td>
<td>841035.1</td>
<td>2245528</td>
<td>314847.9</td>
<td>-34813.0</td>
</tr>
<tr>
<td>1973</td>
<td>382608.7</td>
<td>817070.6</td>
<td>2304875</td>
<td>279578.4</td>
<td>-249831.9</td>
</tr>
<tr>
<td>1974</td>
<td>427415.0</td>
<td>737432.9</td>
<td>2474040</td>
<td>33839.4</td>
<td>-251282.7</td>
</tr>
<tr>
<td>1975</td>
<td>455359.0</td>
<td>692373.4</td>
<td>2746390</td>
<td>463087.2</td>
<td>-216089.1</td>
</tr>
<tr>
<td>1976</td>
<td>453796.4</td>
<td>738333.6</td>
<td>2862184</td>
<td>488084.2</td>
<td>-249831.9</td>
</tr>
<tr>
<td>1977</td>
<td>533119.8</td>
<td>817070.6</td>
<td>3211565</td>
<td>506059.6</td>
<td>-312631.6</td>
</tr>
<tr>
<td>1978</td>
<td>573252.1</td>
<td>898908.6</td>
<td>3327903</td>
<td>500949.1</td>
<td>-366591.3</td>
</tr>
<tr>
<td>1979</td>
<td>580282.5</td>
<td>941680.8</td>
<td>3598729</td>
<td>556214.7</td>
<td>-402152.5</td>
</tr>
<tr>
<td>1980</td>
<td>673971.2</td>
<td>912459.0</td>
<td>3817090</td>
<td>526760.9</td>
<td>-365657.7</td>
</tr>
<tr>
<td>1981</td>
<td>659773.5</td>
<td>1041013.0</td>
<td>4149700</td>
<td>585697.3</td>
<td>-520792.0</td>
</tr>
<tr>
<td>1982</td>
<td>790145.6</td>
<td>1126159.0</td>
<td>4537178</td>
<td>691601.3</td>
<td>-410442.3</td>
</tr>
<tr>
<td>1983</td>
<td>872513.2</td>
<td>1117001.0</td>
<td>4866315</td>
<td>730834.2</td>
<td>-608723.1</td>
</tr>
<tr>
<td>1984</td>
<td>936130.0</td>
<td>1230600.0</td>
<td>5204200</td>
<td>779300.0</td>
<td>-516154.0</td>
</tr>
<tr>
<td>1985</td>
<td>1046029.0</td>
<td>1403391.0</td>
<td>5370918</td>
<td>845893.7</td>
<td>-463333.3</td>
</tr>
<tr>
<td>1986</td>
<td>1142620.0</td>
<td>1596089.0</td>
<td>5616790</td>
<td>922878.2</td>
<td>-372824.7</td>
</tr>
<tr>
<td>1987</td>
<td>1341154.0</td>
<td>1610127.0</td>
<td>5975233</td>
<td>943765.9</td>
<td>-425999.1</td>
</tr>
<tr>
<td>1988</td>
<td>1505212.0</td>
<td>1706187.0</td>
<td>6271619</td>
<td>1046934.0</td>
<td>-432946.7</td>
</tr>
<tr>
<td>1989</td>
<td>1382689.0</td>
<td>1835761.0</td>
<td>6437203</td>
<td>1067628.0</td>
<td>-428526.3</td>
</tr>
<tr>
<td>1990</td>
<td>1529606.0</td>
<td>1974052.0</td>
<td>6738774</td>
<td>1146129.0</td>
<td>-360752.5</td>
</tr>
<tr>
<td>1991</td>
<td>1655795.0</td>
<td>2189611.0</td>
<td>7207185</td>
<td>1320966.0</td>
<td>-422279.2</td>
</tr>
<tr>
<td>1992</td>
<td>1906022.0</td>
<td>2136100.0</td>
<td>7777753</td>
<td>1446641.0</td>
<td>-434248.0</td>
</tr>
<tr>
<td>VARIABLE</td>
<td>$\phi_j$ STATISTIC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YRL</td>
<td>4.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MYRL</td>
<td>7.21*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TR</td>
<td>4.38</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRL</td>
<td>4.66</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GXRL</td>
<td>4.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The critical values at 5% and 10% level are 6.73 and 9.31. These values are for a sample size of 50. * indicates significance at 10% level.
<table>
<thead>
<tr>
<th>Variables</th>
<th>Single Unit ADF Test Statistic</th>
<th>Second Unit ADF Test Statistic</th>
<th>Third Unit ADF Test Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>MYRL</td>
<td>0.0092</td>
<td>-4.4956</td>
<td>N.A</td>
</tr>
<tr>
<td>TR</td>
<td>-0.9175</td>
<td>-5.3018</td>
<td>N.A</td>
</tr>
<tr>
<td>GXRL</td>
<td>-0.7272</td>
<td>-4.1913</td>
<td>N.A</td>
</tr>
<tr>
<td>IRL</td>
<td>0.2043</td>
<td>-2.9098</td>
<td>-5.2360</td>
</tr>
<tr>
<td>YRL</td>
<td>0.3235</td>
<td>-2.8045</td>
<td>-5.2303</td>
</tr>
</tbody>
</table>

Critical values at 1%, 5% and 10% level are -3.6852, -2.9705 and -2.6242 respectively. N.A stands for not applicable.
TABLE 4
PAIRWISE GRANGER-CAUSALITY TEST

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>F-Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>MYRL does not Granger Cause YRL</td>
<td>.432</td>
<td>.65</td>
</tr>
<tr>
<td>YRL does not Granger Cause MYRL</td>
<td>2.38</td>
<td>.115</td>
</tr>
<tr>
<td>GXRL does not Granger Cause YRL</td>
<td>4.15</td>
<td>.029*</td>
</tr>
<tr>
<td>YRL does not Granger Cause GXRL</td>
<td>.894</td>
<td>.423</td>
</tr>
<tr>
<td>GXRL does not Granger Cause MYRL</td>
<td>.328</td>
<td>.723</td>
</tr>
<tr>
<td>MYRL does not Granger Cause GXRL</td>
<td>.795</td>
<td>.463</td>
</tr>
</tbody>
</table>

* indicates significance at the 5% level.
### TABLE 5

JOHANSEN'S COINTEGRATION TEST

<table>
<thead>
<tr>
<th>Eigenvalue Ratio</th>
<th>Likelihood Value</th>
<th>5 % Critical Value</th>
<th>1 % Critical Value</th>
<th>Hypothesized No. of CE(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.670408</td>
<td>91.71158</td>
<td>59.44</td>
<td>66.54</td>
<td>None**</td>
</tr>
<tr>
<td>0.61842</td>
<td>61.74430</td>
<td>39.89</td>
<td>45.58</td>
<td>At most 1**</td>
</tr>
<tr>
<td>0.562427</td>
<td>35.73128</td>
<td>24.31</td>
<td>29.75</td>
<td>At most 2**</td>
</tr>
<tr>
<td>0.321358</td>
<td>13.41546</td>
<td>12.53</td>
<td>16.31</td>
<td>At most 3*</td>
</tr>
<tr>
<td>0.103456</td>
<td>2.94860</td>
<td>3.84</td>
<td>6.51</td>
<td>At most 4</td>
</tr>
</tbody>
</table>

*(**) denotes rejection of the null hypothesis at 5%(1%) significance level.
L.R. test indicates 4 cointegrating equation(s) at 5% significance level.
DYRL and DDIRL are first differences of original series. Lag length is 2.
<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>LAGS</th>
<th>Q-STATISTIC</th>
<th>PROBABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GXRL</td>
<td>2</td>
<td>1.03</td>
<td>.31</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>4.72</td>
<td>.31</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>5.58</td>
<td>.47</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>5.88</td>
<td>.66</td>
</tr>
<tr>
<td>MYRL</td>
<td>2</td>
<td>.45</td>
<td>.79</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>.57</td>
<td>.76</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>4.76</td>
<td>.57</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>7.70</td>
<td>.46</td>
</tr>
<tr>
<td>YRL</td>
<td>2</td>
<td>1.83</td>
<td>.40</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3.50</td>
<td>.47</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>7.33</td>
<td>.29</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>9.48</td>
<td>.30</td>
</tr>
<tr>
<td>IRL</td>
<td>2</td>
<td>.34</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>.63</td>
<td>.90</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>2.42</td>
<td>.87</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>4.18</td>
<td>.84</td>
</tr>
<tr>
<td>TR</td>
<td>2</td>
<td>.31</td>
<td>.85</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1.48</td>
<td>.82</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1.83</td>
<td>.93</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>2.07</td>
<td>.97</td>
</tr>
</tbody>
</table>

The critical values are for 2, 4, 6, and 8 lags are 3.84, 7.81, 11.57 and 14.06
### TABLE 7

VARIANCE DECOMPOSITIONS

#### Variance Decomposition of GXRL:

<table>
<thead>
<tr>
<th>P</th>
<th>S.E.</th>
<th>GXRL</th>
<th>MYRL</th>
<th>YRLD</th>
<th>IRLD</th>
<th>TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.052311</td>
<td>100.0000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>2</td>
<td>0.061078</td>
<td>82.53608</td>
<td>0.661082</td>
<td>0.509307</td>
<td>16.28548</td>
<td>0.008056</td>
</tr>
<tr>
<td>3</td>
<td>0.069519</td>
<td>73.08805</td>
<td>1.258812</td>
<td>0.509307</td>
<td>16.28548</td>
<td>0.008056</td>
</tr>
<tr>
<td>4</td>
<td>0.076029</td>
<td>61.46241</td>
<td>1.423674</td>
<td>15.18128</td>
<td>18.14916</td>
<td>3.783470</td>
</tr>
<tr>
<td>5</td>
<td>0.086396</td>
<td>48.68005</td>
<td>1.966531</td>
<td>13.70335</td>
<td>27.48186</td>
<td>8.168210</td>
</tr>
<tr>
<td>6</td>
<td>0.096830</td>
<td>39.59702</td>
<td>1.580374</td>
<td>12.21288</td>
<td>31.41233</td>
<td>15.19740</td>
</tr>
<tr>
<td>7</td>
<td>0.109960</td>
<td>31.19714</td>
<td>1.246029</td>
<td>11.54491</td>
<td>34.04037</td>
<td>21.97155</td>
</tr>
<tr>
<td>8</td>
<td>0.126771</td>
<td>24.61288</td>
<td>0.955121</td>
<td>10.44841</td>
<td>36.70988</td>
<td>27.27371</td>
</tr>
<tr>
<td>9</td>
<td>0.144399</td>
<td>20.59108</td>
<td>0.736975</td>
<td>10.53083</td>
<td>37.83209</td>
<td>30.30903</td>
</tr>
<tr>
<td>10</td>
<td>0.165057</td>
<td>17.88800</td>
<td>0.616091</td>
<td>10.11168</td>
<td>38.90434</td>
<td>32.47989</td>
</tr>
</tbody>
</table>

#### Variance Decomposition of MYRL:

<table>
<thead>
<tr>
<th>P</th>
<th>S.E.</th>
<th>GXRL</th>
<th>MYRL</th>
<th>YRLD</th>
<th>IRLD</th>
<th>TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.061146</td>
<td>18.39761</td>
<td>81.60239</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>2</td>
<td>0.088622</td>
<td>22.85603</td>
<td>73.90386</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>3</td>
<td>0.096885</td>
<td>27.76809</td>
<td>65.01937</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>4</td>
<td>0.103661</td>
<td>33.09641</td>
<td>57.09413</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>5</td>
<td>0.109863</td>
<td>33.88594</td>
<td>51.32053</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>6</td>
<td>0.113022</td>
<td>33.11463</td>
<td>50.07283</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>7</td>
<td>0.112817</td>
<td>32.23207</td>
<td>48.89244</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>8</td>
<td>0.116298</td>
<td>30.56224</td>
<td>46.69784</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>9</td>
<td>0.120317</td>
<td>29.11273</td>
<td>44.87678</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>10</td>
<td>0.125143</td>
<td>27.29645</td>
<td>42.67163</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
</tbody>
</table>

#### Variance Decomposition of YRLD:

<table>
<thead>
<tr>
<th>P</th>
<th>S.E.</th>
<th>GXRL</th>
<th>MYRL</th>
<th>YRLD</th>
<th>IRLD</th>
<th>TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.061910</td>
<td>4.810044</td>
<td>0.088877</td>
<td>95.10108</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>2</td>
<td>0.079839</td>
<td>13.50497</td>
<td>4.015854</td>
<td>60.32969</td>
<td>14.30316</td>
<td>7.846331</td>
</tr>
<tr>
<td>3</td>
<td>0.093813</td>
<td>31.37831</td>
<td>3.498932</td>
<td>43.77313</td>
<td>12.53962</td>
<td>8.810009</td>
</tr>
<tr>
<td>4</td>
<td>0.097769</td>
<td>29.18585</td>
<td>3.658243</td>
<td>41.08555</td>
<td>12.48175</td>
<td>13.58862</td>
</tr>
<tr>
<td>5</td>
<td>0.102057</td>
<td>28.48774</td>
<td>3.428890</td>
<td>37.80089</td>
<td>14.37399</td>
<td>15.90849</td>
</tr>
<tr>
<td>6</td>
<td>0.102918</td>
<td>28.07063</td>
<td>3.574145</td>
<td>37.49051</td>
<td>14.19708</td>
<td>16.66764</td>
</tr>
<tr>
<td>7</td>
<td>0.105865</td>
<td>27.68676</td>
<td>3.378215</td>
<td>36.99967</td>
<td>14.78277</td>
<td>17.15258</td>
</tr>
<tr>
<td>8</td>
<td>0.108783</td>
<td>27.59823</td>
<td>3.736431</td>
<td>35.09145</td>
<td>15.95749</td>
<td>17.61640</td>
</tr>
<tr>
<td>9</td>
<td>0.112216</td>
<td>28.42260</td>
<td>4.260195</td>
<td>33.14650</td>
<td>16.36511</td>
<td>17.80559</td>
</tr>
<tr>
<td>10</td>
<td>0.114136</td>
<td>28.24466</td>
<td>4.396240</td>
<td>32.31180</td>
<td>16.65297</td>
<td>18.39433</td>
</tr>
</tbody>
</table>
TABLE 7 (Continued)

<table>
<thead>
<tr>
<th>Variance Decomposition of IRLD:</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P S.E.</td>
<td>GXRL</td>
<td>MYRL</td>
<td>YRLD</td>
<td>IRLD</td>
<td>TR</td>
</tr>
<tr>
<td>1</td>
<td>0.069758</td>
<td>7.216408</td>
<td>2.875238</td>
<td>52.12892</td>
<td>37.77944</td>
</tr>
<tr>
<td>2</td>
<td>0.088241</td>
<td>15.74636</td>
<td>19.26883</td>
<td>34.65820</td>
<td>28.48338</td>
</tr>
<tr>
<td>3</td>
<td>0.107739</td>
<td>31.62024</td>
<td>21.34016</td>
<td>24.97700</td>
<td>19.52235</td>
</tr>
<tr>
<td>4</td>
<td>0.113056</td>
<td>28.83574</td>
<td>20.97110</td>
<td>22.98088</td>
<td>19.74357</td>
</tr>
<tr>
<td>5</td>
<td>0.120007</td>
<td>28.22474</td>
<td>19.52295</td>
<td>20.79061</td>
<td>19.25457</td>
</tr>
<tr>
<td>6</td>
<td>0.123162</td>
<td>27.21941</td>
<td>18.79173</td>
<td>20.24512</td>
<td>18.45825</td>
</tr>
<tr>
<td>7</td>
<td>0.126554</td>
<td>25.82343</td>
<td>17.83840</td>
<td>20.15032</td>
<td>19.51397</td>
</tr>
<tr>
<td>8</td>
<td>0.128966</td>
<td>25.20888</td>
<td>17.34186</td>
<td>19.99423</td>
<td>20.51277</td>
</tr>
<tr>
<td>9</td>
<td>0.132854</td>
<td>26.30980</td>
<td>17.29358</td>
<td>19.71329</td>
<td>20.13746</td>
</tr>
<tr>
<td>10</td>
<td>0.136671</td>
<td>26.61616</td>
<td>17.11211</td>
<td>19.17182</td>
<td>20.39592</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variance Decomposition of TR:</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P S.E.</td>
<td>GXRL</td>
<td>MYRL</td>
<td>YRLD</td>
<td>IRLD</td>
<td>TR</td>
</tr>
<tr>
<td>1</td>
<td>44955.35</td>
<td>15.26478</td>
<td>5.498641</td>
<td>2.745492</td>
<td>12.29111</td>
</tr>
<tr>
<td>2</td>
<td>60538.22</td>
<td>11.07409</td>
<td>20.60768</td>
<td>8.670549</td>
<td>9.908335</td>
</tr>
<tr>
<td>3</td>
<td>79842.42</td>
<td>13.50353</td>
<td>11.99195</td>
<td>10.78068</td>
<td>17.02314</td>
</tr>
<tr>
<td>4</td>
<td>91273.45</td>
<td>16.09922</td>
<td>9.249888</td>
<td>13.41963</td>
<td>16.43559</td>
</tr>
<tr>
<td>5</td>
<td>112987.3</td>
<td>19.67933</td>
<td>7.668737</td>
<td>8.761315</td>
<td>20.45415</td>
</tr>
<tr>
<td>6</td>
<td>127724.9</td>
<td>20.57059</td>
<td>8.190635</td>
<td>8.509955</td>
<td>21.98322</td>
</tr>
<tr>
<td>7</td>
<td>140583.2</td>
<td>20.53185</td>
<td>7.482422</td>
<td>8.035404</td>
<td>23.35726</td>
</tr>
<tr>
<td>8</td>
<td>153102.6</td>
<td>22.13078</td>
<td>7.210356</td>
<td>8.591461</td>
<td>22.92431</td>
</tr>
<tr>
<td>9</td>
<td>166462.0</td>
<td>23.01008</td>
<td>6.559482</td>
<td>7.875255</td>
<td>23.38092</td>
</tr>
<tr>
<td>10</td>
<td>179475.5</td>
<td>23.71517</td>
<td>6.138204</td>
<td>7.445475</td>
<td>23.79729</td>
</tr>
</tbody>
</table>

Version 1- Baseline Ordering: GXRL MYRL YRLD IRLD TR


Functions of Estimated VAR Models with Orthogonal Residuals. Journal of Econometrics 42.


