Channels and Lags in Effects of Monetary Policy's Transmission Mechanism: A Case of Pakistan

By

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Abstract

This study examines the strength and delays in effects of different channels of monetary transmission mechanism for Pakistan**.** Successful implementation of monetary policy requires an accurate assessment of how fast the effects of policy changes propagate to economic activities and how large effects are. Accordingly a quantitative measure of policy stance is important for empirical study of the transmission of monetary policy actions through the economy. We, in this study, first construct two measures of policy stance i.e. Monetary Condition Index (MCI) and Financial Condition Index (FCI), currently used by many central banks and other organizations, and than evaluate these measures on the basis of performance criterion. We found that performance of financial condition index is better than monetary condition index. Then we use this measure as policy instrument to further examine the transmission channels of monetary policy. We use transfer function methodology to examine the strength of different channels and time period involved in transmission of monetary changes through different channels to output and inflation. The results show that supply side is dominant in Pakistan and that exchange rate and lending channels, enjoy dominance over interest rate channel. Output responds faster than inflation to change in policy stance. Money supply affects the output before exercising impact upon inflation. The interest rate, affects inflation positively, perhaps because of its positive impact upon cost of production. Given this the use of interest rate to control inflation may prove counter productive. Furthermore monetary policy is less effective to control the inflation; it may due to facts larger part of domestic inflation constitutes imported inflation as results show.

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1 INTRODUCTION

The economic growth and the low inflation are primary goals of the macro-economic policies. The monetary policy that encompasses these goals is considered a powerful tool for a robust economy. Economists rarely agree in totality on a given issue, but most of the contemporary economists are convinced that monetary policy has economic effects and that the interest rate changes serve as an indicator of the direction and outcomes of a monetary policy. Economists are, however, unsure about the exact nature of the channels through which the monetary changes are transmitted to economic activities. The recent literature discusses many channels that supposedly transmit policy changes to the goals of a monetary policy i.e. output and inflation. The policy-induced changes are transmitted to economic activities through different channels as well as with delays. Friedman (1961) suggests that it is not only current policy changes which affect the output and inflation but actions taken in the past (pipeline effects) can also change the course of economy. Besides, the speed of propagation through different channels may be different i.e. the effects of policy-induced changes through one channel may be more effective towards attaining goals than through various channels.

A successful implementation of a monetary policy, therefore, requires an accurate assessment of how fast the effects of policy changes propagate to monetary policy goals and how large are these effects in magnitude. The process requires a thorough understanding of the mechanism through which monetary policy affects its goals. A better understanding of transmission mechanism is also essential for it can improve the knowledge of linkage between the financial and real sector of the economy. It helps in interpreting the movements of the financial variable and provides a better choice of targets for monetary policy[1].

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[1] See for example Islam and Raisi (2003).

Transmission mechanism - the process through which monetary policy may change income and inflation (Taylor 1995) - is complex but interesting because there are many channels through which monetary policy operates. The interest rate channel is the primary mechanism at work in conventional macroeconomic models. An increase in nominal interest rate, given some degree of price stickiness, is translated into an increase in real interest rate and user cost of capital. These changes influence the composition of consumption and investment spending. Bernanke and Gertler (1995) have pointed out the macroeconomic response to a policy-induced interest rate change is considerably larger than what is implied by conventional estimates of the interest elasticity of consumption and investment by different economic agents. The observation suggests that some mechanisms, other than the interest rate channels, may also be at work in transmission of monetary changes. Besides interest rate channel, other channels of monetary policy identified in literature: interest rate channel; exchange rate channel; credit channel; assets price channel; consumption wealth channel; and expectations channel. The working and functions of different channels, however, depends on the financial structure and macroeconomic environment of the economy.

Empirical assessment of the macroeconomic impact of various channels of monetary transmission is quite difficult and, therefore, poses a daunting challenge for researchers. The difficulties include simultaneity and concurrent operation of different channels. The simultaneity problem arises because the authority may respond to any movement in the economy i.e. it loosens policy when the economy weakens and tightens when the economy strengthens. Such an endogenous response of policy to economic conditions makes it difficult to identify the impact of policy. Economists have employed a variety of techniques to solve the simultaneity problem, but none of them emerged is entirely satisfactory. The most common of these approaches is the use of Vector Auto Regression (VAR) model. However, this approach is criticized for its ostensible implausibility that the monetary authority behaves randomly, and that the shocks actually represent either model specification errors or changes in overall policy regime. Besides, VAR models are not useful for analysis of changes in the systematic component of the monetary policy because they focuse on shocks only. Quite often, we are interested in the effect of a change in a coefficient in the policy reaction function, such as how aggressive the authorities are about reacting to high inflation rather than the shock to policy. Although shocks and systematic component both are important, it is more fruitful to emphasize the latter because the quantitatively unsystematic part (shock) of policy instrument variability is quite small in relation to the variability of the systematic component [Taylor (1995), Rotenberg and Woodford (1997, 1999), Bernanke, Gertler and Watson (1997)]. In spite of such shortcomings, VAR methodology is most popular and commonly used approach, though some identification restrictions need to be used (triangular aspects or long run restrictions based on economic theory).

The second difficulty - the concurrent operation of multiple channels - makes it hard to separate the impact of one channel from the other. To avoid this problem, one may analyze the effect transmitted through one channel with all other channels econometrically turned off.

There is a huge literature on transmission mechanism and empirical studies testing the existence of different channels for the developed countries as well as for the developing countries. Most of these studies attempt to find the evidence about the prevalence of a single channel (mostly the credit channel). The empirical findings of these studies are mixed e.g. some studies confirm the existence of interest rate channel [Cagan (1972), Schlogehauf and

Wrase (1995), Bernanke and Mihove (1998), Sgherri (2000), Chiades and Gambacarto (2000), Loayza (2002), Citu (2003), and Casuso (2004)]. Others argue that liquidity effect almost disappeared [Melvin (1983), Christiano (1995), Lopes (1998), Dovciak 91999), and Kuijs (2002)]. Empirical findings on credit channel are also mixed. Some studies find evidence in favour of credit channel effects [Friedman (1988), Kashyap *et al*. (1993), Gertler and Gilchrist (1994), Oliner and Rudebusch (1995), Dale and Haldane (1995), Ganely and salmon (1997), Hallsten (1999), Asheraft (2001), Krylova (2002), Latterman (2003), and Casuso (2004). Other studies find the credit channel to be unimportant (Bernanke and Blinder (1988), Romer and Romer (1990), Fuerst (1995), Fisher (1996), Yuan and Zimmerman (1999), Favero et al. (1999), Caversogla (2002), Ageloniet al. (2002)].

Most of the studies that include the exchange rate channel in the analysis of transmission mechanism, confirm the importance of this channel [Eyzagurri (1998), Lopes (1998), Dovciak (1999), Peersman and Smet (2000), Jang and Ozaki (2001), Lyziak (2001), Loayza (2002), and Citu (2003)]. For Pakistan, to the best of our knowledge, there is only one such study [Agha *et al*. (2005) on transmission mechanism of monetary policy. This study does not take into account the lags involved in transmission through different channels. Furthermore, it does not identify an exogenous measure of monetary policy stance which is essential to study transmission mechanism of monetary policy. Given the paramount importance of transmission mechanism for understanding the monetary policy, one of the objectives of this study is to analyze the strength of different channels of monetary policy transmission mechanism.

In addition to the simultaneity and multiplicity, the third aspect pertains to lags involved in transmission of monetary changes to the goals of the policy. Generally, it is impossible for the monetary authority to influence the ongoing inflation rate and the level of output, unless it takes calculated measures and focuses on such objectives in advance. The Central Bank uses its predictive assessments about the movements in these variables (output growth and inflation rate). Any policy action on the basis of such an assessment, however, may even worsen the situation, if the assessment of lags involved is not reasonably true. The existence of such lags makes it difficult to devise an appropriate monetary policy. This, in turn, makes the task of achieving the goals of monetary policy more difficult. Blinder (1997) argues that one of the main reasons of the central bank error in devising a monetary policy is owed to the failure in taking proper account of the lags in transmission of monetary policy towards policy goals. There are only a few empirical studies on lags in effects of monetary policy. Prior to 1960, quantitative estimates of lags in effects of monetary policy were rare. Friedman (1961) viewed that the impact of policy-induced changes occur only after a lag, which are not only long-term but hardly acceptable to many economists [Culbertson (1961), Ando et, al. (1963), and Mayer (1967)]. The latter studies [Taner (1979), Gruen *et al*. (1997), and Lakshmi (2002)] confirm, howeverthat the prolonged lags are involved in effect of monetary policy. These studies just consider that how much time is taken by changes in monetary aggregate to affect the output and inflation. No account is taken in regards the lags in transmission through different channels, which is important as rightly pointed out by Culbertson (1961). For Pakistan, some studies [Khan and Schimmelpfennig (2006), and Kemal (2006)] analyze the lags from changes in monetary aggregates to inflation. But none of them considers particularly the lags in transmission through different channels. One objective of the study therefore, is to examine lag with which monetary changes influence the goals of monetary policy, as well as the duration for which impacts transmitted through different channels last.

Vector Auto-regressive technique has been used to handle the problem of simultaneity. But it requires identification restrictions. In this study, we use multi-inputs multi-outputs transfer function model developed by Box and Jenkins (1976), which handles the simultaneity problem without any identification restrictions. While using the transfer function model each of the output series is pre-whitened once for each of the input series, which is capable of separating the effect of each individual channel. This method also has the advantage of identifying the delay period and the duration for which the input (monetary changes here) affects output (inflation and GDP growth). We use iterative regression procedure developed by Muller and Wie (1994), which provides consistent estimates of parameters to identify the transfer function.

Besides analyzing the importance of different channels, a quantitative measure of stance of policy is important for empirical study of the transmission of monetary policy actions through the economy (Fung and Yuan 2002). Enabling a discussion on the effect of monetary policy changes, one needs an exogenous monetary policy; but there is a general disagreement towards defining the exogenous monetary policy. The traditional approach is to use a single variable (such as monetary aggregate or discount rate) as policy measure, which could be misleading as some puzzling characteristics in pattern of subsequent economic development are attached with these changes i.e. interest rate puzzle, price puzzle, and exchange rate puzzle (Sims and Zha, 1998). Milton Friedman and Anna Schwartz (1963) advocate the innovations in the monetary aggregates as a good approximate measure of monetary policy shocks. Some studies [e.g. Bernanke and Blinder (1992), and Sims (1992)] consider that the federal funds rate could be a better indicator of policy stance. Yet some (e.g. Christians and Eichanbaum, 1992), suggest quantity of non-borrowed reserves as an indicator of monetary policy. The problem with such policy measures pertains to the presumption of a constant set of operating procedure by the authorities (Fund-rate or non borrowed reserves based procedure). Armour et al. (1996) proposed that innovation in overnight rate could be a good measure of innovations to the Canada's policy. All these studies assumed *a priori* that a single financial variable is the best policy indicator. There exists, however, a little agreement as to which single variable captures the stance of policy accurately.

Romer and Romer (1989) use Index of minutes of Federal Open Market Committee as the stance for a monetary policy. An appealing aspect of this approach is that it uses additional information (policy makers' statement of their own intentions) in an effort to disentangle money supply from money demand shocks. Besides the inherent problem of subjectivity, however, another disadvantage stems from the approach through its inability to distinguish between endogenous and exogenous components of policy changes, which are essential for identifying the effect of monetary policy on economy [Dotsey and Reid (1992), Leeper (1993), Shapiro (1994), Hoover and Pervez (1994), Sims and Zha (1995), and Bernanke et al. (1997)]. Romers' approach considers only concretionary episodes, but not expansionary shifts. Similarly, it fails in accounting for the severity or duration of each episode.

Bank of Canada first constructs and uses monetary condition index (MCI), which is weighted sum of changes in interest rate and exchange rate from a given base period, as measure of policy stance (Freedman 1995). Many other organizations and central banks including SBP now use MCI as policy stance. MCI, however, is criticized for the reasons given below: First, the computation includes all changes in the interest and exchange rates including the ones that may not be results of the central bank policy (Gauthier et at.,2004). Second, MCI does not consider financial variables other than interest and exchange rates that may comprise of an important element of transmission mechanism (Batani, 2002). Third, MCI, by taking a particular linear combination of interest and exchange rates, loses some information that may be available in the two series separately, thus a policy stance based on a single measure may not be appropriate.

Bernanke and Mihov (1998) suggests a VAR methodology inclusive of all the variables that can be instrumental in policy changes. This approach does not assume that a single variable is the best indicator of monetary policy. This method has several advantages over other approaches as suggested by Bernanke and Mihov (1998). First, it nests the quantitative indicators of monetary policy. Second, it is applicable to other countries and periods, and to alternative institutional setups. Given the importance of monetary policy stance for analysis of transmission mechanism, the measurement of policy stance is also an objective of this study.

The recent literature [Goodhart and Hofmann (2001), Mayes and Viren (2001), and Gauthier et al (2004)] use Financial Condition Index (FCI), which is basically an extension of monetary condition index (MCI). The FCI includes other financial variables, besides the interest rate and exchange rate that are important in transmission mechanism of monetary policy.

There are two studies [Qayyum (2003) and Hyder & Khan (2006)] which estimate the MCI for Pakistan. These studies do not consider the dynamics, over time, of the variables used in the construction of MCI. While constructing MCI, we have accounted for the dynamics of the variables as well. Besides the MCI, we constructed FCI also that - in addition to interest rate and exchange rate - incorporates some other variables as well. These two measures are being used by some central banks and other organizations to measure the stance of monetary policy

Objectives of the study

No comprehensive study exists to probe into channels of monetary policy, lags involved in transmission through these channels, and the duration for which the impact of monetary policy changes last. Given the importance of the matter referred above, this study attempts to investigate the way policy changes are transmitted to output and inflation, as well as it deals with the duration of delay. The channels included in this study are interest rate, exchange rate, and bank lending channel. The study is anticipated to have far reaching implications for monetary authorities in formulating the monetary policy designed to achieve the goals, besides examining the consequences of their actions.

Pakistan offers a unique environment for assessing the effects of monetary policy through different channels and lags involved in transmission of monetary changes because:

(1) It has experienced double-digit inflation in the 1990s.

(2) It initiated the financial reforms in the late1980s.

(3) It is a small open economy.

Considering the abovementioned reasons, our study is focused on Pakistan. The main objectives of the study are to analyze:

(1) The relevance of different policy measures in designing the monetary policy.

(2) The effectiveness of monetary policy on macroeconomic goals of the policy.

(3) The importance of different channels of monetary transmission, as well as the mechanism.

(4) Lags involved in transmission through different channels.

(5) The extent to which Pakistan - being a small open economy - is affected by the external shocks

The monthly data from January 1982 to July 2007 are used. The commencement date is meant to exclude the fixed exchange rate regime, while the July 2007 - the time of empirical investigation - represents an ending period in terms of the data availability. The data are taken from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). The use of the monthly data, however, has its own limitations. We use industrial production index as proxy for GDP because the GDP data are available only on annual basis. The issue here is whether industrial output is a good proxy for real GDP, which is the output that monetary authorities want to stabilize. Since we used a monthly data, the industrial production index was the best proxy available. In order to examine the effectiveness of our proxy, we examined the correlation of the growth rates of annual industrial production with annual real GDP growth (both plotted on the same graph) to see how closely they move. If they have some reasonable correlation, we can infer that the monthly IP would be a reasonable proxy for monthly GDP (unobserved for the lack of data).

Plan of Study

The plan of the study as follows: the chapter 2 provides a literature review. The chapter 3 presents the review of monetary management in Pakistan. In the chapter 4, the model and methodology are discussed. The chapter 5 explains the procedure to test for seasonal unit root. In the chapter 6, different measures of monetary policy are discussed. The chapters 7 and 8 present and examine the empirical results, while the chapter 9 presents conclusions.

2 Literature Review

2.1. Introduction:

The transmission mechanism - the process through which policy changes are transmitted to economic growth and inflation (Taylor 1995) - is complex and debatable as it works through different channels, affecting different variables and markets at various speed and intensities (Loayza and Hebbel 2002). There could not be two opinions in regards to the knowledge of transmission mechanism owing to its essential role in conducting monetary policy effectively. In order for achieving the objectives (i.e. output growth and price stability) of monetary policy, the policy makers must be aware of timing and magnitude of the impact of monetary policy changes on real economy. In the earlier literature, the interest rate was considered the sole channel of monetary policy transmission. But the recognition that effects of policy-induced interest rate change are considerably larger than what is implied by conventional estimates of the interest elasticity of consumption and investment (Bernanke and Gelter 1995), promoted the idea that there are other channels involved in the transmission of monetary policy, in addition to interest rate channels. The idea of transmission goes back to Frisch (1933) who separated the dynamic analysis of economic fluctuations into impulses and propagation process. The channels of monetary policy transmission identified by Mishkin (1995) include: (i) interest rate channel, (ii) credit channel, (iii) exchange rate channel, (iv) asset prices channel, (v) consumption wealth channel, and (vi) expectations channel.

An important aspect in analysis of transmission mechanism is the lags involved in this process. Friedman (1961) argues that the affects of policy-induced changes occur only after a lag which is both long and variable. He maintains that even if policy makers could accurately forecast, the lags are so variable that active stabilizing monetary policy may amplify the cycles it seeks to ameliorate.

There is a vast literature - theoretical as well empirical - on monetary transmission mechanism. Yet there are only a few studies on lags in effects of monetary policy. A review of some studies is presented in this chapter.

2.2 Theoretic:

In this section, we briefly describe the working of different channels of monetary transmission and lags involved in transmission of policy changes through these channels.

2.2.1 Transmission Mechanism

Interest Rate Channel

The traditional mechanism - often regarded as main channel – pertaining to monetary policy transmission is the interest channel (Loayza and Hebbel 2002). Policy-induced changes (change in money supply or central bank rate) lead to change in long-term interest rate, which in turn affects different components of investment that shifts aggregate demand and eventually a change in output and prices occurs. Only two assets, i.e. money and bonds are assumed, and the bank credit does not play any role in this traditional view. This transmission mechanism depends on several links, such as: a link between nominal interest rate and real interest rate, a link between short-term and long-term interest rates, and a link between aggregate demand and prices).

The interest rate influences output and inflation through changes in investment and consumption. A contarctionary monetary policy that results into an increase in the interest rate reduces the ongoing (current) consumption by altering the inter-temporal substitution between current and future consumption. The aggregate demand shifts downward while causing a decline in output and inflation.

The driving mechanism in interest rate channel is the liquidity effect. The liquidity effect implies a change in real money supply that causes the nominal interest rate to move in the opposite direction to restore equilibrium in the money market. The real interest rate occurs through wage and price rigidity.. The evidence in the support of liquidity effect, however, is not strong. Some earlier studies support the liquidity effect (Cagan 1972), however, later work casts some doubt on the length and size of the liquidity effect. Melvin (1983) argues that the liquidity effect disappeared completely in the1970s.

Credit Channel

The traditional interest rate channel has become a subject of criticism as it faildc to explain how small or seemingly irrelevant shocks, such as small changes in interest rate result into large and persistent changes in output (Wright, 1997). One explanation in the literature pertains to credit market's frictions, which propagates financial shocks that otherwise may appear to be of no consequence. Gertler and Gilchrist (1994) argue that a monetary policy would be least effective in the absence of credit constrained firms since a smaller reduction in investment would have been possible with a large increase in the interest rate. The recent literature (Bernanke and Gertler 1995, Wright 1997, Oliner and Rudebusch 1996, Krylova 2002, and Caruso2004) considers credit market as a key player in the transmission of monetary policy to real economy. The relationship between credit and the macroeconomic developments has been debated since long (Hallsten, 1998). In the 1930s, after the great depression, the role of credit in the macroeconomic development was emphasized by Fisher (1933). He was of the view that the financial market's bad performance resulted into a deep recession of the 1930s. The theoretical research, during the 1960s, however, suggested that the financial system has no role to play in the macroeconomic development. Modigliani and Miller (1958) assuming perfect information showed that under certain conditions the capital structure of a firm is economically irrelevant. In the 1970s, different studies examined the importance and implications of asymmetric information in the financial markets. Hallsten (1998) feels that the advancement in the microeconomic theory and growing difficulties in explaining the macroeconomic developments with conventional monetary theory has induced a renewed interest in credit channel.

According to this transmission mechanism, external financial premium, which is a wedge between the cost of funds raised externally by issuing equity or debt and the opportunity cost of funds raised internally by retaining earnings, plays a crucial role in the economic activities. Larger the size of this premium greater would be the imperfections in credit markets. A policy-induced change in the interest rate causes the external finance premium to move in the same direction, and amplifies the direct effect of monetary policy. This phenomenon, besides the interest rate channel, may help to explain the strength, timing and composition of the monetary policy effects in a better way. The credit channel of a monetary policy can be further segregated into the balance sheet effect as well as the bank lending effect.

The Exchange Rate Channel:

The relationship between net private capital inflows and monetary policy has become more important with liberalization of capital flows. Obstfeld and Rosoft (1995) and Taylor (1995) emphasize the role of this relationship in a monetary policy. A tight monetary policy leads to an increment in real interest rate, this in turn boosts capital inflows causing the domestic currency to appreciate. This appreciation in turn adversely influences competitiveness and the trade balance, therefore, deteriorates.

The real appreciation - that results from a monetary contraction - cuts the prices of imported goods reducing inflation directly. Moreover, the lower price of imported inputs expands the aggregate supply while output increases and inflation is also curtailed. The net effect of exchange rate changes on output and inflation depends on whether demand or supply side factors are dominant.

Asset Price Channel:

The monetary policy may influence the economy by altering the price of other assets, such as equity, bonds and real estate. A change in monetary policy leads to a change in equity prices, which in turn affects investment through Tobin's q — the ratio of market value of firms to replacement cost of capital. If q is low, the market price of firms is low relative to replacement cost of capital, and new plant and equipment is costly relative to market value of firms. The investment spending will reduce as firms cannot buy many new investment goods. This in turn affects the aggregate demand negatively.

Wealth Channel:

The proponents of wealth channel argue that the monetary policy changes cause the changes in stock prices, which in turn influences the value of household wealth. The ripple effects cause the consumption to change and, ultimately, the aggregate demand shifts leading to a change in output and prices.

This channel has deep roots in the literature on monetary policy and economic stabilization. Reaching back to the literature, stimulated by Keynes's General theory,. Modigliani (1944, 1963) and Patinkin (1968) have derived the necessary conditions for money market, goods market and labor market that are essential for real balance effect to stabilize the economy at full employment. Modigalini (1971) states that consumption is a function of lifetime resources of consumers and the financial wealth is an important component of these resources.

2.2.2. Lags in Effect of Monetary Transmission Mechanism

The role of monetary policy as a stabilizing tool has been emphasized by activists, as it can be altered quickly and tuned finely to changing economic environment (Tanner, 1972). A group of economist, led by Friedman argues, howeverthat the affects of policy-induced changes occur only after a lag which is both long and variable. They maintain that even if policy makers could accurately forecast, the lags are so variable that active stabilizing monetary policy may amplify the cycles that it seeks to ameliorate. The evidence furnished by Friedman (1961) on lags is based on a turning points' analysis. The turning points of the money change rate are compared with turning points of the level of business activities. The turning point approach has its critics (Culbertson 1961, Ando *et al.* 1963). Generally, the critics argue that the determination of a lag length calls for examining as to when the policy action influences the level of income rather than the examination of turning points proposed by Friedman. Culbertson (1960) criticizes the Friedman's interpretation of lags as the time involved between policy action and succeeding cyclical turning point. He argues that lag involves time between policy action and the time at which things begin to go differently than they would have in the absence of the action. He also questions the treatment monetary changes as exogenous. . He further argues that most promising approach to estimating the lag in effect of stabilizing monetary policy seems to be an analysis of channels that affect the economy and an appraisal on the basis of evidence regarding the time involved in pass through for each channel. Mayer (1967) criticizes Friedman's results on the following grounds: firstly, the pre-1908 data for money stock is annual or semi-annual while data for income has monthly frequency; secondly, no account is taken of variance in the strength of policies and finally, no account is taken of what the income level would have been had the Monetary policy changes not occurred. Mayer argues that given the aforementioned shortcomings, Friedman's technique over estimates the variance of lags. The later studies (Tanner 1979, Gruen *et al*. 1997, Lakshmi, 2002) confirm, however, the existence of long and variable lags in effect of monetary policy.

The effects of monetary policy are transmitted to its final objectives, i.e. output and inflation caused by lags. These lags are of two kinds: the inside lags and the outside lags. The inside lags represent the time duration involved between the recognition that a monetary change is required and actual implementation of this change. This type of lags is considered to be relatively shorter. The outside lags reflect the time span in which the policy action influences the economy and such lags are relatively longer. It is only the outside lags that can be estimated with formal statistical techniques.

Sources of Lags

Different sources may contribute to long lags of monetary policy effects on economic activities. One possible source of lags is slow pass-through of monetary changes to interest rates. The empirical evidence available so far indicates that the short-term money market interest rates respond rapidly and completely to monetary changes. The pass-through to the other interest rates, such as deposits and lending rate of financial intermediaries appears to be slower and less than hundred percent [Lowe (1995), Qayyum et al.(2005)]. As these interest rates are an important determinant of cash-flow, asset prices and an incentive for postponing expenditure, the slow pass-through to these rates contributes towards the transmission of lags to economic activities.

The rate of time-preference could be another source of lags. The investment responds gradually to changes in monetary policy. With the change in interest rate, the incentives to postpone investment are altered owing to uncertainty. As the investments are largely irreversible in nature, there is always an option value to waiting to invest in the world of uncertainty (Dixit and Pindyck 1994). A change in the interest rates alters this option value, and hence the timing of the investment is affected as a result.

Yet another source of lags could be the delayed response of exchange rate to monetary changes. Besides, the affect of exchange rate on tradable sector of the economy is also gradual and prolonged due to the *j*-curve phenomenon.

Finally, the different sectors of the economy may respond to policy changes as well as to developments in each other with varying speed and in different ways.

2.3 Empirics

A large number of empirical studies carried out in various countries are available that tested the existence of different channels by using different techniques, different variables, and different types of data. These studies considered a single country as well as a group of countries. There are, however, only a few studies on lags in effects of monetary policy. The review of a few studies on transmission mechanism and lags in effect of monetary policy is presented in the following section.

2.3.1. Transmission Mechanism

Credit channel

The empirical studies investigating the role of credit channel can be categorized in different ways. Some studies analyze the relative importance of interest rate (money) channel and credit channel [Bernanke (1986), Friedman (1988), Bernanke and Blinder (1988), Romer and Romer (1990) Bernanke and Blinder (1992), Butliglione and Ferri (1994) Bernanke and Gertler (1995), and Halsten (1999)]. Some of them [Bernanke (1986), Friedman (1988), Bernanke and Blinder (1988), Bernanke and Blinder (1992), Butliglione and Ferri (1994), Bernanke and Gertler (1995), Halsten (1999), Martinez *et al*. (2000), and Heuvel (2002)], suggest that money and credit are more or less equally important forces in the monetary transmission mechanism. While other [Romer and Romer (1990), Morris and Sellon (1995), Warner and Georges (1998)] find no evidence that bank lending has played an independent worth while role in the transmission of monetary policy.

The other studies [Dale and Halden (1993), Kashyap and Stein (1993,1997) , Oliner and Rudebusch (1995,1996), Ageloni *et al*. (1995), Gavely and Salmon (1997),, The Bank of Korea (1998), Favero *et al*. (1999), Dedole and Lippi (2000), Asheraft (2001), Gambacorta (2001), Ageloni *et al*. (2001), Brissimi *et al*. (2001), Hann (2001) Kalckrenth (2001), Lunnemann and Matha (2001), Caversoglu (2002), Casuso (2004), Casuso (2004)] attempted to discover the mechanism through which the credit channel works. They used disaggregated data on firms [Oliner and Rudebusch (1995,1996), Gavely and Salmon (1997), Dedole and Lippi (2000), Chatelain and Timo (2001), Kalckrenth (2001), Lunnemann and Matha (2001)] and banks [Dale and Halden (1993), Kashyap and Stein (1997), The Bank of Korea (1998), Favero *et al*. (1999), Asheraft (2001), Gambacorta (2001), Ageloni *et al*. (2001) Hann (2001), Caversoglu (2002), Casuso (2004)] and tried to investigate how the heterogeneous nature of firms/banking system affects the credit channel.

Most of these studies confirm the importance of broader credit channel of a monetary policy. Dale and Halden (1993) find that sectoral measure of money and credit provides more accurate and timely signal of future movements in inflation. Kashyap and Stein (1993) discover that tighter monetary policy leads to a shift in firms' mix of external finances whereby the commercial paper issuance grows while bank loans decline. They concluded that contractionary policy shrinks loan supply, influences investment, interest rate and real output. Oliner and Rudebusch (1995) find evidence consistent with a broader view of the credit channel that underlines the information asymmetries faced by all lenders. Gertler and Gilchrist (1995) argue that the credit market's imperfections facilitate in propagating the impact of monetary policy. Ageloni *et al*. (1995) results also support the credit view of monetary policy transmission. They find that following a negative monetary shock, the spread between loan rates and bond market rates widen in all bank groups and it increases with bank size increase, and that large banks respond more promptly to monetary shocks than do smaller banks. Wright, J. (1997) finds that credit frictions amplify monetary shocks by shifting resources away from small firms where there is a monetary tightening, and not by affecting the ability of financial intermediaries to lend to such firms. Gavely and Salmon (1997) indicate that industries showing large sensitivity of output to changes in monetary conditions are made up of relatively small firms, which means that credit market imperfection may play a role in transmission of monetary policy changes. The Bank of Korea (1998) presents a survey of studies analyzing the existence of bank lending channel in transmission of monetary policy in Korea. The main finding is that loan shrinks among smaller banks more in the wake of monetary contraction, and these banks attract external financing at a rather high interest cost. This implies that decline in credit allocated to bank-dependent borrower is disproportionate. Dedole and Lippi (2000) analysis reveals that the impact of monetary policy is stronger in industries that produced durable goods with greater financing requirements and a smaller borrowing capacity. Favero *et al*. (1999) conclude, however, that the largest banks use their strength to contract the effect of monetary restrictions while the smallest ones react by expanding their loans portfolio which conflicts with prediction of the credit channel. Ageloni *et al*. (2001) argued that the role of credit channel varies from country to country and is perhaps smaller than might be expected considering the dominant role of banks as provider of credit in the euro-area. Caversoglu (2002) found no evidence on the existence of bank lending channel in Turkish economy.

Exchange rate channel

The studies that extended their analysis to open economy suggest a strong role of exchange rate in the effectiveness of a monetary policy. Piere Deguay (1994) laid emphasis on the transmission mechanism through interest and exchange rates rather than through change in monetary aggregates. Lopes (1998) argued that the high inflation significantly reduces the effectiveness of interest rate channel as well as wealth and credit channels making monetary policy ineffective. The reason for inefficiency of interest rate channel in the context of high inflation is that monetary policy cannot easily control the direction of real interest rate owing to the existence of high volatility premium in the agent's expectations. The wealth channel is ineffective due to the absence of long-term debt instrument in a high inflation economy. This also makes the balance sheet channel less effective. The use of the bank lending demand is also rather limited because credit offering is not an important source of revenue in the context of high inflation. The only channel through which a monetary policy can initially operate in a high inflation economy is the exchange rate channel. Dovciak (1999) finds that the interest rate channel is not important, as there is a slow response of money market interest rates to policy change. The study finds that the exchange rate channel is important. The study concludes that the slow responsiveness of variables influencing the non-financial sector stems from the low competition in the banking sector and limited number of alternative sources of finance in Slovakia. Peersman and Smets (2001) argued that a temporary rise in nominal or real short-term interest rate tends to be followed by a real appreciation of exchange rate and a temporary decline in output. Lyzaik (2001) suggest that the exchange rate channel constitutes the only mechanism through which monetary policy influences inflation following the shock. Kuijs (2002), shows that the main direct determinants of inflation are exchange rate and aggregated demand. There is no direct effect of interest rate on inflation. Cumungharn (2002) finds that marginal effects of interest rate and exchange rate on output are fairly equal. Citu (2003) finds that investment responses are stronger than expected to a surprise change in monetary policy. Exchange rate channel plays an important role in Transmission of monetary policy changes in New Zealand and in explaining the deviation of real GDP from trend. Martinez *et al*. (2000) finds that there has been a high pass-through of changes in exchange rate to prices in Mexico, but this phenomenon is decreasing. As for the credit channel goes, they find that interest rate significantly influences the lending-deposit rate spread, which in turn has a significant impact on output. Besides, they find that alternative credit mechanisms are also negatively influenced by monetary contraction. This suggests that interest rate negatively influences the amount of credit in the economy despite the limited amount of bank credit in Mexico.

Chiades and Gambacarta (2000) suggest that, in short run, monetary policy shocks are diffused into the economy through both money and credit channels, while an "exchange rate puzzle" arises, since the exchange rate does not respond to the interest rate shocks. As to the long run, the results confirm the neutrality hypothesis. The authors also find that bank lending channel exerts greater influence on output than the money channel, however the converse is true as well when the effects on prices are considered.

Consumption-wealth channel

The studies investigating the role consumption-wealth channel are limited. Sgherri (2000) quantifies the total impact of temporary monetary shock on main GDP components, and the contribution of the various channels. He finds that interest sensitivity of consumption becomes significantly low when consumers 'excessively discount the future'. The study suggests that it is the direct channel (interest channel), which transmits most of the policy changes to real economy. Wealth effects are also found important. Roberts (2001) estimates wealth effect in several countries under different exchange regimes. Wealth effect is estimated for changes in target and indicator variables associated with monetary actions under different transmission models. On the one hand, the results indicate the existence of a significant wealth effect in all countries, especially when monetary aggregates are used as the indicators of a monetary policy. The results differ, on the other hand, across countries and exchange rate regimes based on the usage of short-run interest rate as the indicator of a monetary policy. Lettau *et al*. (2001) investigates the importance of the consumption-wealth linkage in transmitting a monetary policy to a real economy. The overall results provide little support for the view that the consumption-wealth channel is a dominant source of transmission of the monetary policy changes to consumption.

The empirical analysis on the role of other channels i.e. assets price and expectations channel are scanty because of the difficulties, such as data unavailability and the integration of these channels in a model, particularly the expectations channel.

2.3.2. Lags of Monetary Policy

Prior to 1960, the quantitative estimates of lags in effect of monetary policy were rare. Though there have always been disagreements on effectiveness of monetary policy. Numerous economists seem to accept the proposition that there was sufficient impact in short-run for a monetary policy to be used as a device for the economic stability. Although this view did not go unquestioned, the main challenge to conventional thinking came from Friedman (1961). He argued that given the state of our knowledge, we cannot hope to use monetary policy as a precision instrument to offset other short-run forces that contribute towards instability. Albeit the scarcity of knowledge, the attempt to accomplish such a task may cause additional instability into the economy, instead of stabilizing it. Using the US data from 1876 to 1960 on money, stock and income, he compares the peaks and troughs in money growth with corresponding peaks and troughs in the level of income. He finds that changes in money growth lead income i.e. the causality runs from money to income. He also finds that on the average of 18 cycles, peaks in the rate of change in money stock tend to precede the peaks in general business by 16 months and troughs in the rate of change in money stock precede the trough in general business by about 12 months. For the individual cycle, the recorded lead varies from 6 to 29 months for the peaks and around 4 to 22 months for the troughs. Tanner (1979) using the US quarterly data from 1953 to 1974 finds the evidence pertaining to the existence of long lags. He also finds that lags are different for different policies, over different time periods and over the business cycles. The evidence indicates significant lengthening of the lag over time. Moreover, the lags tend to lengthen in response to a recession as well as a tight monetary policy during a recession, the lags frequently become so long that expansionary monetary policy does not exert a positive effect for at least eight quarters. The variables used in the study are change in the stock of money and change in GNP. Gruen *et al*. (1997) examines the existence of lags and finds strong evidence that the level of short-term real interest rate has sizable and statistically significant impact on output. Their results do not suggest any shortening in the lags. Batini and Nelson (2002) confirm Friedman (1972) on finding of a one-three year lag between money growth and inflation. They suggest based on the US data that money leads inflation by once a year. Nachane and Lakshmi (2002) use the concepts of causal lags and causal coherency introduced by Granger (1964) to study the impact of monetary policy on output and prices using the Indian monthly data from 1977 to 1997. The empirical results show that the monetary policy affects output as well as inflation and the lags in two cases are likely to differ. They also find that the monetary policy lags have been shorter rather than otherwise. They find that M_1 is more proactive and potent measure with pronounced impact on output. The role of M_3 has been largely accommodative so far as output is concerned though it does seem to exercise a direct influence on prices. In Pakistan, like many developing economies, the switch from a regulated economy to a market-oriented one started to take place in the early 1990s. The reforms include: the privatization of the nationalized commercial banks, the auction of government debt, the replacement of credit ceiling with open market operations (OMO), the removal of maximum limit on lending rate. However, the most significant reform, in the context of monetary policy, has been the autonomy of the State Bank of Pakistan (though limited in nature).

Despite the reform initiatives, the developing countries, in contrast to advance economies, still have a fragile economic structure, under-developed financial markets, and a low level of the central bank independence, credibility, and transparency. In such a situation, the influence of monetary instruments on the real sector becomes unpredictable (Aslanidi, 2007). In order to design and implement, therefore, a prudent monetary policy that would ensure stability (price or output or both) in these countries, the knowledge about the working of the monetary transmission mechanism is essential. Such knowledge turns out to be instrumental in understanding the linkages between the financial and real sectors and figuring out as how decisions of the monetary authorities affect the final goals. However, the linkages between financial and real sectors can be of different strengths depending on the state of the economy.

The strength and importance of monetary transmission channels may differ across countries due to differences in the extent of financial intermediation, the development of capital markets, and structural economic conditions (Checetti 1999). It is the financial system's depth, breadth, and structure that determine the link between the monetary policy instruments and the variables that drive the conditions in the non financial sector (Noris and

Floerkemeier, 2006). The macroeconomic conditions and structural features of the economy, in turn, determine the link between financial conditions and spending/investment decisions among different agents (Creel and Levasseur, 2005).

The empirical evidence suggests that the interest rate channel is the most important transmission channel in industrial countries with developed financial markets, while the exchange rate channel has dominance in transitional economies (Coricelli, Egert, and MacDonald, 2005). Similarly, the exchange rate channel is more influential in small open (developing) economies with flexible exchange rates (Noris and Floerkemeier, 2006). Interest rate, credit, balance sheet, and asset price channels remain largely ineffective on the face of underdeveloped financial intermediation and rudimentary capital markets as well as the presence of non-bank financial institutions. Furthermore, the effectiveness of the exchange rate channel is strengthened because it affects both the aggregate demand and the aggregate supply through the cost structure (Juks, 2004).

Since the working of monetary transmission in developed and developing economies is different, the model used to analyze the operation of monetary channels of developed economies may not be relevant for developing economies., A model is required, therefore, that allows for an investigation into the monetary transmission mechanism in developing countries and which can be applied to Pakistan as well. Such a model would help in investigating the real effects of a monetary policy. The model would also facilitate the formulation of an appropriate monetary policy in Pakistan — a small open economy vulnerable to external shocks.

Most of the studies reviewed analyze the transmission mechanism in developed countries. Besides, the methodologies used in these studies are not appropriate for providing evidence in regards to the strength of different channels, as no effort has been made to address the problem of inter-relationships among the independent variables. In many of the studies, the impulse response functions are used for dynamic relationship between the variables. In case of reduced form VARs, the impulse responses are linear combinations of structural shocks. Hence it is not appropriate to use impulse response functions for dynamic relationship between the variables. However, if we orthoganilize the shocks by using the recursive Choleski decomposition or by employing the exclusion restrictions used by Bernanke, for example, then the structural shocks have some meaning, but of course, only under the identification assumptions. Thus structural VARS, as opposed to reduced-form VARs, do embed the identification assumptions, and the impulses do have economic meaning. But the problem here is whether the right identification restrictions have been imposed, i.e. whether these make sense and are plausible or not.

Besides the problems mentioned above, the proper account is not taken for delays in and the distribution of effects of policy shocks on output and inflation in the studies conducted so far. Most of the studies do not test for the time series properties of the data.

The studies investigating the transmission mechanism and lags involved in the process of transmission of the monetary policy are scant for Pakistan. The only study on the transmission mechanism for Pakistan is carried out by Ahmed et al. (2005). The study, covering the period from July 1996 to March 2004, uses VAR methodology with six lags only, which we think are too little, especially for monthly data of this kind. Furthermore, VAR and hence impulse response function are very sensitive to the ordering of variables. Another issue pertains to identifying restrictions. In an ideal situation, the identifying restrictions come from the fully specified macroeconomic model. In practice, this is rare and the common approach is to impose a set of identification restrictions that are consistent with the economic theory. However, imposing restrictions, consistent with the economic theory, is typically not different from other specification methods. Besides, Ahmed's use of KSE index as proxy for assets price may not be appropriate because the index is very volatile as well as sensitive to speculation and it can be manipulated by the big players. Ahmed et. al employ impulse responses to investigate the response of different shock variables to a particular variable (policy instrument). But this approach does not identify the exact lags and strength with which a variable responds to policy changes. In addition, it authors the estimate model with and without a particular channel and then compares the results to test the significance of that specific channel. We feel that the concurrent operation (while including the channel) of different channels and the model specification (due to excluding that channel) makes the approach inappropriate. Furthermore, the time span covered (July1996-March 2004) is too short for such an analysis. Lastly, as Pakistan is a small open economy vulnerable to external shocks, therefore, external variables should be essential part of the kind of study referred above. This is not the case of the aforementioned study..

We, in this study, have used an alternative methodology (i.e. transfer function approach), which is capable of addressing most of the issues raised above as well as in chapter one. Besides, we have included external variables to take in to account the impact of external shocks to the economy.

The main objectives of this study are to determine:

1. The relevance of different policy measures in designing the monetary policy;
2. The effectiveness of a monetary policy in achieving macroeconomic goals of the policy;

3. The importance of different channels of monetary transmission mechanism;
4. Lags involved in transmission of monetary changes through different channels[2].
5. The extent to which Pakistan's small open economy is affected by the external shocks

2.4 Conclusions

In this chapter, we reviewed theoretical as well as empirical studies on transmission channels of monetary policy and lags involved in transmission of monetary changes through these channels. It needs no emphasis that the knowledge of transmission mechanism is essential for conducting monetary policy effectively. To achieve the objectives of a monetary policy i.e. price stability and stable output growth, the policy makers must be aware of the timing and magnitude of the impact of monetary changes on real economy. In traditional literature, the interest rate channel was considered to be the sole channel of monetary policy. But the recognition that the macroeconomic response to a policy-induced interest rate change is considerably larger than that implied by conventional estimates of the interest elasticity of consumption and investment, induced the idea that the mechanism other than the narrow interest rate channels may also be at work in transmission of monetary changes. Besides the interest rate channel, the channels identified in the literature include: the credit channel, the exchange rate channel, the asset prices channel, the consumption wealth channel and the expectations channel. Another important aspect in the analysis of transmission mechanism is the lags involved in this process.

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[2] With simple mathematical manipulation, lags can be translated into leads that may help in designing a monetary policy.

There is a huge theoretical literature on the monetary transmission mechanism and empirical studies that test for the existence of different channels. However, there are only a few studies on lags in effects of monetary policy. These studies use various techniques, different variables and different types of data. Single countries as well as group of countries are considered in these studies.

Most of the studies focus on the existence of credit cannel. These studies use macro-level data as well as micro-data on banks and firms. The evidence on this channel is mixed. A few studies test the role of wealth, the consumption channel and the exchange rate channel. All the studies on the exchange rate find evidence on existence of this channel. Some studies investigate the role of more than one channel.

Mostly the Vector Auto Regressive (VAR) methodology is employed. However, other techniques, such as Generalized Method of Moments (GMM), Ordinary Least Square (OLS), Auto Regressive Distributed Lags (ADL), Events study, Two Stage Least Square (2SLS), and Error Correction Model(ECM) have also been used.

3 Monetary Policy in Pakistan

A monetary policy performs many functions in a given economy, such as regulation of quantity, cost, and distribution of money and credit to different sectors of the economy. Currently, the monetary policy is considered an important instrument for stabilization of policies, which includes price stability and stabilization of output. The price stability aspect is regarded as the most important aspect of monetary policy goals in most of the economies around the world, but the output stabilization is also considered quite important. Monetary policy, however, is a complicated process for it requires constant revision and seasonal adjustments to meet the changing economic needs. Any miscalculation can obviously create complications. The management of monetary policy in most countries is market-based since the central bank attempts to achieve a target interest rate by influencing the market forces, but the authorities do not directly fix the interest rate. The economies practicing very successful monetary policy are the ones that adhere to the laws of the land as well as uphold the independence of their central bank. In such economies, the governments only set targets for monetary policy and outcomes and consequences are then left to the market to determine.

In Pakistan, however, the case is different since its monetary policy until 1991 has been predominantly influenced by the government. The government borrowed from the State Bank at a rate of 0.5 percent per annum. The commercial banks owned by the government were required to invest 30-35 percent of their demand and time liabilities in government Paper. The paper carried an arbitrarily fixed return of 6 percent per annum. Given this background, one can safely say that the monetary policy was subservient to its fiscal policy, the central bank was not independent and markets were not allowed to play an influential role till the early 90s.

3.1. Historical Overview of Monetary Policy in Pakistan

In Pakistan, like many other developing economies, the switch from a regulated economy to a market-oriented one started to take place in the early1990s. The reforms include: the privatization of nationalized commercial banks, the auction of government debt, the replacement of credit ceiling with open market operations (OMO) and the removal of the maximum limit on lending rate. However, the most significant reform in the context of a monetary policy has been the autonomy of the State Bank of Pakistan (though limited in nature). A brief history of major developments that took place during 1992 - 2008 is provided in the forthcoming paragraphs.

Before 1991, the government's debt management program was considered to be a loosely managed and highly unorganized system based on ad-hoc treasury bills and readily refinanced non-marketable long-term papers. In 1972, the national credit consultative council (NCCC) was established with the main responsibility of the distribution of credit in the economy, especially to improve the availability to less developed sectors of the economy. The main mechanism of the monetary policy and management between 1972 and 1991 was the control of volume, cost, and the allocation of credit. The fiscal requirements of the government determined as to how the government would manage its credit and debt policy for the year. The government used to borrow from the State Bank by selling its ad-hoc T. Bills at a rate of return of 6.0 percent per annum. The commercial banks had to invest at least 30-35 percent of their demand and time deposits in the government papers. However, the monetary policy has been successful in maintaining growth and price stability during the period (Zaidi, 2005). The government's economic growth strategy was based on controlling interest rate, directing credit to priority sectors, and obtaining cheep credit from the banking sector for budgetary sport. The growth rate of GDP averaged 4.8 percent during the 70s rising to 6.5 percent across the 80s. The inflation rate was more than 12.0 percent in the 70s (largely due to factors out of the government control such as of oil prices and failure of crops). The inflation rate, however, fell to 7.3 percent in the 80s. The critics (Khan and Mahmood, 1995), nevertheless, attributed numerous problems and consequences to the old monetary structure. These include excess liquidity problem, non-performing loans on political and uneconomic grounds, undermining of the SBP targets by the non-bank financial institutions, and the segmentation of financial market owing to high interest rate on the government saving instruments etc.

In the 1990s, the financial sector reforms were initiated with the objective of transforming the financial structure from a controlled to a market based system. Though the government started auction of T-Bills in 1988, but this did not cast much impact on the money market, because the amount auctioned was small and the rate of return was low as compared to the national saving scheme. In 1991, the government started a full-fledged system of the auction of the government debt and allowed the rate of return on T. Bills to rise from 6.0 percent to 13.0 percent. The federal investment bonds with maturity of three, five, and ten years were introduced as a long-term instrument. In 1992, the system of credit ceiling was replaced by credit to deposits ratio (CDR) and the open market operations (OMO). From 1995, OMOs become the major instrument of monetary management (SBP 2000). Another important reform undertaken in 1995 was the removal of the maximum lending rate charged by the banks. This step is considered an important move towards making money and credit policy more market oriented as commercial banks can now charge any rate they want and their clients agree to. The CDR was abolished in 1995 to make the structure of the credit availability in the economy fully market based. Some other measures taken to reform the financial sector are discussed below.

The banking sector was opened to the private sector with fresh licenses to 10 local sponsors and 3 foreign banks in 1991. Besides, in the same year, the privatization of public sector banks was initiated with the privatization of the Muslim commercial bank (MCB) to be followed by the privatization of Allied Bank (ALB) in 1992.

The government extended the supervisory jurisdiction of the SBP to non-bank financial institutions (NBFIs) in 1992. These include leasing companies, investment banks, and housing finance companies. SBP issued prudential regulations for the banks, which cover various aspects of the operations of commercial banks. The main objective of the regulation is to ensure the financial soundness of the banks. The State bank of Pakistan was granted some autonomy in 1994, which was strengthened in 1997 with the issuance of three more ordinances. In 1995, all NBFIs and subsequently in year 2000 all commercial banks were required to have themselves credit rated by a rating agency approved by the SBP. In 1997, banks were asked to apply the system of risk-weighted capital in the line with Basel accord, whereby banks are required to maintain unencumbered capital and general reserves of not less then 8% of risk their weighted assets. The public sector banks and the domestic financial institutions were facilitated towards restructuring and downsizing their organizations to reduce the intermediation cost, while their loss-making branches were closed.

Numerous efforts were made to improve the financial health of the banks. These include requiring the banks to lay down a quarterly recovery as well as the periodic monitoring of recovery against targets. Banks were also asked to provide for their non-performing loans. In order for providing the necessary legal framework for expediting the recovery of the stuck-up loans, suitable amendments were made in the concerned laws in 1997. The same year banking courts were established and two separate incentive schemes were introduced to provide opportunities to loan defaulters to pay their overdue loans and reschedule/ regularize their remaining amounts. Finally, the non-performing loans of public sector banks and NBFIs were transferred to corporate and industrial restructuring corporation (CRIC) that was specifically established in year 2000 for this purpose.

In the 1990, a securities department was set up in the SBP to launch an auction system of public debt and to develop a secondary market for the government securities. A foreign exchange dealing room was set up in 1998. These measures eventually evolved into an exchange and the debt management department in 2000. The sale of all types of bearer instrument was discontinued in 1999.

The statutory liquidity reserve (SLR) requirement was significantly reduced in the early 90s and it has remained in the range 0f 15-20 percent including a cash reserve requirement of 4-7 percent. The NBFIs, which was earlier exempted from maintaining an SLR, was also asked in 1992 to maintain it so that the monetary targets are not defeated.

As a part of the liberalization of the foreign exchange regime initiated in 1991, the resident Pakistanis like non-residents were allowed to open foreign currency accounts in banks in Pakistan. Besides, the authorized dealers designated by foreign companies were allowed to remit profits abroad without the approval of the SBP. In 1988, the managed float was initially replaced with the dual exchange rate system based on a composite rate that gave a significant recognition to the prevalent rate in the open market. Later in 1999, the SBP stopped the practice of announcing the official rate. Now, the rate prevalent in the inter-bank market determined on the basis of market forces, is accepted as the official rate

In 1984, the Pakistan credit rating agency limited (PACRA) was set up to improve transparency in the stock market. In 1997, the central depository company of Pakistan limited was set up to facilitate the electronic transfer of stock. The Securities and Exchange Commission of Pakistan (SECP) was established in 1999 through SECP act, 1997, replacing the Corporate Law Authority (CLA).

To ensure the capital adequacy of banks, the SBP raised minimum paid-up capital requirements for banks from Rs. 500 millions to Rs.750 millions in 2002 and to Rs.1000 millions in 2003, to Rs.1.5 billions in 2004 and to Rs.2.0 billions in 2005. Currently, the minimum paid up capital requirement is Rs. 6.0 billions. Besides, amendments in banking company's ordinance, 1962 and income tax ordinance, 2001 were made. These measures facilitated the merger and acquisition (M&A) of many banks and non-bank financial institutions. Around 29 cases of M&A, of which seven were acquisitions and 22 mergers, have been observed during 2000-2006. Consequently, the number of banks was reduced from 46 in 1997 to 39 in 2006.

In 2004, an international accord - Basel II to which Pakistan is a signatory, was finalized. The accord provides a framework towards more risk sensitive new capital adequacy, which provided a framework for capital allocation that is more risk sensitive as compared to Basel I, the accord became operative on January 01, 2008.

in 2006, banks and DFIs were directed to use KIBOR as a benchmark for determining pricing of all rupee corporate/commercial bank lending, this was to make pricing loan system more transparent and consistent,. Same year, the statutory reserve requirement was set at 18% of total time and demand liabilities.

The SBP lowered the interest rate from 14% in 2001-02 to 7.5% in 2002-03, mainly to bring the stability in exchange rate and stimulate the economic growth, mainly through the private sector. The SBP kept the interest rate low during 2003-04 and did not make changes in the CRR or SLR requirements. The CRR and SLR have remained unchanged during 2002-04. This was meant to pursue an easy monetary policy initiated in 2002. In 2004, all the commercial banks were directed to link their lending rates with one, three, six months & any other longer period tenors of Karachi Inter-Bank Offered Rate (KIBOR). SLR, for DFIs, was fixed at 15 percent of the total Time & Demand Liabilities in the form of liquid assets. In addition, they were to continue maintaining Cash Reserve (CRR) with the SBP at 1 percent of their Demand & Time Liabilities. In 2005, the SBP allowed domestic banks to open their branches abroad. The same year, the SBP decided to adopt the Basel II in Pakistan.

The country moved to floating Exchange rate regime in 1999. The exchange rate had always been on the depreciation course since Pakistan adopted the managed float exchange regime in 1992. After reaching a peak level in 2001, some appreciation was registered due to favorable developments vis-à-vis external account in the aftermath of 9/11. The favorable developments included the increase in remittances and the US financial aid to Pakistan for being an ally in the war on terrorism. These factors helped in accumulation of the foreign reserves and stabilized the exchange rate. But the recent increase in oil and food prices in the international market has contributed to a huge current account deficit that has caused the exchange to depreciate. To arrest the depreciation of the exchange rate, the SBP has taken various measures, including the imposition of cash margin on the import of some of the commodities and restraining the exchange companies from exporting the foreign currency for capital transactions abroad. These measures helped to lessen the pressure on the Pak Rupee.

Earlier in 2007, the anti-money laundering ordinance was promulgated to prevent the use of the banking channel for the purpose of money laundering.

The SBP continued the tight policy it was pursuing since 2005 due to upsurge in the inflationary pressure. The interest rate as well as reserve requirement by the banking system was increased. The interest rate was first raised by 50 basis points to 10% in August 2007. However, due to the high demand pressure, the SBP increased the rate by another 50 basis points again and cash reserve requirement by 100 basis points in February 2008. Given the unprecedented inflation hikes mainly due to high oil and food prices in the international market besides high government budgetary borrowing from the central bank, the SBP took further tightening measures in May 2008

3.2. Money Supply

The State bank of Pakistan, with its establishment in 1948, fixed the bank rate at 3% to encourage the credit expansion in the economy. The main objective, at that time, was the establishment of an industrial set up and expansion of commerce in the economy with almost non-existent industrial base. The cash reserve requirement ratio was fixed at 5%, while the liquidity ratio was fixed at 20%.

In 1949-50, the money supply stood at 3266.10 millions, which with an increase of 14%, rose to 3737.90 millions in 1950-51. For the next 15 years or so the supply grew at an average of around 14 percent except for a few outliers. For example, in 1951-52 the trade account turned into surplus with cotton export boom due to the Korean War. The money supply growth in this year was contained at mere 3 percent. When the Pak-Rupee was devalued for the first time in 1956, the money supply growth was kept down.

In May1972 the Pak Rupee was devalued 131%. The devaluation did not work well to stop the rising general price level because its favorable impact on exports was more than offset shortly due to oil shock of 1973. The growth rate of money supply during the 70s fluctuated around 20 percent on the average. During the late 70s, the growth rate of money supply ranged between 22-25 percent. This remained the trend despite the increase in bank rate initially to 6 percent in 1972 and then to 10 percent in 1977, increase in liquidity ratio to 35 percent by 1973 and the introduction of credit ceilings in 1973—all directed towards containing the growth of money supply.

All the scheduled banks were nationalized in 1974 to break up the concentration of the financial power. The Pakistan banking council was set up to coordinate banking activities and analyzes the balance sheet of the banks.

The money supply growth fell down to 7.7% in 1974-75 due to strict control. The bank rate was raised to 10% in 1977 and the growth rate of money supply remained high (between 22% and 25%) during the late 1970s (from 1975-76 to1978-79). In 1980, however, it came down to 17.6%. The floating exchange rate was introduced in 1982, which caused the reduction in the trade deficit, but the money supply growth jumped to 25.3% in 1982-83. This high growth was mainly due to expansion of the credit to government and the high growth of time deposits. The state bank, with floating exchange rate, could not insulate the economy from the effect of depreciated value net foreign reserves. As a result, the money supply fell to 11.8% in1983-84. The growth rate money supply was between 12% and 14% for the next four years. The money supply growth, however, touched an alarming 28.13% in 1991-92 due to floods. The financial sector reforms were initiated in 1991as discussed earlier.

During 1992-93, the credit deposit ratio was introduced as an instrument to control the private sector credit of commercial banks replacing the credit ceilings. The effort was made to ensure the adequate flow of credit to private sector for productive activities in general and priority sector in particular. The monetary expansion was 17.8%. The expansion was accounted for by both government borrowing for budgetary support and the credit extended to private sector. The inflation rate remained essentially unchanged during 1992-93.

The domestic credit expanded in 1993-94 to accommodate the government borrowing for deficit financing. This loose policy also generated pressure on prices to increase and excess liquidity posed a serious threat to the balance of payments. A tighter monetary policy, therefore, was pursued in 1993-94. The growth of money was 18.1%. The discount rate of SBP was increased from 15% to 17%. There was an upward pressure on inflation due to expansionary monetary and fiscal policies and depreciation of the exchange rate followed in previous years. The Pak Rupee was depreciated 5% during 1994.

In 1994-95, there was a move towards adopting indirect monetary controls and market based instrument of monetary management. The structure of interest rate underwent changes, the wedge between maximum and minimum lending rate was reduced to eliminate the distorting impacts. The reserve requirements of scheduled banks and the rupee rate were increased to regulate the liquidity in the economy. The growth rate of money supply was 17.2% and inflation was 13.02%. The main reasons for the higher inflation: the low agriculture production, the high international commodity prices (edible oil), and the support prices of agriculture crops.

In 1995-96, a tight monetary policy was persuaded, the monetary expansion was13.8% and the inflation rate was 10.79% and the credit expansion was lower than the previous year. This tight monetary policy continued to be persuading till 1998-1999 due to inflationary pressure built during the early 1990s. The inflation remained at double digit level till 1996-97, which had daunted affects on the economy, but it was brought down to 7.8% in 1997-98 and was further reduced to 6.1% in 1998-1999. The domestic credit expanded a great deal between1993 and 1998 with private sector credit taking lead but slowed down after that.

The financial year 1999-2000 witnessed further reduction in the interest rate, the growth rate of money supply was with in credit plan target, though higher than previous year. Notwithstanding an easy monetary policy, the credit to private sector did not increase. The interest rate was low even though the government borrowing increased, it was caused by the government borrowing that shifted from the scheduled banks to the SBP, and hence there was a downward pressure on T. Bill rate. The exchange rate remained low and the return on foreign currency account was low, therefore the domestic dollarization took place in 1999-2000. Though there was no inflationary pressure but was a shift toward demand deposit and currency in circulation.

The growth rate of money supply slowed down in 2000-01 and the growth of currency in circulation also started to taper, but the growth of the bank deposits remained high. This was a difficult time for the monetary management due to structural changes in the exchange rate regime, the need to increase liquid foreign assets, and increasing interest rate. However, the expansion in credit to private sector, in spite of a high interest rate and a shift of government borrowing to commercial banks, helped the SBP in mitigating these challenges.

The monetary policy was accommodating in 2001-02 and the growth rate of the money supply was 14.8%, the highest in the last five years. This was because of the enhanced ability of the SBP to implement the easy monetary policy due to macroeconomic discipline in the previous year. The excess liquidity due to increase in foreign purchases of the the SBP resulted into a shift in public debt (borrowing from the scheduled banks rose sharply at the cost of borrowing from the SBP) without increase in interest rate. The credit to private sector, however, declined in 2001-02.

As the private sector credit was low in 2001-02, therefore, the SBP chose to increase the market liquidity by reducing the sterilization of its rising forex market purchases. As a result, the domestic interest rate plunged to an all time low. This quoted a revival of economic activity and the expansion of private sector credit took place. The financial year 2002-03 witnessed a strong growth of 18% in the money supply, the SBP continued its accommodating monetary policy in 2003-04 and the money supply growth rate rose to 19.6%, the highest in last 12 years. This easy monetary stance was successful in inducing a massive increase in the aggregate demand, deriving the GDP growth over 6% for the first time since 1995-96. However, the increase in the inflation rate (mostly due to food and oil prices) and the exchange rate pressure became a source of concern. The SBP, therefore, began a gradual tightening of the monetary policy by influencing an upward movement in the interest rate, moving the interest rate steadily upwards.

The monetary policy was switched to an aggressive tightening in 2004-05 from a broadly accommodative stance for the last three years. Though there was a gradual increase in the interest rate in 2004-05 for addressing the inflation, but the SBP was still more concerned about the economic growth, which was steadily gaining a momentum. The SBP, however, raised the interest rate by 150 basis points as a corrective measure to divide the overheating of the economy as singled by the continued hike in oil and food prices. The growth of the money supply declined to 14.5% in 2004-05. Even the aggressive tightening, however, could not ensure the containing of inflationary pressure given the carry forward liquidity over hanged for the preceding three years and the persistent fluctuation in the international oil prices. The growth rate of monetary aggregate was 16.9% in 2006-07, while it was 14% in 2007-08. The SBP continued tight policy while increasing the interest rate as well as the reserve requirement by the banking system.

3.3. Inflation

The inflation rate was well under control in the 1950s i.e. the annual average rate was 2.12 percent. The inflation rate remained around this level even in the first half of the 60s. However, the general price level increased significantly in 1966-67 and the inflation rate touched 8.58 percent. The increasing inflation rate followed the growth in the money supply in 1965-66 due to large scale deficit financing for addressing the defense expenditure required for the 1965 war. However, despite the staggering defense expenditure, the inflation rate averaged 3.35% in the 60s.

The rate of inflation began to rise rapidly following the hike in oil prices in 1972. Despite the devaluation of Pak rupee, the balance of payment deficit continued to grow. In 1973-74, the public investment expenditure was increased significantly. The increase was mainly financed through foreign aid flows and large-scale deficit financing. Owing to this unhealthy trend, the inflation rate rose to 30 percent in 1973-74 and remained high i.e. 26.71% in 1974-75. However, it came down to 11.675 in 1975-76 due to the improved growth rate of commodity producing sector. The overall inflation rate was 13.6% between 1969-70 and 1974-75. The rate was brought down to 8.975 during the second half of the 1970s because of the controlled growth rate of the money supply.

With the onset of the 1980s, however, the inflation rate began to rise again, and remained at 10% per annum from 1979-80 to 1981-82. This could partly be attributed to the world economic trend and partly to the revival of economic activities following the 1970s recession. The inflation rate, however, had declined to 4.59 percent, which was reasonably low. This was mainly due to the improvement in commodity producing sector and the reduction in public investment and expenditure. In 1988-89 the inflation increased suddenly 10.4 percent due to supply shock — the agricultural production fell because of the natural disasters, such as drought and floods etc. while the industrial production declined due to poor law and order situation in Karachi. However, the inflation rate declined to 6 percent in 1989-90. The overall inflation rate for the 80s averaged 6.6 percent to 7.8 percent for the first half of the decade and 6.4 during the second half. This rate was almost half the average rate (13 percent) for the 70s.

The inflationary pressure increased in the 90s due to expansionary monetary and fiscal policies, structural reforms, depreciation of Pak Rupee and the adverse weather conditions. The inflation remained in double digits till 96-97, but it started declining thereafter with the rate 6.6 percent and 7.8 percent in the next two years and reaching 3.6 by 98-99, the lowest level in three decades. Not only the inflation rate was low but its incidence on poorer group was lower than average (3.2 percent).

The price level remained subdued during the initial years of the current decade with inflation rate fluctuating between 3.1 - 4.4 percent in the first three years. The inflationary pressure became visible in 2003-04 when inflation rose to 4.6 percent and, then, suddenly jumped to 9.3 percent in 2004-05. Critics of the SBP lay the blame on loose monetary policy practiced by the SBP during the previous years, however, the contribution of supply side factors, such as the hike in oil prices cannot be ignored altogether. Since then, the SBP has somewhat tightened the policy stance, and resultantly the inflation declined to 7.9 percent in 2005-06 and it remained at 7.8 percent during the 2006-07, considerably higher than the 6.4 percent target for the year. Despite the tight monetary policy by the SBP, the inflationary pressure even increased further due to a a surge in global inflation, which hurt developing economies more as compared to developed one. The CPI inflation increased to 9.8% in 2007-08 from 7.8% in 2006-07. The food inflation was 15.8% in 2007-08, almost double than (8.1%) food inflation in 2006-07. The summery of the major developments of the monetary sector is given below:

Summary of the Major developments of the monetary sector and changes in monetary policy in Pakistan since 1972

year	Development	Objective(s)/Details
1972	National Credit Consulate Council (NCCC)	National Credit Consulate Council (NCCC) was established with main responsibility of distribution of credit in the economy especially to improve availability of credit to less developed sectors of the economy.
1980	Managed floating exchange rate	A first step to move from fixed exchange rate regime toward market based.
1984	PACRA was set up to	Provide rating of the corporate sector and thereby facilitate investors. .
1990	Financial Sector Reforms	Financial Sector Reforms were initiated with the objective of transforming the financial structure from regulated to a market based system.
1990	Securities department was set up	To launch an auction system of public debt and to develop a secondary market for government securities
1991	Banking sector was opened to the private owners	Banking sector was opened to the private sector with fresh licenses 10 local sponsors and 3 foreign banks in 1991. Besides, in the same year, the privatization of public sector banks was initiated with privatization of Muslim commercial bank (MCB) to be followed by privatization of Allied Bank (ALB) in 1992.
1992	Removal of Credit Ceiling	The System of Credit Ceiling was replaced by credit to deposits ratio (CDR) and open market operations (OMO).
1992	Extension of the supervisory jurisdiction of SBP to NBFIs.	The main objective of the regulation was to ensure financial soundness of .
1994	SBP Autonomy	State bank of Pakistan was granted some autonomy .it was an important development regarding the function of SBP.
1995	Removal of ceiling on. lending rate	This step is considered an important move toward making money and credit policy more market oriented as commercial banks can now charge any rate they want and their clients agree to.
1995	CDR was abolished	To make the structure of credit availability in the economy fully market based.

1997	Banking Courts were established	Banking courts were established and two separate incentive schemes were introduced to provide opportunities to loan defaulters to pay their overdue loans and reschedule/ regularize remaining amounts.
1997	Central Depository Company was set up	To facilitate electronic transfer of stock
1998	Foreign exchange dealing room was set up	These were merged and become exchange and debt management department in 2000. The sale of all types of bearer instrument was discontinued in 1999.
1999	Fully floating exchange rate	SBP stopped the practices of announcing the official rate and now the rate prevalent in the inter-bank market, determined on the basis of market forces, is accepted as the official rate.
1999	SECP was established	Securities and Exchange Commission of Pakistan (SECP) was established in 1999 through SECP act, 1997, replacing the Corporate Law Authority (CLA).
2000	CRIC was established	To take over the chronic non-performing loans of public sector banks and NBFIs .
2002	Minimum paid- up capital requirements Were raised from 500 million to 750 million.	To facilitate the merger and acquisition (M&A).
2002	The SBP lowered interest rate to 7.5%	To bring the stability in exchange rate and stimulate economic growth mainly through private sector
2002	Amendments in banking company's ordinance, 1962 and income tax ordinance, 2001 were made	To facilitate the merger and acquisition (M&A).
2003	Minimum paid- up capital requirements Were raised 1000 million.	To facilitate the merger and acquisition (M&A),
2004	Minimum paid- up capital requirements Were raised 1.5 billion.	To facilitate the merger and acquisition (M&A).
2005	Domestic banks were allowed to open their branches abroad	To make local banks more competent.
2005	Minimum paid- up capital requirements Were raised 2 billion.	To facilitate the merger and acquisition (M&A),
2006	Mergers and Acquisitions	Around 29 cases of M&A, of which seven were acquisitions and 22 were mergers, have been observed during 2000-2006. This reduced the number of banks from 46 in 1997 to 39 in 2006.
2007	Interest rate was raised by 50 basis points.	To reduce inflationary pressure that built up due to high oil and food prices in international market.
2007	Anti-money laundering ordinance was promulgated.	To prevent the use of banking channel for the purpose of money laundering.
2008	Interest rate was first raised by 50 basis points and then by 150 basis points.	To reduce inflationary pressure that built up due to high oil and food prices in international market.

Summary: Money Growth, Credit, and Inflation

Year	Money Growth%	Inflation Rate%	Credit Growth%	Year	Money Growth%	Inflation Rate%	Credit Growth%
1970	19.6	14.5	16	1995	17.2	13	20.5
1982	11.4	11.1	19.1	1996	13.8	10.8	15.9
1983	25.3	4.7	21.4	1997	12.2	11.8	14.3
1984	11.8	7.3	16.7	1998	14.5	7.8	12.4
1985	12.6	5.7	29.0	1999	6.2	5.7	11.3
1986	14.8	4.4	16.8	2000	9.4	3.6	14.2
1987	13.7	3.6	3.3	2001	9	4.4	7.3
1988	12.3	6.3	12.5	2002	15.4	3.5	5.3
1989	7.8	10.4	7.7	2003	18	3.1	24.3
1990	17.5	6	7.8	2004	19.3	4.6	35.2
1991	17.4	12.7	9.8	2005	14.5	9.3	14.8
1992	26.2	10.6	25.4	2006	15.2	7.9	25.0
1993	17.8	9.8	15	2007	16.9	7.8	17.3
1994	18.1	11.3	14.5				

Source: SBP.

Changes in Monetary Instrument in Pakistan (1991-2007)

No	Discount rate			CRR			SLR	
	Date	Change (Basis point)	Rate	Effective from	Percentage of demand and time liabilities		Effective from	Ratio in %
					Minimum	Weekly average		
1	04- 03- 99	-100	14.0	01-01-91	-	5.0	13-08-92	35
2	05- 19-99	-100	13.0	28-07-97	4.0	5.0	19-12-92	40
3	01- 05-00	100	11.0	22-06-98	-	3.75	27-10-93	30
4	09-19-00	100	12.0	05-09-99	4.0	5.0	01-03-94	25
5	10- 05-00	100	13.0	19-05-99	2.5	3.5	28-05-97	20
6	06- 07-01	100	14.0	12-07-99	4.0	5.0	02-01-98	18
7	07-19-01	-100	13.0	07-10-00	6.0	7.0	22-06-98	15
8	08-17-01	-100	12.0	16-12-00	4.0	5.0	19-05-99	13
9	10- 02-01	-200	10.0	30-12-01	3.0	5.0	12-07-99	15
10	01-23-02	-100	9.0	06-01-01	4.0	5.0	22-07-06	18
13	11-18-02	-150	7.5	05-01-06	4.0	5.0		
14	04-11-05	150	9.0	22-07-06	4.0	7.0		
15	07-22-06	50	9.5					
16	08- 01-07	50	10.0					

Source: Qayyum (unpublished paper 2007)

4 Model, Methodology and Data[3]

4.1. Introduction:

In Pakistan, as in most other developing economies, the effectiveness of the monetary transmission channel is constrained by a number of factors: among the factors that impede the transmission of monetary impulses, the most important one pertains to spending and investment decisions that appear to be insensitive to the availability and cost of credit (see Khan and Khan, 2007). This trend seriously hampers the effectiveness of a monetary policy. Besides, the high domestic and international debt and consistently high budget deficits remain central issues in Pakistan's (Khalid, 2005). In such a situation, the ability of the monetary authority to control inflation is drastically reduced (Sargent and Wallace, 1981).

As discussed earlier in the chapter 2, the interest rate channel works through the influence of real interest rate changes on the aggregate demand. In the traditional Keynesian view, the monetary policy can influence the real cost of borrowing by setting nominal short-term interest rates. In the presence of price rigidities, the change in the nominal interest rate leads to a corresponding change in the real interest rate, which impacts business, housing, and inventory investment as well as spending on consumer durable spending. Aggregate demand in Pakistan responds very little to changes in the interest rate [for example see Khan and Khan, (2007)]. The market segmentation, together with a low degree of competition between banks, may also lower the interest rate elasticity of demand for deposits and loans. This factor is evident through the high and persistent banking spread despite reductions in real interest rates (Khawaja and Din, 2007).

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[3] In this chapter we make liberal use of Box-Jenkins(1976),Enders(1995), and Muller and Wei (1994)

The credit channel operates as an accelerator of monetary policy transmission. The monetary policy affects real economy through this channel indirectly. There are two different approaches to defining the credit channel of monetary transmission i.e. bank lending channel and balance sheet channel. The bank lending channel operates via the influence of monetary policy on the supply of bank loans that is, the quantity rather than the price of credit. A contractile monetary shock reduces the bank reserves and, therefore, the total amount of the bank credit available, leading to a fall in investment by the bank-dependent borrowers and possibly in consumer spending. For the bank lending channel to work, a monetary policy tightening must effectively limit banks' ability to supply loans by reducing the bank reserves. The necessary condition for the bank lending channel is the lack of substitutes, such as the government bonds for deposit liabilities and for bank credit [Walsh, (1998)]. Ahmed *et al in* (2005) shows that the role of bank lending in Pakistan is prominent because of the lack of non-bank sources of finance. Actually, the channel is based on the dual nature of banks as holders of deposits and as sources of loans [Bernanke and Blinder, (1988)]. Due to a growing banking infrastructure, the credit channel may matter in the monetary transmission in a country like Pakistan. The balance sheet channel is based on the notion of asymmetric information in credit markets, emphasizing the role of collateral in reducing moral hazards.

An expansionary monetary policy, by causing a rise in financial and physical asset prices, increases the net worth of firms and, hence, the value of collateral, company cash flow, and firms' creditworthiness. In addition, a rise in asset prices increases the ratio of the liquid financial assets to household debt, reduces the probability of financial distress, and eventually increases the consumption and housing investment (Mishkin, 2001). The banks in Pakistan - given their lack of expertise in properly assessing the credit risk - mostly charge the same rate to all customers. This practice raises the banking spread and reduces the effectiveness of the balance sheet channel.

The asset price channel operates by the way of the monetary policy impact on the net wealth of the economic agents. Tobin's q theory provides a base for this channel, which can be applied to both firm investment and to the housing market. The monetary transmission through this channel can further be derived from Modigliani's lifecycle model, according to which an increase in the financial wealth raises consumption. The asset price channel is not likely to operate in Pakistan due to the less developed capital markets. The financial sector is dominated by banks, which account for the larger part of the financial system's assets. The non-bank financial sector (stock market, debt securities market, mortgage market, insurance industry) is less developed. The market financing matters a little since it precludes the channel's working through wealth and income effects.

The monetary policy can influence the exchange rate through direct intervention in the foreign exchange market or inflationary expectations. The changes in exchange rates affect aggregate demand and the price level through their influence on (1) the cost of imported goods; (2) the cost of production and investment; (3) international competitiveness and net exports; and (4) firms' balance sheets in the case of high-liability dollarization. There are several reasons to expect the nominal exchange rate to a have considerable influence on inflation and aggregate demand in Pakistan: firstly, the effect of exchange rate changes on inflation may be significant due to the relatively high imports/export ratio. Secondly, the aggregate demand in Pakistan is substantially influenced by the flow of remittances from the overseas Pakistanis. Any appreciation or depreciation, consequently, of the local currency could result in a wealth effect with a significant impact on the consumption spending. Thirdly, the changes in the real exchange rate have implications for the international competitiveness of competing goods. Given the foregoing reasons, there is an ample evidence to expect that the exchange rate channel is operational in Pakistan.

The monetary policy actions may also exercise an influence on the economy through their impact on the confidence and expectations of the economic agents about the future outlook of the economy. In particular, such expectations' effects may improve the monetary policy transmission through other channels by shortening reaction lags (Mayes, 2004). The more effective the expectation channel is the greater the credibility of the central bank. If the central bank enjoys a high degree of credibility in pursuing its objectives, the monetary policy can exert a powerful yet direct influence on the price developments by guiding the economic agents' towards the expected level of inflation in future, thereby influencing their wage and price-setting behavior. The credibility of the central bank to maintain price stability in a lasting manner is crucial in this respect. The economic agents' belief in the central bank's ability and commitment towards maintaining the price stability would play a vital role in firmly anchoring the inflation expectations with price stability. This, in return, will influence wage and price-setting in the economy given that in an environment of price stability, the wage and price-setters will no longer have to adjust their prices upwards for the fear of future inflation hike. The credibility aspect surely facilitates the task of a monetary policy. The prevalence of expectation channel is possible only in more advance economies, where central banks are autonomous, transparent and committed only to the objective of low inflation, whereas, the situation in Pakistan is quite contrary.

4.2. Model Specification

Following Aslanidi (2007), who modified the Kim and Roubini (2000) model, and keeping in mind the foregoing discussion, our model specification is, in vector form, given as:

$$Z=(i^*, y^*, y, \pi, m, cr, , i, e) \qquad (4.1)$$

The external sector is represented by the US interest rate (i^*) and the US output (y*). The foreign variables have been introduced to control the foreign monetary policy shock in setting domestic monetary policy. This will help to isolate exogenous monetary policy changes (Aslanidi, 2007). Both the domestic output (y) and the inflation rate (π) represent domestic activity and characterize a goods' market in the economy. The credit (cr) remains inclusive, for looking at the interaction of a monetary policy through the credit channel of the monetary transmission mechanism. The variable (i) is a domestic short-term interest rate, while (e) is the nominal exchange. The monetary aggregate (m) is included as it has been used as a monetary policy target in Pakistan.

4.3. Methodology:

The two of the objectives of this study indicated in the chapter 1 are as follows:

(i) To analyze the strength of different channels of monetary policy transmission mechanism;

(ii) To analyze the lags involved in different channels of monetary policy.

In order to achieve the abovementioned objectives empirically, we have used the transfer function methodology. This chapter is geared towards explaining the methodology employed. The transfer function model has the advantage of identifying the delay period and the duration of effect of input(s) on output accurately. The transfer function model is the generalization of univariate model in that it allows the time path of the dependent variable to be influenced by the time path of the independent variable(s). It is among the most widely used linear times series models in many areas of application, such as economics, engineering, and environmental sciences that are effective tools for forecasting as well as hypothesis testing.

We use the Transfer Function Model developed by the Box and Jenkins (1976). To explain the method, we started with a simple case of one input and one output, then we generalized it to a more general case of multi-input-multi-output.

Let x_t be input series and y_t be the output series. Further assume that input and output series are jointly stationary. Split y_t into two components as:

$$y_t = z_t + N_t \qquad (4.2)$$

Where z_t contains that part of y_t which can be explained in term of x_t, and N_t is an error or noise term which in general is auto-correlated but is independent of the input series x_t. Here, both y_t and x_t are observable, while z_t is not observable. Suppose the dynamic relationship between z_t and x_t is represented as:

$$z_t - \delta_1 z_{t-1} - \delta_2 z_{t-2} - \dots\dots\dots - \delta_r z_{t-r} = \omega_0 x_{t-b} - \omega_1 x_{t-b-1} - \dots\dots\dots - \omega_s x_{t-b-s}$$

or

$$z_t = \left[\frac{\omega_0 - \omega_1 B - \dots - \omega_s B^s}{1 - \delta_1 B - \dots - B_r B^r} \right] x_{t-b} = \nu(B)\, x_t$$

Whereby $\nu(B) = \left[\frac{\omega(B)}{\delta(B)}\right] B^{b}$ and is called transfer function, while b is the delay period.

Therefore, the model (4.2) can be written more generally as:

$$y_t = \nu(B)\, x_t + N_t \qquad (4.3)$$

In many practical situations, the term N_t is non-stationary and it can be represented by an ARIMA (p, d,q) i.e.

$$N_t = c + \left[\frac{\theta(B)}{\phi(B)}\right] a_t \qquad (4.4)$$

The function noise model, therefore, can be written as:

$$y_t = c + \nu(B)\, x_t + \left[\frac{\theta(B)}{\phi(B)}\right] a_t \qquad (4.5)$$

Here, $\omega(B)$ is moving the average operator i.e. $\omega(B) = \omega_0 - \omega_1 B - .... - \omega_s B^s$, $\delta(B)$ is the autoregressive operator i.e. $\delta(B) = 1 - \delta_1 B - \delta_2 B^2 - ..... - \delta_r B^r$. In practice, we normally do not know the form of ν(B) and the structure of N_t i.e. the parameters *r, s, b, p*, and *q* and have to identify them through the analyses of data on variables x_t and y_t.

Multi-inputs-multi-outputs Models

The transfer function models, discussed above, assume that input variables (x_{it}) affect the output variable (y_t), but that y_t in turn does not affect x_{it}. This assumption, however, does not hold in practice due to feedback between inputs and output. It is, therefore, unwise to treat one as input and the other as an output in the transfer function model. To deal effectively with such a situations it is necessary to treat both (generally all variables included in the model) on an equal basis so that the two-way feedback between each pair of variables can be disentangled.

The multi-inputs and multi-outputs models are similar in concept to simultaneous equations models, but with more general lag and error structure. In general, the n-equations model can be written in a compact matrix form:

$$z_t = v(B)\, z_t + \mu_{it} \qquad (4.6)$$

Where, z_t is a column vector of n variables and v (B) is a n×n matrix of $v_{ij}(B)$ with 0,s at diagonal i.e.

$$v(B) = \begin{bmatrix} 0 & v_{12}(B) & . & . & . & . & v_{1n}(B) \\ v_{21}(B) & 0 & . & . & . & . & v_{2n}(B) \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ v_{n1}(B) & . & . & . & . & . & 0 \end{bmatrix}. \text{, where } v_{ij}(B) = \frac{\omega_{sj} B^b}{1 - \delta_i(B)}$$

Here $\omega_{sj}(B) = \omega_{0j} + \omega_{1j} B + \omega_{2j} B^2 + ... + \omega_{sj} B^s$

and $\delta_i(B) = \delta_{1i} B + \delta_{2i} B^2 + ... \quad .... \quad ... + \delta_{ri} B^r$

The transfer function model depends on the parameters *r, s, b, p*, and *q* and the identification of values of these parameters is important. We use the cross-correlation function (CCF) between the input and output and a sample autocorrelation, and the sample partial autocorrelation identify these parameters.

4.3.1. Pre-whitening:

Before computation of CCF, a pre-whitening step should precede, especially if input and output series are stationary. Then, CCF between pre-whitened series can be used for identification. In this section, we will discuss the pre-whitening process of input and output series.

Pre-whitening refers to the process of applying a given set of auto-regression and moving average factors to a stationary series. The stationary input series is pre-whitened by its own ARMA factors. The output series is also pre-whitened by the input ARMA factors. Pre-whitening removes the interrelationship in the individual series and allows us to assess the interrelationship between input and output series accurately. The cross-correlation between the pre-whitened input and output series reveal the extent of this inter-relationship.

Let us assume that the time series x_t follows an ARMA process as:

$$\phi_x(B)\, x_t = \theta_x(B)\, \alpha_t\,,$$

Where, α_t is white noise. The input series χ_t is filtered as:

$$\alpha_t=\{\phi_x(B)/\theta_x(B)\}x_t$$

Then, the output series y_t is transformed through the same filterization process as:

$$\beta_t=\{\phi_x(B)/\theta_x(B)\}y_t$$

it can be deduced that

$$\beta_t = \nu(B)\, \alpha_t + e_t \qquad (4.7)$$

Where, $\beta_t=\{\phi_x(B)/\theta_x(B)\}y_t$ and $e_t = \{\phi_x(B)/\theta_x(B)\}N_t.$

The multiplying equation (4.7) by α_{t-k} and taking the expectations, we get

$$E(\alpha_{t-k}\beta_t) = E[v(B)\alpha_{t-k}\alpha_t] + E(e_t\alpha_{t-k})$$

Or

$$\gamma_{\alpha\beta}(k) = \gamma_k \sigma^2_\alpha$$

By applying the usual assumption that CCF, $\rho_{\alpha\beta}(K)$ between pre-whitened series is proportional to v_k, $\forall$ k $\in$ z^+ i.e.

$$v_k = \rho_{\alpha\beta}(K)\frac{\sigma_\beta}{\sigma_\alpha} \qquad (4.8)$$

Where, σ_β is the standard deviation of filtered output β_t and σ_α is standard deviation of the pre-whitened input α_t and $\rho_{\alpha\beta}(K)$ is kth cross-correlations between α_t and β_t. Since the σ_β, σ_α, and $\rho_{\alpha\beta}(K)$ are not known, therefore, the estimated standard deviations and cross-correlations are used in practice.

A serious problem with either model (4.5) or (4.7) is that both contain an arbitrarily large number of parameters. Consider the following rational transfer function (as Box et al. 1994 suggest):

$$\upsilon(B) = \omega_s(B)\, B^b / \delta_r(B) \qquad (4.9)$$

Where, $\delta_r(B) = 1 - \delta B - \delta B^2 \ldots\ldots\ldots - \delta_r B^r$

$\omega_s(B) = \omega_0 + \omega_1 B + \ldots\ldots\ldots + \omega_s B^s$ and *b* is a delay parameter representing the time lag that elapses before changes in the input, produces an effect on the output. Box et al. (1994) suggest that the pattern of $\hat{v}_k$ can be used to identify *b*, and order *r* and *s*. By computing $\hat{e}_t = \beta_t - \upsilon(B)\alpha_t$, where υ(B) is finite order approximation of υ(B) with υ_k replaced by $\hat{v}_k$, we can also identify the model for e_t from $\hat{e}_t$ using a standard univariate model building procedure. If e_t follows an ARMA (p, q) model, say:

$$e_t = \{\theta_q(\beta)/\phi_p(\beta)\}a_t \qquad (4.10)$$

Where, $\varphi_p(\beta) = 1-\varphi_1\beta - \ldots\ldots - \varphi_p\beta^p, \theta_q - 1 - \theta_1\beta$ and the a_t is white noise, the transfer function model (4.3) becomes:

$$\beta_t = \frac{w(\beta)\alpha_{t-b}}{\delta_r(\beta)} + \frac{\theta_q(\beta)a_t}{\phi_p(\beta)} \qquad (4.11)$$

The model in (4.11) can also be written as:

$$\delta^*_{p+r}(B)\beta_t = \omega^*_{p+s}(B)\alpha_{t-b} + \theta_{r+q}(B)a_t \qquad (4.12)$$

Where,

$$\delta^*_{p+r}(B) = \delta_r(B)\phi_p(B) = 1-\delta^*_1 B - \ldots\ldots - \delta^*_{r+p}B^{p+r}$$

$$\omega^*_{p+s}(B) = \omega_s(B)\phi_p(B) = \omega_0 + \omega^*_1 B + \cdots + \omega^*_{p+s}B^{p+s}$$

$$\theta^*_{r+q} = \delta_r(B)\ \theta_q(B) = 1-\theta^*_{1B} - \ldots\ldots - \theta^*_{r+q}B^{r+q}$$

More explicitly, we have:

$$\beta_t = \sum \delta^*_i \beta_{t-i} + \sum \omega^*_1 \alpha_{t-b-l} + \varepsilon_t \qquad (4.13)$$

Where

$$\varepsilon_t = a_t - \theta^*_1 a_{t-1} - \ldots\ldots - \theta^*_{r+q} a_{t-r-q} \qquad (4.14)$$

The estimation of (4.11) or (4.13) by using maximum likelihood method requires the knowledge of *r, s, b, p* and *q*. The identification of delay parameter *b* means the first statistically significant v_k, *p* and *q* can be determined through sample autocorrelation function (Tsay and Tiao, 1984). However, the identification of *r* and *s* from v_k is rather subjective. For any chosen *b, p* and *q*, Muller and Wei (1994) propose an iterative regression method to identify the orders *r* and *s* through pre-whitened and filtered variables α_t and β_t using equation (4.13). Durbin (1960) shows that the Ordinary Least Square (OLS) estimators of (4.13) are consistent when $\varepsilon_t = \alpha_t$ i.e. white noise in (4.14). However, for the more general transfer function model given in (4.13), the OLS estimators are not consistent (Tsay and Tiao 1984 & Wie 1990). Muller and Wei (1994) present the consistent moment estimators and use a regression concept for introducing the iterative least square estimation to prove their consistency and develop a method of identifying *r* and *s*.

4.3.2 Model Identification:

The model identification refers to a methodology for identifying the delay parameter b and the polynomial orders γ and s in the rational transfer function $\upsilon(B)$, and also the ARMA order P and q for the error term given (4.11). The specification of *p* and *q* is simple and can be obtained using the methodology based on behavior of sample autocorrelation, sample partial autocorrelation from the residuals $e_t = \beta_t - \upsilon(\beta)\alpha_t$. The identification of the delay parameter *b* is also straightforward since the cross-correlation function $\rho_{\alpha\beta}(k)$ exhibits a pattern which is zero for all lags smaller than b. However, the identification of *r* and *s* from υ_j is rather subjective. The two methods for the identification of parameters r and s are discussed below.

4.3.2.1 Box-Jenkins Procedure:

Box-Jenkins suggests the following procedure for the identification of Transfer Function Model. Let β_t and α_t be pre-whitened output and input series respectively. Then, the procedure consists of the following:

(1) Deriving rough estimates ν_k of impulse response weights ν_k as

$\nu_k = \gamma_{\alpha\beta}(k)\left[\frac{S_\beta}{S_\alpha}\right]$, where $\gamma_{\alpha\beta}$ is the cross-covariance at lag +k between β_t and α_t, and S_α and S_β are standard deviation of α_t and β_t respectively.

(2) Using the estimates ν_k to make some guesses of the order *r & s* and delay parameter *b* using facts:

(i) *b* zero values $\nu_0, \nu_1, \ldots\ldots, \nu_{b-1}$

(ii) A further s – r + 1 values, $\nu_b, \nu_{b+1}, \nu_{b+2}, \ldots, \nu_{b+s-r,}$ following no fixed pattern.

(iii) ν_k with k≥b+s-r+1 following pattern an r^{th} order differential equation.

(3) Using the estimates ν_k, with values *r,s* and b to obtain initial estimates of the parameters δ and ω as

$$\nu_k = 0 \qquad k<b$$

$$\nu_k = \delta_1 \nu_{k-1} + \delta_2 \nu_{k-2} + \ldots\ldots + \delta_r \nu_{j-r} + \omega_0 \qquad k=b$$

$$\nu_k = \delta_1 \nu_{k-1} + \delta_2 \nu_{k-2} + \ldots\ldots + \delta_r \nu_{k-r} - \omega_{j-b} \qquad k=b+1, b+2, \ldots.., b+s$$

$$\nu_k = \delta_1 \nu_{k-1} + \delta_2 \nu_{k-2} + \ldots\ldots + \delta_r \nu_{k-r} \qquad k> b+s$$

4.3.2.2. Muller and Wie Tentative Regression Method:

Muller and Wie (1994) developed an Iterative Regression method to identify the transfer function which gives consistent estimates of parameters. Their methodology is explained below.

Suppose that n observations of β_t and α_t are available. The model (4.13) can be written as:

$$\beta_t = \sum_{i=1}^{m} \delta^*_i \beta_{t-i} + \sum_{l=0}^{m} \omega^*_l \alpha_{t-b-l} + a_t - \sum_{i=1}^{r+q} \theta^*_i a_{t-I} \qquad (4.15)$$

We perform the iterative regression as follows:

(1) Suppose that we fit the following multiple linear regression model:

$$\beta_t = \sum_{i=0}^{m} \delta^{(0)}_{i(m)} \beta_{t-i} + \sum_{l=0}^{m} \omega^{(0)}_{l(m)} \alpha_{t-b-l} + \varepsilon^{(0)}_{m,t} \qquad t=m+b+1,\ldots,n \qquad (4.16)$$

Where subscript (m) indicates the order of the regression, the superscript (0) denotes initial stage of ordinary regression, and $\varepsilon^{(0)}_{m,t}$ is the corresponding error term. The estimated residual $\varepsilon^{(0)}_{m,t}$ of (4.16) is

$$\varepsilon^{(0)}_{m,t} = \beta_t - \sum_{i=0}^{m} \delta^{(0)}_{i(m)} \beta_{t-i} + \sum_{l=0}^{m} \omega^{(0)}_{l(m)} \alpha_{t-b-l} \qquad (4.17)$$

Where the $\delta^{(0)}_{i(m)}$ and $\omega^{(0)}_{l(m)}$ are OLS estimates from initial stage fitted regression.

(2) For the assumed (r,s,b) x (p, q) model, the OLS estimates $\delta^{(0)}_{i(m)}$ and $\omega^{(0)}_{l(m)}$ are known to be inconsistent, and residual $\varepsilon^{(0)}_{m,t}$ computed in (4.17) are auto-correlated. Consider the following first iterated regression of order m:

$$\beta_t = \sum_{i=0}^{m} \delta^{(1)}_{i(m)} \beta_{t-i} + \sum_{l=0}^{m} \omega^{(1)}_{l(m)} \alpha_{t-b-l} + \theta^{(1)}_{l(m)} \varepsilon^{(0)}_{m,t} + \varepsilon^{(1)}_{m,t} \qquad (4.18)$$

Where t = m + b + 2,… n, the superscript (1) denotes the first iterated regression, and $\varepsilon^{(1)}_{m,t}$ denotes corresponding error term.

(3) More generally, for j = 0, 1,…… and m = 1,2,…….. the jth iterated regression of order m can be defined as.

$$\beta_t = \sum_{i=0}^{m} \delta^{(j)}_{i(m)} \beta_{t-i} + \sum_{l=0}^{m} \omega^{(j)}_{l(m)} \alpha_{t-b-l} + \sum_{i=0}^{m} \theta^{(j)}_{l(m)} \varepsilon^{(j-i)}_{m,t-1} + \varepsilon^{(j)}_{m,t} \qquad (4.19)$$

Where

$$\varepsilon^{(v)}_{m,t} = \beta_t - \sum_{i=0}^{m} \delta^{(v)}_{i(m)} \beta_{t-i} + \sum_{l=0}^{m} \omega^{(v)}_{l(m)} \alpha_{t-b-l} - \sum_{i=1}^{v} \theta^{(v)}_{l(m)} \varepsilon^{(v-i)}_{m,t-1}$$

is estimated residual of the vth iterated regression of order m, and $\delta^{(v)}_{i(m)}$, $\omega^{(v)}_{l(m)}$ and $\theta^{(v)}_{i(m)}$ are corresponding OLS estimates of the equation (4.13) implies that to obtain consistent estimates δ^{*}_{i}, ω^{*}_{l} and θ^{*}_{i} we should start the iteration with j = 0,1,…..

Let $\delta^{(j)}_{i}(m)$ and $\omega_{l(m)}$ be the OLS estimates from model (4.19), it can be proved that for larger j (j ≥ max (m, r+q) ≥ max (p, q) and m = max (p + r, p + s) these are indeed consistent estimates for parameterδ^{*}_{i}, ω^{*}_{l}.

The tentative model identification proposed by Muller and Wie (1994) deals with the specification for r and s after values b, p and q are determined. For each jth iterated regression for j≥ max (p, q) as described in (4.19) the OLS estimates $\delta^{(j)}_{i(m)}$ and $\omega^{(j)}_{l(m)}$ for m = 1, 2……; i = 1,…,m l=0,1,…,m can be computed and arranged in two-way table as:

Table 4.1: coefficients $\delta^{(j)}_{i(m)}$ of equation 4.19

m \ i	1	2	3…….
1	$\delta^{(j)}_{1(1)}$		
2	$\delta^{(j)}_{1(2)}$	$\delta^{(j)}_{2(2)}$	
3……	$\delta^{(j)}_{1(3)}$	$\delta^{(j)}_{2(3)}$	$\delta^{(j)}_{3(3)}$

Table 4.2: coefficients $\omega^{(j)}_{l(m)}$of equation 4.19

m \ l	0	1	2…….
1	$\omega^{(j)}_{0(1)}$	$\omega^{(j)}_{1(1)}$	
2	$\omega^{(j)}_{0(2)}$	$\omega^{(j)}_{1(2)}$	$\omega^{(j)}_{2(2)}$
3……	$\omega^{(j)}_{0(3)}$	$\omega^{(j)}_{1(3)}$	$\omega^{(j)}_{2(3)}$

.

Using theorem, which states that "If β_t and α_t are two time series related through the (r, s, b) x (p, q) the transfer function model given by

$$\beta_t = \frac{\omega_s(\beta)\alpha_{t-b}}{\delta_r(\beta)} + \frac{\theta_q(\beta)a_t}{\phi_p(\beta)}$$

Or equivalently by

$$\beta_t = \sum_{i=1}^{p+r} \delta^* \beta_{t-i} + \sum_{l=0}^{p+s} \omega_l \alpha_{t-b-l} + \varepsilon_t$$

and the roots $\delta^*_{p+r}(B)$ are outside the unit circle. Then, if

m = max (p + r, P +s) and j≥ max (m, r+q), we have

$$\delta^{(j)}_{i(m)} = \delta^*_i + 0p(1) \qquad i=1,2,\ldots\ldots,m$$

$$\omega^{(j)}_{l(m)} = \omega^*_l + 0p(1) \qquad l=1,2,\ldots\ldots,m$$

Where it is understood that $\delta^*i=0$ for i>p+ r and $\omega^*_l=0$ for l> p + s", then for any given p, the order of *r* and *s* can be found as:[4].

(a) For any given jth iteration with j≥ max (p, q), we examine whether any rows in the $\delta^{(j)}_{i(m)}$ table(4.1) and/or $\omega^{(j)}_{l(m)}$table(4.2) have values near zero. If the answer is yes, we know j ≥ m ≥ max (p + r, p +s) and, therefore, we stop the iteration and identify the row with near zero elements. Let us assume that the row with near zero elements is the kth row in one of the tables.

If this kth row with near zero elements appears first in the $\delta^{(j)}_{i(m)}$ table, then m=k = p + s and we take s = max (0, m-p) the value of p + r can easily be seen to be equal to the column position of the last non-zero element in this row. Let l be this column position; the r = max (0,

[4] See Muller and Wie (1994) for more detail.

l–p). If all elements in this row are zero, then r = 0. Similarly, if the row with near zero-elements appear first in kth row of $\omega^{(j)}{}_{l(m)}$ table, the m=k=p+r and r = max (0, m–p). The value of p+s is given by the column position of last nonzero element in this row. Let l be column position of this last non-zero element; then s = max (0, l – p). If all elements in this row are zero then s = 0.

If the first row with near zero elements is the kth row of both the tables then m = k = p + r = p + s and r = s = max (o, m – p).

(b) If none of the rows in the tables $\delta^{(j)}{}_{i(m)}$ and $\omega^{(j)}{}_{l(m)}$ has elements near zero it implies that j < max (p + r, P + S), thus we need to increase the order j of the iterated procedure and repeat the process.

(c) After the determination of *r* and *s,* we need to make a final check to find out whether the convergence conditions of theorem stated earlier are satisfied. If so, we stop the process. Otherwise, once again, we increase the order j of iterated regression and repeat the above two steps i.e (a) & (b) discussed above.

We can use the above iterated identification procedure for the multi-inputs-output transfer function. Suppose we have n-outputs series $y_i(t)$ and n-inputs series $x_i(t)$, i = 1,2,……n.

In this case, each input series $x_i(t)$ is pre-whitened by its own ARMA model and the output series is pre-whitened once for each input series. Then, we use the abovementioned iterative procedure, discussed above, for identification.

4.3.3 Estimation of Transfer Function:

In the transfer function model, as we have to estimate the coefficients involved in both the numerator and the denominator, a non-linear estimation technique is, therefore, required.

The problem faced in non-linear estimation is to find the values of parameters that optimize (i.e. maximize or minimize) an objective function F (θ). Different Nonlinear Optimization Algorithms are used for this purpose. The iterative optimization algorithms work by taking an initial set of values for the parameters, and then performing calculations based on these values to obtain a better set of parameter values. This process is repeated until the objective function F no longer improves between iterations.

Their main features of the optimization process are:

(1) Obtaining the initial parameter values

(2) Updating the candidate parameter vector at each iteration, and

(3) Determining the optimum point.

The algorithms may be broadly classified into two types: the first derivative methods (e.g. Gauss-Newton) and the second derivative methods (e.g. Newton-Raphson). The first derivative methods form candidate values using only the current parameter values and the first derivatives of the objective function. The second derivative methods evaluate both the first and the second derivatives of the objective function during the iteration process.

We use Gauss-Newton method for non-linear estimation, as the second derivative methods may be computationally costly since we need to evaluate the k(k+1)/2 elements of the second derivative matrix at every iteration.

4.4. Variables and Data

The variables used in this study are: industrial production index(y_t) as proxy of gross domestic product, inflation rate (π_t) calculated as $\pi_t=(cpi_t-cpi_{t-1})/cpi_{t-1}$, reserve money ($m_{0t}$), banks advances, money market rate (i_t) as a short-term interest rate, real exchange rate (e_t) the US dollars/rupee. The US industrial production (y*) as proxy of foreign GDP and federal fund rate (i*) as proxy of foreign interest rate are included to represent the external shocks. Here it is noteworthy (also discussed earlier) that the industrial production in Pakistan has on the average comprised only 25 percent of the GDP. Given this fact, we would like to caution the reader that the industrial production may not be an entirely satisfactory proxy for the real income. However, we use the proxy because it constitutes the best amongst the ones for which the data is available on the monthly frequency[5]. We plot the annual data of GDP and industrial production and find a close association between the two. The graph representing the two series is given in the appendix.

We included an exogenous monetary policy measure (Financial Condition Index) as a policy instrument in our transfer function model. The development of this monetary policy measure has been discussed in later chapters. The inclusion of this policy measure in the model makes it possible to compare the performance of this measure in predicting the stance of the monetary policy with the performance of traditional measures, such as interest rate or monetary aggregates[6].

The monthly data from 1982:01 to 2007:07 has been used. The motivation for using the high frequency data is that the data includes monetary variables besides the exchange rate. These variables have dynamic properties that can be best captured with high frequency data. All the data has been taken from the international financial statistics (IFS) CD-ROM.

[5] Many others[Butliglione and Ferri (1994), Oliner and Rudebusch (1995, Dedole and Lippi (2000)) have alsoused also this proxy. For Pakistan, see Ahmed *et al*.(2005) and Khawaja (2007).
[6] Heuvel (2001) used this measure as policy stance in his analysis.

5 Test for Stationarity in Monthly Data

5.1 Introduction:

Most of the economic time series involve seasonal components and there exist various models of seasonality that may differ across the series (Hylleberg *et al*. 1990). The different seasonality models differ in statistical properties and, therefore, the imposition of one kind, when the other is present, can result in serious biases or the loss of information (Beauliue and Miron 1993). It is, therefore, essential to test for the kind of seasonality present in the data. The literature mentions three kinds of seasonalities i.e. deterministic seasonality, stationary stochastic seasonality, and non-stationary stochastic seasonality. The last one is due to the presence of seasonal unit roots, and it is this kind of seasonality that raises the most troubling statistical issues (Beauliue and Miron 1993). Fuller (1976) and Dicky and Fuller (1979) were among firsts to develop the procedure for unit root test. But Dicky Fuller test is not appropriate when unit roots exist at seasonal frequencies. Hasza and Fuller (1982) developed a procedure for seasonal unit root test. The problem with the test procedure developed by Hasza and Fuller is that the interpretation of results becomes difficult for two reasons: firstly, it imposes two unit roots at zero frequency under null, and secondly, it is unclear as how the performance of the test changes when only some of the seasonal frequencies possess a unit root (Hylleberg *et al*. 1990).

Furthermore, the rejection does not prove that no unit root exists at any frequency and the failure to reject does not help to identify the frequencies that may be integrated. Dicky, Hasza, and Fuller (1984) test for seasonal unit root, bypasses the assumption for two unit roots at frequency zero, but this test also suffers from the problems of interpreting rejection, low power, and residual autocorrelation. Hylleberg, Engle, Granger, and Yoo (1990) explain how to test for the seasonal unit roots in the processes that may also exhibit either the deterministic or the stationary stochastic seasonality. It also shows how to test for a unit root at zero frequency when unit roots may be present at some or all of the seasonal frequencies for quarterly data. Beaulieu and Miron (1993) and Franses (1990) extended their procedure for monthly data. The methodology that we have outlined in the chapter 6 is based on all the data series being stationary. Thus any unit root that may be present need to be filtered out prior to applying the transfer function model.As our data is monthly, therefore, we need to test for unit root as well as the seasonal unit root. The conventional Dicky and Fuller (1979) and Phillips and Perron (1988) tests do not test for seasonal unit root. Therefore, we have adopted the HEGY (Hylleberg, *et al*., 1990) framework suitably extended to the monthly context by Beaulieu and Miron (1993).

5.2. Seasonal Unit Root: The Test Procedure[7]

Beaulieu and Miron (1993) extended the HEGY (1990) procedure to monthly context, the procedure is as under:

Let x_1 be the series, generated by a general auto regression of the form:

$$\varphi(B)\, x_1 = E_1 \qquad (5.1)$$

Where, $\varphi(B)$ is a polynomial in the backshift operator and E_1 is a white noise process. Let γ_k be the roots of the characteristic polynomial associated with $\varphi(B)$. Under the

[7] In this section we make use of Beaulieu and Miron (1993)

assumption that deterministic terms, such as seasonal dummies or time trends, is absent from the process for moment. Generally, some or all of the roots γ_k may be complex.

The frequency associated with a particular root is the value of α in $e^{\alpha i}$, the polar representation of the root. A root is seasonal if $\alpha = 2\Pi j / S$, j = 1, ….., S - 1, where S is the number of observations per year. For monthly data, the seasonal unit roots corresponding to 6,3,9,8,4,2,10,7,5,1 and 11 cycles per year respectively are:

$$-1; \pm \iota ; -\frac{1}{2}(1 \pm \sqrt{3}\,\iota); \frac{1}{2}(1+\sqrt{3}\,\iota); -\frac{1}{2}(\sqrt{3} \pm \iota); \frac{1}{2}(\sqrt{3} \pm \iota) \qquad (5.2)$$

The frequencies of these roots are $\Pi, \pm \Pi/2, \pm 2\Pi/3, \pm \Pi/3, \pm 5\Pi/6$ and $\pm \Pi/6$ respectively. We have to check whether $\phi(B)$ has roots equal to one in absolute value at the zero or seasonal frequency. The goal, in particular, is to test the hypotheses about a specific unit root without taking a stand on the probable presence of other seasonal or zero frequency unit roots.

By linearizing the polynomial $\phi(B)$ around the zero frequency unit roots plus the (S – 1) unit root given in (5.2) we may write $\phi(B)$ as:

$$\phi(B) = \sum_{k=1}^{s} \lambda_k \Delta(B) \frac{1-\delta_k(B)}{\delta_k} + \Delta(B)\phi^*(B) \qquad (5.3)$$

Where:

$$\delta_k(B) = 1 - \frac{1}{\theta_k}B, \; \lambda_k = \frac{\phi(\theta_k)}{\prod_{j \neq k} \delta_j(\theta_k)}, \Delta(B) = \prod_{k=1}^{s} \delta_k(B)$$

$\phi^*(B)$, is a remainder with roots outside the unit circle, and the θ_k are the zero frequency unit root plus the (S – 1) seasonal unit roots. Substitution of (5.3) into (5.1) yields:

$$\phi^*(B)\, y_{13t} = \sum_{k=1}^{12} \prod_k y_{k,t-1} + \varepsilon_t \qquad (5.4)$$

Where

$$y_{1t} = (1 + B + B^2 + B^3 + B^4 + B^5 + B^6 + B^7 + B^8 + B^9 + B^{10} + B^{11})x_t,$$
$$y_{2t} = (1 - B + B^2 - B^3 + B^4 - B^5 + B^6 - B^7 + B^8 - B^9 + B^{10} - B^{11})x_t,$$
$$y_{3t} = (B - B^3 + B^5 - B^7 + B^9 - B^{11})x_t,$$
$$y_{4t} = (1 - B^2 + B^4 - B^6 + B^8 - B^{10})x_t,$$
$$y_{5t} = \tfrac{1}{2}(1 + B - 2B^2 + B^3 + B^4 - 2B^5 + B^6 + B^7 - 2B^8 + B^9 + B^{10} - 2B^{11})x_t,$$
$$y_{6t} = \frac{\sqrt{3}}{2}(1 - B + B^3 - B^4 + B^6 - B^7 + B^9 - B^{10})x_t,$$
$$y_{7t} = \tfrac{1}{2}(1 - B - 2B^2 - B^3 + B^4 + 2B^5 + B^6 - B^7 - 2B^8 - B^9 + B^{10} + 2B^{11})x_t,$$
$$y_{8t} = -\frac{\sqrt{3}}{2}(1 + B - B^3 - B^4 + B^6 + B^7 - B^9 - B^{10})x_t,$$
$$y_{9t} = \tfrac{1}{2}(\sqrt{3} - B + B^3 - \sqrt{3}B^4 + 2B^5 + \sqrt{3}B^6 + B^7 - B^9 + \sqrt{3}B^{10} - 2B^{11})x_t,$$
$$y_{10t} = \tfrac{1}{2}(1 - \sqrt{3}B + 2B^2 - \sqrt{3}B^3 + B^4 - B^6 + \sqrt{3}B^7 - 2B^8 + \sqrt{3}B^9 - B^{10})x_t,$$
$$y_{11t} = \tfrac{1}{2}(\sqrt{3} + B - B^3 - \sqrt{3}B^4 - 2B^5 - \sqrt{3}B^6 - B^7 + B^9 + \sqrt{3}B^{10} + 2B^{11})x_t,$$
$$y_{12t} = \tfrac{1}{2}(1 + \sqrt{3}B + 2B^2 + \sqrt{3}B^3 + B^4 - B^6 - \sqrt{3}B^7 - 2B^8 - \sqrt{3}B^9 - B^{10})x_t,$$
$$y_{13t} = (1 - B^{12})x_t,$$

To test the hypotheses about the existence of various unit roots, we have to estimate (5.4) by Ordinary Least Squares and then compares the OLS test statistics to critical vales developed by Beaulieu and Miron. For frequencies 0 and $\prod$, we simply examine the relevant *t*-statistic for $\prod_k = 0$ against the alternative that $\prod_k < 0$. For the frequencies with *k* even, we test $\prod_k = 0$, against the alternative $\prod_k \neq 0$. The even coefficient is zero if the series contains a unit root at that frequency. It is non-zero otherwise for the seasonal frequencies other than $\prod$ /2. For π/2, the coefficient is non-zero if no root exists at that frequency. In case we fail to reject $\prod_k = 0$, then we tests $\prod_{k-1} = 0$ versus the alternative that $\prod_{k-1} < 0$. The test is one-sided because the sensible alternative is that the series contains a root outside the unit circle. Under the stationarity, the true coefficient is less than zero. Another strategy is to test $\prod_{k-1} = \prod_k = 0$ with an *F*-statistic. For non-existence of unit root at any seasonal frequency, $\prod_k$ must not equal zero for k = 2 and for at least one member of each of the sets (3,4), (5,6) , (7,8) (9,10), (11,12).we use the *F*-statistic to test for the unit root at seasonal frequency.

If the alternative includes a constant, seasonal dummies, or a time trend can be added to take of that. In this case equation (5.4) becomes:

$$\phi^*(B)\, y_{13t} = \sum_{k=1}^{12} \prod_k y_{k,t-1} + m_0 t + m_1 + \sum_{k=2}^{12} m_k s_{kt} + \varepsilon_t \qquad (5.5)$$

Where, t , s_k , are respectively time trend and seasonal dummies, while m_1 , m_0 , and m_k denote respectively the constant, coefficient of time trend and coefficient of seasonal dummies. The equation (6.5) can be estimated by OLS, however, the asymptotic and finite sample distributions are different in this case.

5.3. Results of Seasonal Unit Root Test

In this section, we present the results of the test procedure for the seasonal unit roots... We, first, plot the actual data to guess the trend and seasonality and unit root etc. in the data series so that the test can be applied appropriately by incorporating the trend and seasonal dummies where required. This is important because by allowing the trend and seasonal dummies, only where required, helps avoid the loss of power that results from their inclusion when unnecessary. The graph of the actual data series are given in Appendix. The graphs show that all the series contains some sort of seasonality. Furthermore, the reserve money and advances follow a positive trend, while the real exchange rate shows a declining trend over time. The graph of inflation rate displays a stationary series as the series converges to its mean. We use the lags of dependent variables to ensure (using LM serial correlation test) that the error term exhibits the white noise.

The results of the seasonal unit roots test are presented in the table 5.1. The monthly time series we consider include: the industrial production index (Y), the inflation rate (π) rate, the reserve money (M), the real interest rate (R), banks advances (L) proxy for credit, and the real exchange rate (E), the US industrial production (Y*) and the federal fund rate (I*) are included to represent the external shocks. The variables Y, M and L, and Y* are in log form. We reject the seasonal unit root at all seasonal frequencies for all the series. (Π_1 and $F_{i,j}$ are non-zero where (i,j)=(3,4), (5,6), (7,8), (9,10), (11,12) for all the series). However, we fail to reject the unit root at zero frequency (Π_0 is non-zero) for all the series except inflation rate. Here $F_{i,j}$ is joint F-statistic for the pair (i,j).

Table 5.1

The results of tests for the seasonal unit roots (at the monthly data level)

variables	Π_0	Π_1	F3,4	F5,6	F 7.8	F9,10	F11,12
$Y^{c,d}$	-0.3*	-4.6	17.1	10.0	10.6	28.3	14.5
$\pi^{c,d}$	-3.2	-5.6	23.3	18.4	21.8	22.1	11.3
$M^{c,t,,d}$	-1.7*	-6.0	37.8	23.2	7.8	29.0	25.4
$E^{c,d}$	-2.7*	-6.4	28.3	27.6	29.3	18.4	38.0
$L^{c,t,,d}$	-2.1*	-3.7	18.6	11.0	17.1	34.9	10.2
$R^{c,d}$	-1.6*	-3.6	21.2	12.5	15.2	35.1	10.8
I^{*c}	-1.7*	-5.7	31.4	25.4	18.3	24.3	25.1
$Y^{*c,t,,d}$	-2.2*	6.4	21.5	19.6	25.6	22.3	24.8

Note:*denotes insignificance at 5% level. Superscripts c,t, d denotes constant, trend ,and seasonal dummies respectively.

First of all we, then, take the difference of Y, M, L, R, E, Y* and I* as all these series carry unit roots at zero frequency. Small letters denote the first difference of the respective variables. We, then, apply the test procedure to the difference of the series and the results are presented in table 5.2. We reject the seasonal unit roots at all seasonal frequencies as well at zero frequency, which implies that first difference of these series, are stationary.

As some of our series are non-stationary and methodologies (i.e. vector auto regression and the transfer function model) that we are using for estimation, require stationary series. We, therefore, use the differences of all the series, which are non-stationary, in further analysis. The critical values by Beaulieu and Miron (1993) are given in the table 5.3.

Table 5.2

The results of Tests for Seasonal Unit Roots (Monthly Data at First Difference)

variables	Π_0	Π_1	F3,4	F5,6	F7.8	F9,10	F11,12
$y^{c,d}$	-6.6	-3.9	13.8	14.9	16.2	17.6	12.6
$m^{c,d}$	-6.7	-4.6	18.8	16. 3	14.7	17.5	10.6
e^{d}	-4.9	-4.8	19.2	18.9	19.6	17.5	12.9
$l^{c,d}$	-3.7	-4.2	21.6	17.6	16.9	18.4	15.8
$r^{c,d}$	-7.3	-3.7	18.4	10.2	16.4	28.5	10.0
i^{*c}	-4.9	-5.4	46.1	42.1	39.6	29.6	18.2
y^{*d}	-3.9	-4.5	19.5	19.8	18.6	19.7	15.9

Note: All figures in the table are significant at 5% level.

Table 5.3

Critical Values from the Distributions of Test Statistics for Seasonal Unit Roots (Monthly Data)

Auxiliary regression	Π_1 at 5%	Π_2 at 5%	$F: \Pi_{odd}, \Pi_{even}$ at 5%
Nc, Ns, Nt	-1.91	-1.91	3.08
c, Ns, Nt	-2.85	-1.91	3.06
c, s, Nt	-2.81	-2.81	6.42
c, Ns, t	-3.37	-1.93	3.05
c, s, t	-3.32	-2.84	6.43

Note: c, s, and t denote constant, seasonal dummies, and trend respectively.

Though differencing the series on the basis of seasonal unit/unit root test helps to avoid the spurious relationship between variables, but this may result into the loss of information and make interpretation of any subsequent results in terms of economic and any theoretical model difficult. This is a disadvantage of doing unit root tests series by series and then doing multivariate analysis with the resulting stationary series. Nonetheless, this is a common practice in time series analysis.

6 Measures of Monetary Policy Stance

6.1 Introduction:-

The stance of a monetary policy is defined as the quantitative measure to determine whether the policy is too tight, neutral or too loose in relation to objectives (stable prices and output growth) of the monetary policy[8]. An accurate measurement of the policy stance is important for the evaluation of alternative theories of transmission, or to obtain quantitative estimates of the monetary policy changes on output and inflation (Bernanke and Mihov, 1998). Measuring the stance of monetary policy is, however, not an easy task. In this chapter, we provide a brief description of the different measures of monetary policy discussed in the literature.

A variety of empirical approaches have been used to measure the policy stance, by different researchers. The traditional approach is to use a single variable, such as monetary aggregates or discount rate, as policy measure. Milton Friedman and Anna Schwartz (1963) advocate that the innovations in the monetary aggregates are a good approximate measure of monetary policy shocks. But some puzzling characteristics in the economic performance following money stock innovations have been identified, for example the 'liquidity puzzle'[9]. The empirical evidence suggests that an increase in the interest rate follows innovations in monetary aggregates (Leeper and Gordon, 1992). It is also recognized that the money growth rate may not distinguish between changes in money demand and changes in policy (i.e.

[8] See Fung and Yuan (2001) also Bernanke and Mihov (1998)
[9] With monetary contraction, interest rate decreases rather increases. see Sim and Zha(1998)

money supply). Besides, financial innovations and deregulations have rendered the use of money growth rates as a measure of the direction of policy. The recognition that traditional approach of identifying monetary policy shocks with changes in monetary aggregate is misleading encouraged Bernanke (1992) and Sims (1992) to use innovation in the interest rate as a measure of monetary policy change. However, this created additional challenges known as '*price puzzle*'[10]. Furthermore, when looking at interest rates, such as the federal funds rate to measure the stance of a monetary policy, the policy is generally represented as a reaction function; e.g. the Taylor rule implies that the interest rate responds to the deviation of inflation from its target and the output gap (the deviation of output from the long-run full-employment level).

Another common puzzle is that the positive innovation in the interest rates is followed by the depreciation of local currency rather than appreciation, *exchange rate puzzle* [Sim, (1992) and Grilli and Roubini, (1998)]. The use of the changes in these variables as policy measure, therefore, becomes difficult to solve such problems. Some approaches have been advanced through literature, which are briefly discussed below.

6.2 Simple Measures

The use of broad money aggregates to measure the stance of a monetary policy being confronted with the problems discussed above, analysts and policymakers have turned to some other variables which may reflect the stance of a monetary policy more accurately. In this sub-section, single variables that represent the policy stance are discussed. The next sub-section discusses the composite measures.

[10] With positive innovations in interest rate, prices increase rather than decrease. See Sim (1990).

Some studies (e.g. Bernanke and Blinder, 1992 and Sims, 1992) take the stand that the federal funds rate could be a better indicator of a policy stance. However, others (e.g. Christiano and Eichanbaum, 1992), suggest that the quantity of non-borrowed reserves serves as an indicator of the monetary policy stance. But the problem with these measures of policy is that they presume a constant set of operating procedure by the authorities (Fund-rate or non-borrowed reserves based procedures).

Strogin (1992) argues that the authority is constrained to meet total resources demand in the short run, but she can effectively tighten the policy by reducing non-borrowed reserves and forcing banks to borrow more from the discount window. Econometrically, this approach has an edge over the earlier two approaches (*viz.* Bernanke-Blinder and Christian-Eichembaum s discussed above) because it can partake in testing alternative operating procedures. Though the main focus of all the three studies are on the measurement of monetary policy innovation, these studies also suggest some potentially interesting indicators of policy's overall stances. Armour *et al*. (1996) is of the view that innovation in overnight rate could be a good measure of policy innovations in case of Canada's monetary policy. Fung and Kasumovich (1998) suggest that M_1 innovations produces inputs responses that are consistent with what one would expect from a monetary policy shock. Several authors (e.g. Laurent, 1988, Goodfriend, 1991, and Oliner and Rudebusch, 1996) have suggested the term spread as an alternative measure for a monetary policy. They base their argument on the Central Bank actions to change the short-term interest rate and market participants' expectations about this change. For example, if market participants expect the short-term rate to return gradually back to the starting value in future, then the long term rate will change less than short term rate on the one hand. If market participants expect that this change is just the first stage of more episodes of change, then the long rate will move by more than the short term rate on the other hand. It is important, therefore, to include term spread i.e. the difference between short-term rate and the long-term rate in monetary policy analysis, as it not only gives information about the current policy stance but also embeds information about the opinions of economic agents regarding the expected future stance of a monetary policy.

All the studies discussed above assume *a priori* that a single financial variable is the best policy indicator. However, there exists a little agreement on which a single variable captures the stance of a policy most accurately.

6.3. Composite Measures

Given the disagreement over the use of single variable as an indicator of the monetary policy stance, some composite measures have been developed and used as a policy indicator. Among other (the Bank of New Zealand, IMF, OECD, and even the SBP), the Bank of Canada, a pioneer in constructing MCI, currently use monetary condition index (MCI), which is weighted sum of changes in the interest rate and exchange rate from a given base period as the measure of a policy stance. MCI, however, is criticized on the ground that the interest rate and exchange rate are not directly related to the central bank's policy. Some critics of the measure also argue that it does not consider other financial variables that may be important in the transmission mechanism.

Bernanke and Mihov (1998) suggest a VAR methodology that can include all the policy variables, previously proposed for the United States as particular specifications of the general model. Fung and Yuan (2001) apply Bernanke and Mihov methodology to Canada. They assume that the policy stance, though unobserved, is reflected in the behavior of the financial variables. They include four financial variables, M_1, the term spread, the overnight rate, and exchange rate in their VAR framework.

The recent development in literature [Goodhart and Hofmann (2001), Mayes and Viren (2001), and Gauthier *et al*. (2004)] is the use of the financial condition index (FCI), which is basically an extension of the monetary condition index (MCI). The FCI includes, besides the interest rate and exchange rate, other financial variables as well—the variables that are important in the transmission mechanism of a monetary policy.

6.4. Narrative or Qualitative Approach:

Romer and Romer (1989) adopt a 'narrative approach' to address the identification problems highlighted by the time series models. Based on their reading of Federal Reserve documents, the Romers' created dummy variable for periods when the Fed contracted to offset inflationary pressures. They argued that responses of output and unemployment to such identified monetary policy contractions demonstrate that the monetary policy has strong and persistent real effects on the economy.

This measure of the monetary policy shocks attained the acceptance as a standard indicator of monetary policy (Norrbin 2000). The appealing aspects of this approach pertain to its usage of additional information and it being nonparametric[11], but it also suffers from the problems of subjectivity and endogeniety [Leeper (1993, 1997), Sims and Zha, (1993)][12]. Besides, it considers only contractionary movements and does not distinguish between mild and severe contractionary episodes (Bernanke and Mihov, 1998).

[11] See Bernanke and Mihov (1998)
[12] The problem of subjectivity arises as this approach depends on the interpretation of economists as some one has to interpret the central bank's action to determine whether or not contractionary shock has occurred.

Boschen and Mills (1991) developed a monthly index that not only considers the expansionary episodes but also distinguishes among ‘strong’, ‘neutral’, and ‘mild’ contractionary/expansionary episodes as well. Though more information is used in this measure and it also provides a more continuous measure than Romers’ do but the other two problems i.e. subjectivity and endogeniety are more severe in this case.

Bagliano *et al*. (1999) further extend this narrative approach to an open economy. Here, the identification of interest rate movements as a monetary policy instrument becomes more difficult due to simultaneity between the exchange rate and the interest rate (Norrbin 2000). Other authors have also attempted to extend the Romers’ approach (e.g. Skimmer and Zetblmeyer, 1996, and Rudebusch, 1996). Skimmer and Zettelmeyer use a change in three months interest rate instead of dummy a variable. However, this approach also suffers from endogeneity problem (Norrbin 2000). Rudebusch (1996) uses ‘unexpected change in the interest rate’ from 30-day Fed fund contracts. The problem with this estimate is that it measures all unexpected movements through interest rate rather than measuring the ones that are associated with Fed’s announcements (Norrbin 2000).

We constructed two composite measures i.e. the Monetary Condition Index (MCI) and the Financial Condition Index (FCI). We, then, compared these measures on the basis of performance criteria i.e. the consistency of estimated weights with the economic theory, visual inspection vis-à-vis the output growth as well as the inflation changes in (the Graphical inspection of turning points) and its dynamic correlation with output growth and inflation.

6.5. Methodology

In this section, we present the methodologies to construct the two composite measures i.e. MCI and FCI. These methodologies are explained in the following sub-sections.

6.5.1. Monetary Condition Index (MCI):

The MCI is a weighted sum of changes in short term real interest rate and real exchange rate (the US Dollar/Pak Rupee) relative to the values in the base period. Algebraically

$$MCI_t = \omega_e(e_t - e_0) + \omega_i(i_t - i_0).$$

Where ω_e and ω_i are weights assigned to exchange rate and interest rate, t = 0 is base period, and $\omega_e + \omega_i = 1$.

The MCI by itself tells only how the linear combination of the exchange rate and interest rate has evolved since the base year, therefore, to measure the stance of a monetary policy. We have to look at changes in MCI rather than the level of MCI itself. The change in MCI is interpreted as 'the degree of tightening or easing the monetary condition'. The MCI captures, in a single composite number, the degree of pressure that monetary policy places on the economy and, therefore, upon inflation.

The MCI may be constructed in different ways. Freedman (1994) suggests two ways of constructing MCI. It could be constructed in terms of the effect of the interest rate and the exchange rate changes on either 'aggregate demand' or 'prices'. In the first case, the weights used in MCI are obtained from the estimation of aggregate demand equation. The second alternate focuses on the effect of changes in the exchange rate and the interest rate on prices. In this case, the exchange rate should enjoy a greater weight because it has both direct and indirect impacts (through aggregate demand) on prices (Kesriyeli and Kocaker, 1999).

The monetary condition index has several attractive features; it is easy to work out and captures both domestic and foreign influences on the general monetary conditions of a country. It also provides an interestingly appealing operational target for the monetary policy (Ericsson *et al*. 1998). Though the MCI is considered an improvement over other policy indicators this is subject to some criticisms as well (Ericsson *et al*. 1998, Batini, 2002). These include: model dependency, ignored dynamics, parameter inconsistency, and non-exogeneity of regressors.

In light of the criticism on MCI, Gauthier *et al*. (2004) suggested some methods that could improve the construction of MCI. One of the methods derives weights from reduced form IS-Pillips Curve framework. In this case, weights are obtained in two ways: one, by summing up the coefficients, (obtained by regressing either output or inflation on the exchange rate and the interest rate) on all the lags of the exchange rate and the interest rate. Two, by including individual lags of exchange rate and interest rate in MCI to take into account the dynamics of those variables over time. The second method derives weights based on the generalized impulse-response function from a VAR, and third method derives weights based on factor analysis. The last two methods avoid the non-exogeneity and the model dependency problem. We used the first method to derive weights. This method was first adopted in the construction of MCI at the Bank of Canada. (i.e. Duguay 1994) and is a popular methodology. The Model used for this purpose usually consists of an IS-Philips curve. For example, in Duguay (1994), the IS curve relates to the components of the MCI (the interest rate and the exchange rate) to output growth controlling for external output, commodity prices, and the fiscal policy. The Phillips curve provides the relationship between the output gap and inflation, controlling for expectations.

Goodhart and Hofmann (2000, 2001, and 2002) use a framework proposed by Rudebuesch and Sevenson (1999). In these studies, the IS curve consists of the output gap and is component of MCI, in addition to the lagged output gap. Phillips curve, on the other hand, relates the output gap to inflation, controlling for oil prices and lags of inflation.

We adopted a framework similar to that of Goodhart and Hofmann. Our model, comprised of equations (6.1) and (6.2), represents a backward-looking IS curve and a backward-looking Phillips curve.

$$Y_t = \alpha 1 + \sum_{j=0}^{n} \lambda_j e_{t-j} + \sum_{j=0}^{n} \eta_j i_{t-j} + \sum_{k=1}^{p} \gamma_k y_{t-k} + \varepsilon_{yt} \qquad (6.1)$$

$$\pi_t = \alpha_2 + \sum_{i=1}^{m1} \beta_{1i} \pi_{t-i} + \sum_{j=1}^{m2} \beta_{2j} y_{t-j} + \varepsilon_{\pi t} \qquad (6.2)$$

Where, Y_t is output (IP for monthly data), π_t is inflation rate, e exchange rate and i is interest rate.

6.5.2. *Financial* Condition Index (FCI)

The recent development in the literature [Goodhart and Hofmann (2001), Mayes and Viren (2001), and Gauthier *et al*. (2004)] is the use of the financial condition index (FCI), which is basically an extension of the monetary condition index (MCI). FCI, besides the interest rate and exchange rate, includes other financial variables — the variables that are important in the transmission of changes in the monetary policy to the output and inflation. Though many authors [Alchian and Klein, (1973), Shleifer and Vishny, (1990), Bernanke and Gertler, (1999), Cecchetti *et al.* (2000), and Mishkin, (2001)] emphasize the importance of asset prices, it was Goodhart (2001), who proposed first time a Financial Condition index where some weight could be assigned to asset prices and housing prices. Though FCI outperforms MCI [Goodhart and Hofmann (2002), Lack (2002)] nevertheless, this too suffers from certain criticisms leveled against MCI [Gauthier et at. (2004)]. These criticisms include model dependency, ignored dynamics, parameter inconstancy, and non-exogeneity of regressors. The other financial variables included in FCI, besides the interest rate (short term) and exchange rate, are long-term interest rate or a corporate bond risk premium and term spread. The existing FCIs also use different variables to represent equity market conditions. These include: the stock prices, the measures of stock valuation, the equity market capitalization-to-GDP ratio, the dividend price ratio, and a measure of household equity wealth, property prices and the monetary aggregates. [Goodhart and Hofmann (2001), and Mayes and Viren (2001)]

The Financial Condition Index that we constructed includes real income (y) (proxy: Industrial production index), inflation rate (π), reserve money (m), interest rate (ι), banks advances (l) (proxy for credit), and real exchange rate (e).the US real income (y*) (Proxy the US industrial production index) and federal fund rate (i*). Due to non-availability of data on asset prices in Pakistan, we used credit because a link between two exists-a rise in the asset prices that increases the borrowing capacity of individuals and firms by expanding the value of their collateral and increases bank credit (lending). The foreign variables are included to account for the external shocks[13].

Different approaches have been used to obtain the weights for variables being used to construct the FCI. Mostly the reduced-for VAR are used [e.g Gauthier et at. (2004)], yet others use semi- structural VAR [e.g. Fung and Yuan (2001), and Bernanke and Mihov (1998)].

[13]Some used world commodity prices[e.g. Fung and Yuan (2001), and Bernanke and Mihov (1998)] others used oil prices[e.g. Goodhart and Hofmann (2002), and Gauthier *et al*. (2004)]

We used the structural VAR model to obtain the impulse response functions and then construct weights for our financial variables. The structural VAR - being a standard methodology - is only briefly described below. SVARs are a multivariate, linear representation of a vector of observable variables on its own lags. These models are economically interpretable simplifications of VAR models where the identification restrictions are used according to some economic theories. A structural VAR model with eight endogenous variables is described by a structural form equation as:

$$G(L)z_t = \varepsilon_t \tag{6.3}$$

Where G(L) is a matrix polynomial in the lag operator L; z_t is the eight-dimensional vector variables including *y*, π, *m*, $\dot{\iota}$, *l*, *e*, *y**, *i**.; ε_t is eight-dimensional structural disturbances vector that contains shocks to a particular variable that are orthogonal to other shocks in the economy. These shocks are serially and mutually uncorrelated.

The reduced form representation that can be estimated is the following:

$$z_t = B(L)z_t + u \tag{6.4}$$

Where $E(u_t u'_t)_t = \Omega$ and $E(u_t u'_{t+s})_t = 0$

We my write G(L) as:

$$G(L) = G_0 + G_0(L)$$

Where, G_0 is a non-singular matrix and $G_0(L)$ be a coefficient matrix without G_0 . The link between the structural and reduced form can be written as:

$$B(L) = -G_0 G_0(L)\ ,\ G_0\mu_t = \varepsilon_t \text{ and } \Omega = G_0^{-1}\Lambda(G_0^{-1})$$

Here, B(L) is a matrix polynomial of order 12 and L is a lag operator, u are shocks not orthogonal to each other[14]. Ω is a positive definite matrix, and shocks are linearly independent. We have to estimate Λ and parameters in the structural form representation through Ω containing n(n+1)/2 i.e. 36 parameters, while $G_0^{-1} \Lambda (G_0^{-1})$ matrix has n(n+1) i.e. 72 parameters. So we need to impose n(n-1)/2 i.e. 28 more identification restrictions in order to recover structural form parameters.

We can recover the structural innovations from the residuals u_t. The next step is to obtain impulse response functions to trace out the effect of structural innovations on the observed variables.

Now, rewriting SVAR in vector moving average form in terms of structural innovations as:

$$z_{t_t} = \mu + \sum_{i=0}^{\infty} \phi_i \varepsilon_{t-i} \qquad (6.5)$$

Where ϕ_i are used to generate the effects of structural innovations on time paths of data sequences.

In an ideal situation, the identifying restrictions come from the fully specified macroeconomic model. In practice, this is rare and the common approach is to impose a set of identification restrictions that are consistent with the economic theory (Aslanidi, 2007). Uhlig (2005) argues that the complete model specification is not an easy task while applying the VAR. However, imposing restrictions consistent with the economic theory is typically not different from other specification methods [Leeper, Sims, and Zha (1996)]. The structural

[14] We use 12 lags on the basis of AIC Criteria.

shocks are identified from their reduced form counterparts by imposing restrictions on the contemporaneous coefficient matrix. We impose the following identifying restrictions:

$$\begin{bmatrix} \varepsilon_{i*} \\ \varepsilon_{y*} \\ \varepsilon_{y} \\ \varepsilon_{\pi} \\ \varepsilon_{m} \\ \varepsilon_{i} \\ \varepsilon_{l} \\ \varepsilon_{e} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \alpha_{32} & 1 & 0 & 0 & 0 & \alpha_{37} & 0 \\ 0 & 0 & \alpha_{43} & 1 & 0 & 0 & 0 & 0 \\ \alpha_{51} & 0 & \alpha_{53} & \alpha_{54} & 1 & \alpha_{56} & 0 & \alpha_{58} \\ 0 & 0 & 0 & 0 & \alpha_{65} & 1 & \alpha_{67} & \alpha_{68} \\ \alpha_{71} & 0 & \alpha_{73} & \alpha_{74} & \alpha_{75} & \alpha_{76} & 1 & 0 \\ \alpha_{81} & \alpha_{82} & \alpha_{83} & \alpha_{84} & \alpha_{85} & \alpha_{86} & \alpha_{87} & 1 \end{bmatrix} \begin{bmatrix} u_{i*} \\ u_{y*} \\ u_{y} \\ u_{\pi} \\ u_{m} \\ u_{i} \\ u_{l} \\ u_{e} \end{bmatrix} \qquad (6.6)$$

Here ε_{i*}, ε_{y*}, ε_{y}, ε_{π}, ε_{m}, ε_{i}, ε_{l}, and ε_{e} are structural disturbances representing foreign interest rate (i*), foreign GDP (y*), GDP (y), inflation rate(π), rate, reserve money(m), nominal interest rate ($\dot{\iota}$), banks credit (l), and real exchange rate (e) shocks. While u_k are residuals from reduced form equation showing unexpected movements of each variable given the information in the system.

Considering the system, equation by equation, we impose the following restrictions consistent with *a priori* theoretical expectations. The external variables [the first and second equations in system (6.6)] are unaffected by the contemporaneous movements in any domestic variable. However, the transmission of international shocks to the domestic economy can be very rapid. The third and the fourth equations (aggregate demand and inflation) characterize the equilibrium in goods market. The large number of zero restrictions reflects the idea of nominal rigidities (Kim and Roubini, 2000). That is, the real activity responds to prices, financial signals and the foreign variables, only with lag. However, the domestic GDP is assumed to be influenced contemporaneously by shock to credit, reflecting a quick pass-through of credit to an aggregate demand (Safaei and Cameron, 2003). The rationale is that given the cost of borrowing, the credit will be spent as soon as funds are obtained and this adds to aggregate demand immediately. We also allow for the possibility of the contemporaneous response of prices to output [see Bernanke and Blinder (1992)].

The fifth equation represents the money demand that depends on real income, the opportunity cost of holding money in the domestic currency (nominal interest rate), and the opportunity cost of holding money in the foreign currency. The sixth equation is a reaction function of the monetary authority. Here inflation and output are excluded due to informational lags. That is, the interest rate responds contemporaneously only to credit, the monetary aggregates, and the exchange rate.

Credit [equation seven in (6.6)] is assumed to respond contemporaneously to the domestic output, the money demand, prices, the domestic interest rate and the foreign interest rate.

The exchange rate [last equation in (6.6)] enters endogenously and is assumed to respond contemporaneously to all the variables in the system under a floating exchange rate regime.

For the identification, we need at least 28 restrictions, whereas we have already imposed 33 zero restrictions. No further restrictions, therefore, on lagged structural parameters are needed.

6.6. Empirical Results

In this section, we present the empirical results for the two conditioning measures discussed in the previous section. As some of the data series are non-stationary, we took an appropriate difference on the basis of the results obtained by the seasonal unit root test in the chapter 5 to make the series stationary. The results from estimation of the two composite measures *viz.* MCI and FCI are presented below.

Monetary Condition Index:

To compute MCI, we estimate the equations (6.1) and (6.2). The equations are reproduced below for convenience of the readers. We used three dummies: one for 03:1992 to capture the structural changes due to reforms, and the other two are event dummies. One for 06:1998 and the other 11:2001. Only first dummy is statistically significant. The reasons that the event dummies (06:1998 and 11:2001) are insignificant could be that adverse impact of aid sanctions (06/98) has been nullified by the favorable impact of 9/11. The favorable impact being due to Pakistan becoming the US ally in war against terrorism,[15] Our Philips curve (second equation below) does not play any role in the analysis; it is included to fulfill the theoretical desirablility for data[16].

$$Y_t = \alpha_1 + \sum_{t=0}^{n} \lambda_i e_{t-i} + \sum_{t=0}^{n} \eta_i i_{t-i} \sum_{k=1}^{p} \gamma_k y_{t-k} + \varepsilon_{yt}$$

$$\pi_t = \alpha_2 + \sum_{i=1}^{m1} \beta_{1i} \pi_{t-i} + \sum_{j=1}^{m2} \beta_{2j} y_{t-j} + \varepsilon_{\pi t}$$

The estimation yields the following:

$$\begin{aligned} y_t = & -0.32y_{t-1} - 0.18y_{t-2} - 0.21y_{t-3} - 0.27y_{t-4} - 0.31y_{t-5} - 0.27y_{t-6} - 0.31y_{t-7} - 0.31y_{t-8} \\ & - 0.19y_{t-9} - 0.22y_{t-10} + 0.28y_{t-12} - 1.6e_{t-1} - 1.5e_{t-7} - 0.52i_{t-2} - 0.41i_{t-11} + 0.31y^*_{t-3} + \\ & 0.68y^*_{t-4} + 0.60y^*_{t-5} + 0.68y^*_{t-6} + 90y^*_{t-7} + 0.50y^*_{t-10} - 0.04i^*_{t-3} - 0.02i^*_{t-10} + 0.006d_1 \end{aligned}$$

and

$$\begin{aligned} \pi_t = & \ 0.11\pi_{t-1} + 0.31\pi_{t-3} + 0.01y_{t-7} + 0.1y_{t-8} + 0.01y_{t-9} + 0.06y^*_{t-1} + 0.07y^*_{t-2} - \\ & 0.07y^*_{t-4} + 0.05y^*_{t-5} + 0.08y^*_{t-6} + 0.12y^*_{t-7} + 0.07y^*_{t-8} - 0.002i^*_{t-9} + 0.002d_1 \end{aligned}$$

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15 This point was made by one of the external referee.
16 See Gauthier *et al*. (2004)

The weights for summarized coefficients of MCI are obtained by adding the respective coefficients of lags on exchange rate and interest rate in the IS-equation (first equation above)..

$$w_1 = 1.6 + 1.5 \qquad = 3.1$$
$$w_2 = 0.52 + 0.41 \quad = 0.9$$

And then by dividing w1 and w2 on the sum w1+w2 as:

$$\omega_e = \frac{w_1}{w_1 + w_2} = \frac{3.1}{4.0} = 0.77$$
$$\omega_i = \frac{w_2}{w_1 + w_2} = \frac{0.9}{4.0} = 0.23$$

The weights for individual coefficients of MCI are obtained by dividing individual coefficients of lags on exchange rate and interest rate in the same equation on sum= $w_1 + w_2$.

i.e. $\omega_{i,t-j} = \frac{coefficient}{w_1 + w_2}$, where i=1, 2, 1 stands for exchange rate and 2 for interest rate and j for the lag corresponding to the coefficient.

We, then, construct monetary condition index (summarized coefficient) as:

$$\text{MCI}_t = 0.77(e_t - e_0) + 0.23(i_t - i_0),$$

The base period chosen for the construction of the index is 1992 - 03.

Then monetary condition index (individual coefficient) is constructed as:

$$\text{MCII}_t = 0.3(e_{t-1} - e_0) + 0.4(e_{t-7} - e_0) + 0.2(i_{t-2} - i_0) + 0.1(i_{t11} - i_0),$$

where χ_{i0} is value of variable the in the base period.

Financial Condition Index (FCI):

We estimate the eight variables model given by (6.4) and obtain the weights from impulse response function by imposing the restrictions given in (6.6).

Then we obtain FCI as:

$$FCI = -0.25\, m_t - 0.3\, l_t + 0.22\, i_t + 0.23\, e_t$$

6.7. Monetary Condition Index versus Financial Condition Index

Regarding the first criterion by which we judge the performance of our different policy measures i.e. consistency of estimated weights with economic theory, the results show that our summarized coefficient MCI carries estimated weights for real interest rate (i) and real exchange rate(e), 0.23 and 0.77 respectively. This implies a rise in the MCI, either through the appreciation of exchange rate or an increase in the interest rate represents a contractionary monetary policy. The weight for the interest rate is smaller as compared to the exchange rate, which shows that the exchange rate has a dominant role in the economy.

Similarly, the weights obtained for individual coefficients MCI are in accordance with the theory (coefficients of both exchange rate and interest rate are negative for all lags).

The weights obtained for the Financial Condition Index are also consistent with the theory. The weight for the market interest rate and the exchange rate are positive, which means that a higher interest or exchange rate implies a tight monetary policy and vice versa. The sign of the weight for reserve money and banks advances are negative, which implies that the higher growth of reserve money or banks advances will result into a higher output growth i.e. lose monetary policy i.e. expansionary monetary policy.

The second criterion is to see the dynamic correlations between 'GDP - Growth/ change in inflation' and the change in MCI/FCI. We can see in table 6.2 below that the FCI has stronger and negative correlations with output-growth at different lags though MCIs show a higher correlation with the output-growth and change in inflation at some of the lags.

Table 6.1

Dynamic Correlations between GDP - Growth/ Inflation and change in MC/FCI

Leads Month	Different measures					
	Change in MCI (IS individual coefficients)		Change in MCI (IS-summarized coefficients)		Change in FCI	
	GDP Growth	Changes in Inflation	GDP Growth	Changes in Inflation	GDP Growth	
0	-0.05	-0.07	-0.11	0.04	-0.10	-0.12
1	0.15	0.02	0.09	-0.03	-0.19	0.03
2	-0.09	0.12	-0.09	-0.03	0.09	0.04
3	-0.06	-0.16	-0.08	0.10	-0.08	-0.13
4	0.13	0.07	0.05	-0.14	-0.06	-0.08
5	-0.12	0.02	-0.05	0.09	0.06	-0.05
6	0.05	-0.06	0.05	-0.02	-0.05	-0.03
7	0.07	0.02	0.05	-0.07	-0.04	0.07
8	-0.08	0.06	-0.06	0.04	0.06	0.01
9	-0.04	-0.09	-0.02	0.09	0.02	-0.10
10	0.09	0.02	0.05	-0.12	-0.15	0.06
11	-0.09	0.04	-0.04	0.02	-0.14	0.03
12	0.07	-0.04	0.04	0.05	-0.04	-0.13

The third criterion by which we compare the performance of our measures is visual inspection vis-à-vis the GDP Growth as well as changes in inflation (Graphical inspection of the turning points). Figure 6.1compares different measures with the GDP-Growth while figure 6.2 compares different measures with the change in inflation. Figure 6.1(a), 6.1(b), and 6.1(c) show that all measures perform well *viz-a-viz* GDP- Growth, as upturns of GDP- Growth match with downturns of these measures after 1992 and vice versa, which implies that a higher GDP- Growth is associated with expansionary monetary policy while the lower GDP- Growth is associated with a tighter policy. Similar conclusions can be drawn from the inspection of figure 6.2.

Figure 6.1(a): Change in GDP-Growth and Change in MCII

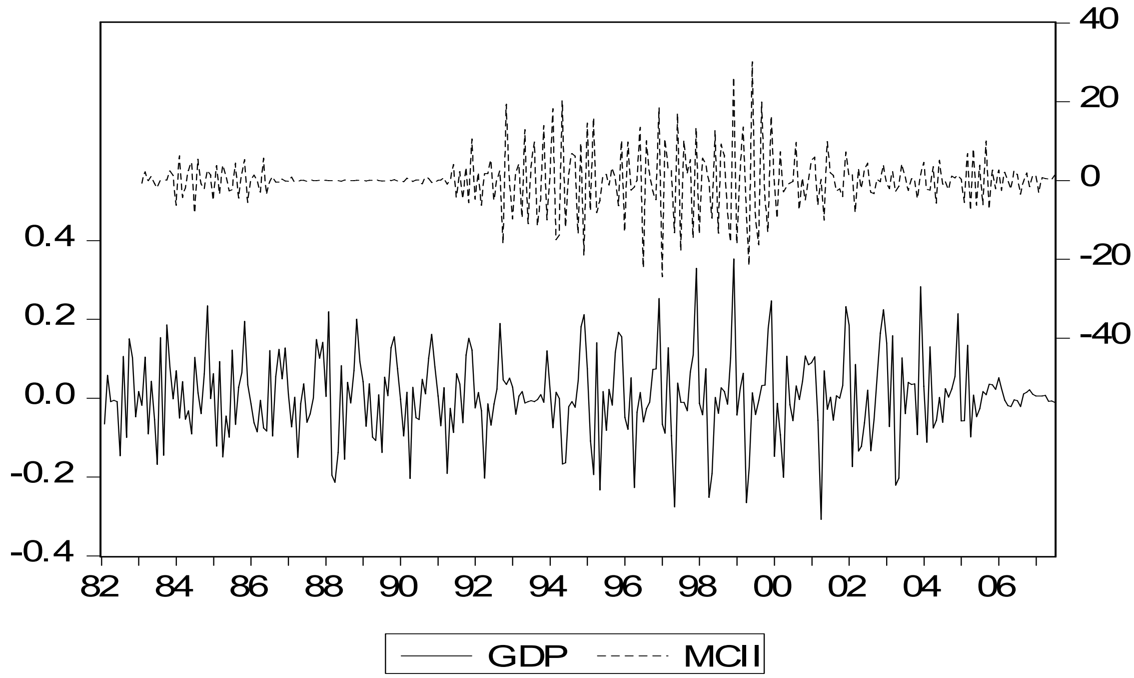


Figure 6.1(b**):** Change in GDP- Growth and Change in MCIS

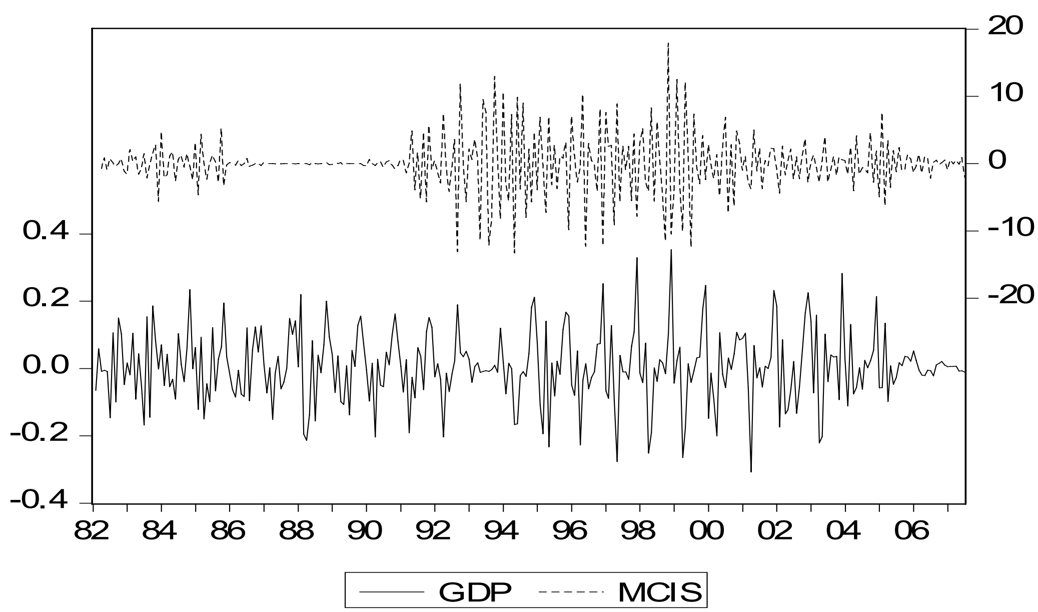


Figure 6.1(c): Change in GDP- Growth and Change in FCI

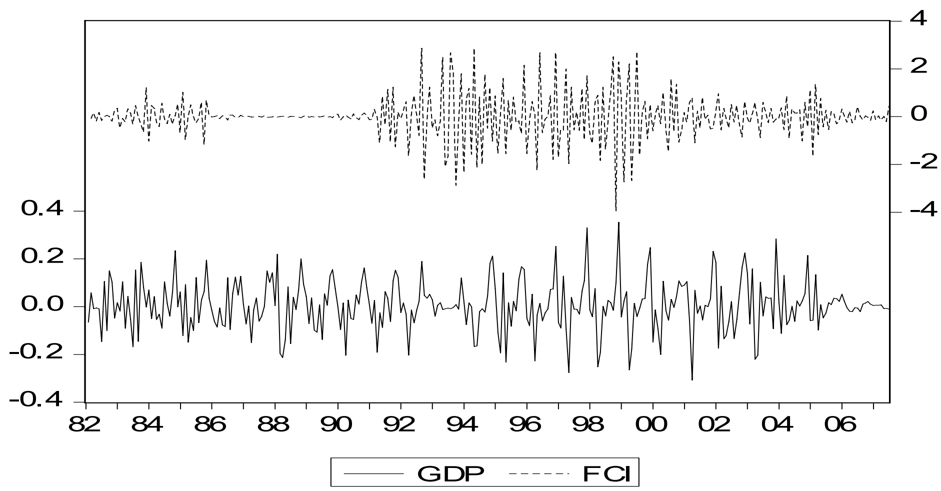


Figure 6.2(a): Change in Inflation and Change in MCII

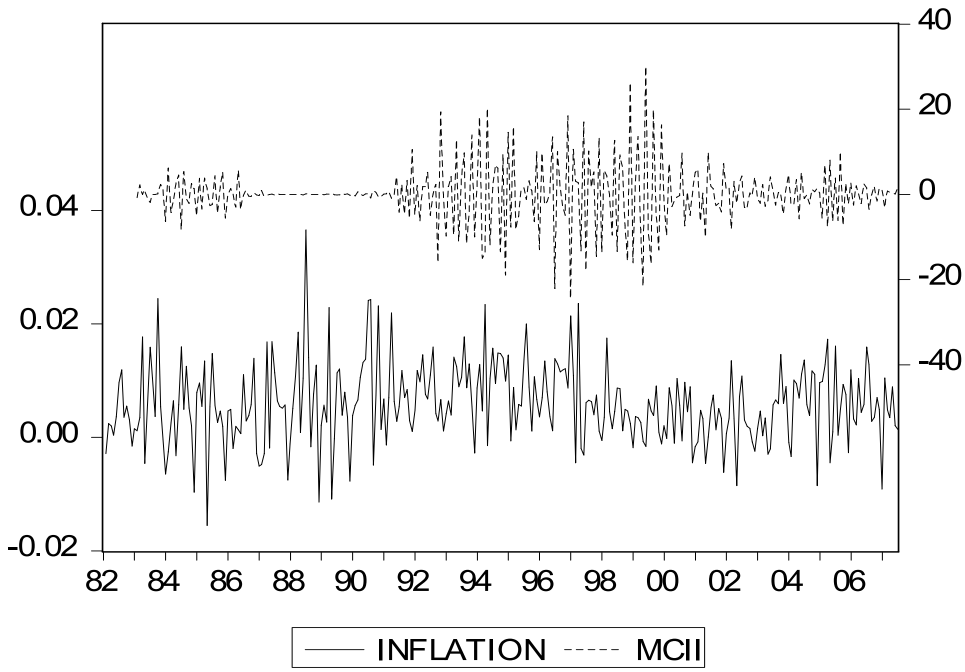


Figure 6.2 (b): Change in Inflation and Change in MCIS

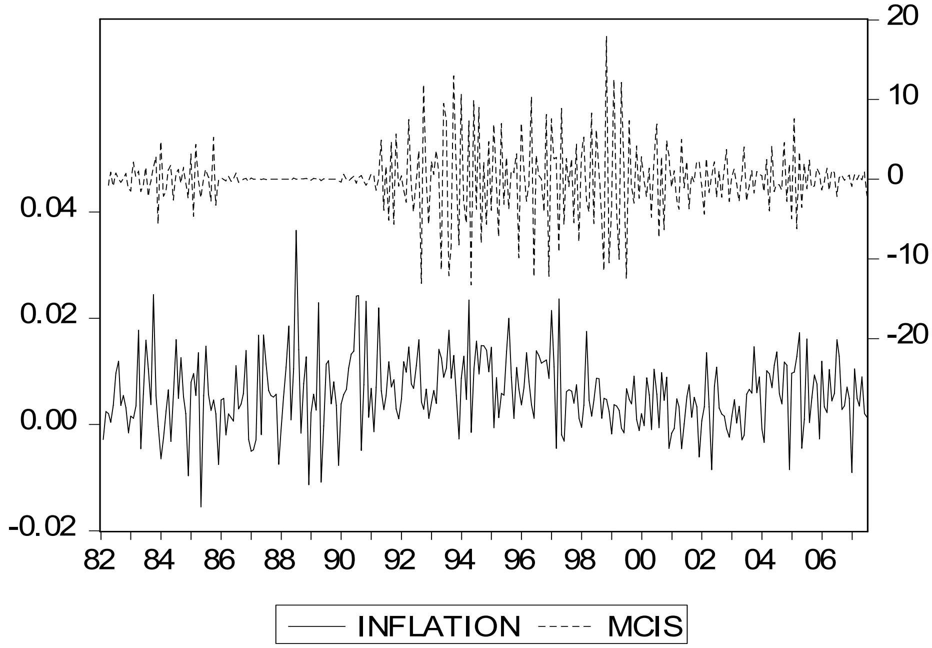
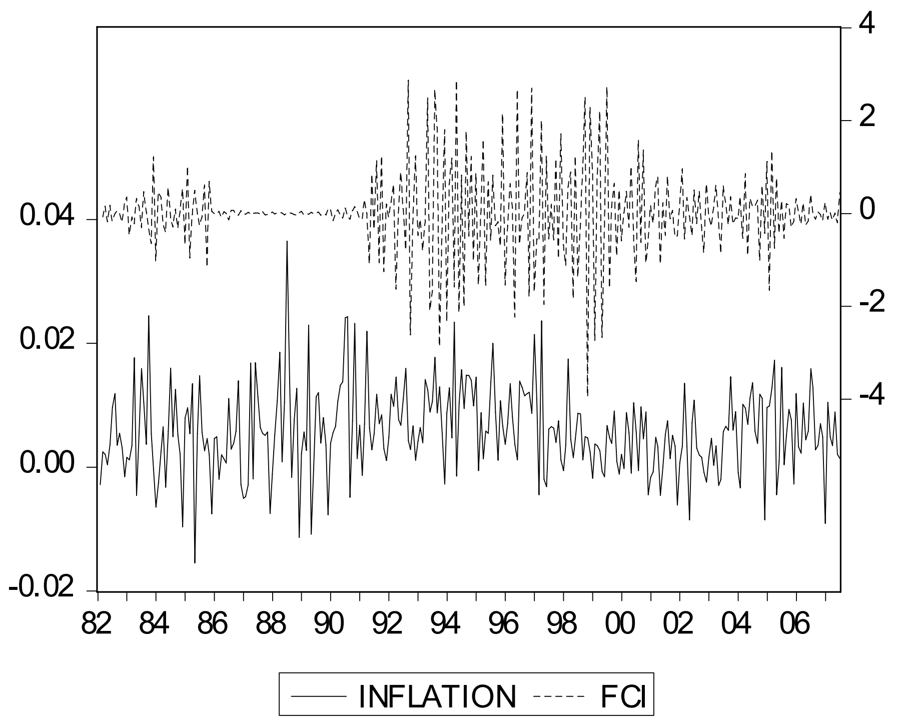


Figure 6.2(c): Change in Inflation and Change in FCI



Next, the stance indices that we have constructed (MCI and FCI) from 1984 to 2006(year average) and one year GDP- Growth and changes in inflation for each year are compared. To compare the stance, the indices have been normalized to a scale. We multiplied these measures by normalizing factors that equate maximum and minimum values respectively to -2 and +2. The scale is presented below in table 6.2.

Table 6.2: Normalized Scale of policy stances (MCI & FCI)

Scale	**Policy**
-2	Very loose
-1	Mildly loose
0	Neutral
+1	Mildly tight
+2	Very tight

In order to draw some meaning from the comparison of policy stances with the GDP Growth and change in inflation each year is labeled either as demand dominated shock (D) or supply dominated shock(S) according to co-movements of the GDP Growth and change in inflation. In any given year, if GDP Growth and inflation move in the same direction, the year is considered to be demand-dominated shock; otherwise it is considered as supply-dominated shock. If the GDP Growth and inflation both increase together then it would be a positive demand shock and if both decrease together then it would be a negative demand shock. Similarly, if the GDP Growth increases but inflation decreases then it would be a positive supply shock and if the case is opposite then it would be a negative supply shock [for more details see Fung and Yuan, (2001))

The comparison of policy stances with the GDP Growth and inflation is presented in the table 6.3 below:

Table 6.3

MCI/FCI as Indicator of Demand Shocks (1984 to 2006)

year	Y_t-Y_{t-12} (GDP-Growth)	π_t- π_{t-12} Change in Inflation	MCI (individual coefficient)	MCI(summarized coefficient)	(FCI)	D or S
1984	0.16	-0.008	1	0	0	+s
1985	0.255	0.014	-1	0	0	+d
1986	0.04	-0.003	1	0	-1	+s
1987	0.08	-0.009	1	0	0	+s
1988	0.09	0.004	0	0	0	+d
1989	0.04	0.003	0	0	0	+d
1990	0.05	0.002	0	0	0	+d
1991	0.05	0.003	-1	0	0	+d
1992	0.05	-0.002	0	0	0	+s
1993	0.06	-0.001	0	-2	-1	+s
1994	0.08	0.004	-2	2	-2	+d
1995	0.07	0.006	1	-2	2	+d
1996	-0.06	-0.011	-1	0	0	-d
1997	-0.04	0.018	0	-2	2	-s
1998	-0.01	-0.001	1	1	-1	-d
1999	-0.04	0.004	2	2	0	-s
2000	0.08	-0.004	-2	0	-2	+s
2001	0.19	0.002	1	2	-2	+d
2002	0.01	0.001	1	0	0	+d
2003	0.06	-0.002	1	1	-1	+s
2004	0.09	0.011	0	-2	-2	+d
2005	0.08	0.002	-2	-1	1	+d
2006	0.01	-0.020	-1	-1	1	+s

In the 23-years data span, the period from 1984 to 2006, we observed that the demand shocks have dominated for about 13 years and the supply shocks have dominated for the remaining 10 years. MCI (IS-Individual coefficient) can explain 3 of these 13 demand shocks (assuming that policy affects the economy with a lag of 1-year): for the years1995, 1996 and 2001. MCI (IS-summarized coefficient) can explain 2 of these: 1994 and 2005. While the FCI explains 8 of these: 1994, 1995, 1996, 1998, 2001, 2002, 2004 and 2005. All the three measures fail to capture demand shocks before 1991. Thus, our analysis suggests that the FCI plays an important role in indicating the movements of the GDP Growth and inflation when the economy is not dominated by the supply shocks[17]. The possible explanation of positive demand shocks in 1994-1995 can be that the economy was recovering from the supply shocks occurred in 1991-1992 because of poor agriculture performance and the Gulf war that resulted into a recession around the globe. However, the economy could not keep the track and growth rate fell down in 1996 mainly due to political instability in the country. The economy witnessed yet another shock in 1998 when it was coping to recover itself from the earlier one. In May 1998, Pakistan went 'Nuclear" and some sanctions including the sanctions on the foreign aid were imposed. Meanwhile, the military took over in 1999 and additional sanctions were imposed by the Commonwealth. Till 2001, Pakistan's economy suffered a lot through these sanctions. However, after the 9/11, capital inflows increased and with it increased the foreign remittances as well as the foreign aid. This trend helped the economy not only in recovering from the earlier shocks but it changed the growth pattern as well. Pakistan's economy experienced a remarkable growth pattern from 2003 to 2007. The average real GDP growth during 2003-07 was recorded 7.0 percent. This showed Pakistan as one of the fastest growing economies in the region (after China, and India). The good performance was mainly owed to the favoring geo-political environment.

These results may be taken with cautions, as the industrial production (IP) index - the proxy used for the GDP may not entirely reflect the movements in GDP. Such shocks to IP index are possible that are not transmitted to overall economy[18].

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[17]It is note worthy here that negative signs with output growth (inflation) does not mean that growth(inflation) was negative rather it means growth rate was slower in current year than in the previous year. As figures in table 6.3 are changes in growth rather than growth itself.

[18] Besides, the GDP growth may differ from the annual growth of IP as we obtained the average annual change by taking twelfth difference of monthly series, for example (Dec.2003-dec2004). We have checked this for the

6.8. Conclusions

In this chapter, we provided a brief detail of different measures of the monetary policy stance discussed in the literature. The stance of a monetary policy regarded as a quantitative measure for determining whether the policy is too tight, neutral or too loose in relation to the objectives of stable prices and output growth is useful and important for at least two reasons: Firstly, it helps the authority (the central bank) to determine the course of monetary policy needed to keep the objectives (goals) within the target range. Secondly, a quantitative measure of the stance is important for empirical study of the transmission of monetary policy actions through the economy. Having a flawless measure of a monetary policy stance, however, is not an easy task as rightly pointed out by Gecchetti (1994) that "there seems to be no way to measure monetary actions that does not raise serious objections".

We constructed two measures viz. a monetary condition index and a financial condition index. Then, we have compared these measures - on the basis of certain performance criteria i.e. the consistency of the estimated weights - with the economic theory, visual inspection vis-à-vis output growth, the changes in inflation (Graphical inspection of turning points) as well as its dynamic correlation with the GDP growth and inflation.. The comparison revealed that the FCI performed better than both MCIs. We, then, identified the demand shocks and the supply shock by looking at co-movements of the GDP growth and inflation rate. The results show that most of the demand shock (whether positive or negative) are explained by FCI but MCIs can explain only a few of these shocks. Thus, the FCI can be

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annual GDP and IPI series and found that changes in growth of both series are more or less the same. However, changes in the two series differ for monthly data. Another point to note is that fiscal year cover from July (previous year's) to June (current year's).

used as an indicator of monetary policy the transfer function model in the next chapter. Main policy implication that come out of these results are that the SBP may consider more financial variables rather than just looking at interest rate and exchange rate while formulating a monetary policy,.

7 Impacts of Monetary Policy on GDP Growth, Its Channels and Lags

7.1. Introduction:

Two of the objectives of this study indicated earlier as well are:

(i) To analyze the strength of different channels of monetary policy transmission mechanism.

(ii) To analyze the lags involved in different channels of monetary

To achieve above mentioned objectives empirically we have used transfer function methodology explained in chapter 4. In this chapter we present the results obtained from estimation of transfer function model for GDP growth and for inflation in next chapter.

One way to identify the transfer function is through pre-whitening (Box and Jenkin1976). For this, we have to identify a univariate ARMA (p, q) of each input series (which is also output series in our case). On the basis of correlogram, autocorrelation functions, and partial correlation functions of the suitably transformed data[19], different plausible models are estimated. Then the best fitted model (on the basis of quality of estimated coefficients, minimum AIC and SBC, and white-noise residual) is selected for each input series. Next we pre-whiten each input series by its own ARMA model and each output series once for each input series. After having pre-whitened the series we use Muller and Wie iterative procedure for transfer function identification, and coefficients are estimated using Gauss Newton algorithm for non-linear estimation. The results obtained from following the procedure mentioned above are presented in the sections ahead.

[19] We take the appropriate difference of the series depending upon the seasonal unit root test.

7.2 Univariate Analysis:

The first step in identification of transfer function is to identify the Autoregressive Moving Average (ARMA) model for each of the input series so that the input series and output series can be pre-whitened. For this purpose we used correlogram(Autocorrelation and Partial Correlation Functions) of each of the input series.

Figures 7.1 to 7.9 show the correlogram of different series, while Auto-correlations and partial correlations are given in table 7.1.

Figure 7.1(a): Autocorrelation Functions of GDP-Growth (y)

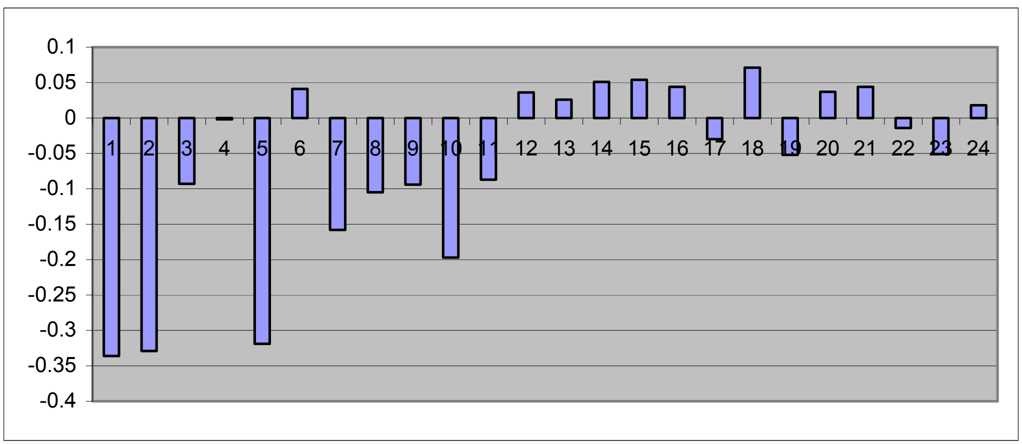


Figure 7.1(b): Partial Correlation Functions of GDP-Growth (y)

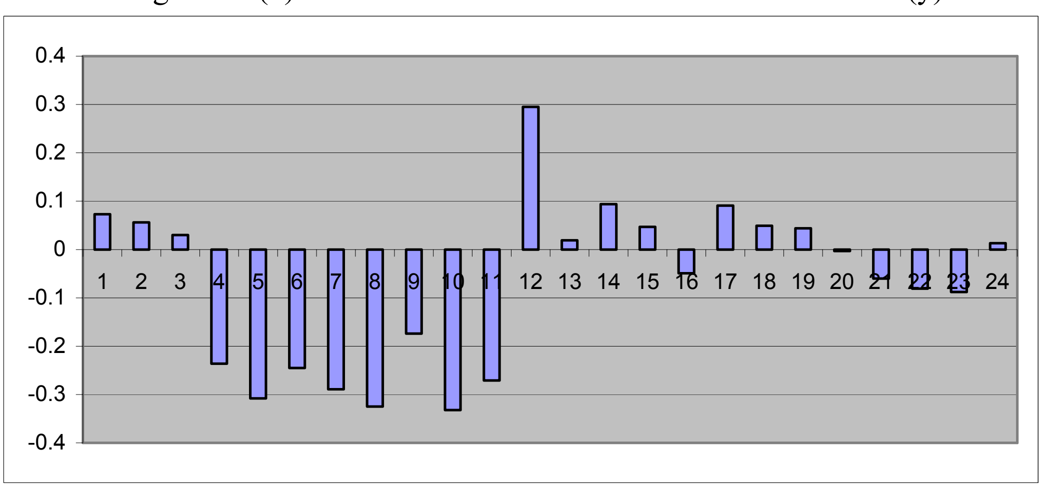


Figure 7.1 shows that spikes, in both Autocorrelation and Partial Correlation Functions, disappear after twelfth lag thus indicating an ARMA (12, 12) for the GDP growth series. Then we estimate different specification of ARMA model up to AR (12) and/or MA (12) for this series. The most plausible specification is presented in table 7.2.

Figure 7.2(a): Autocorrelation Functions of Inflation (π)

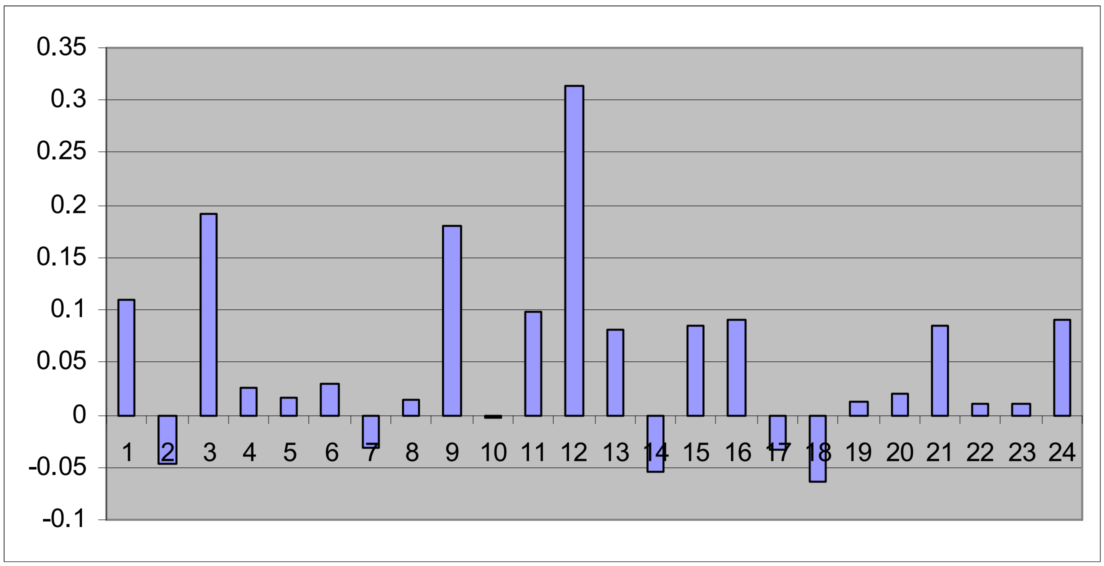
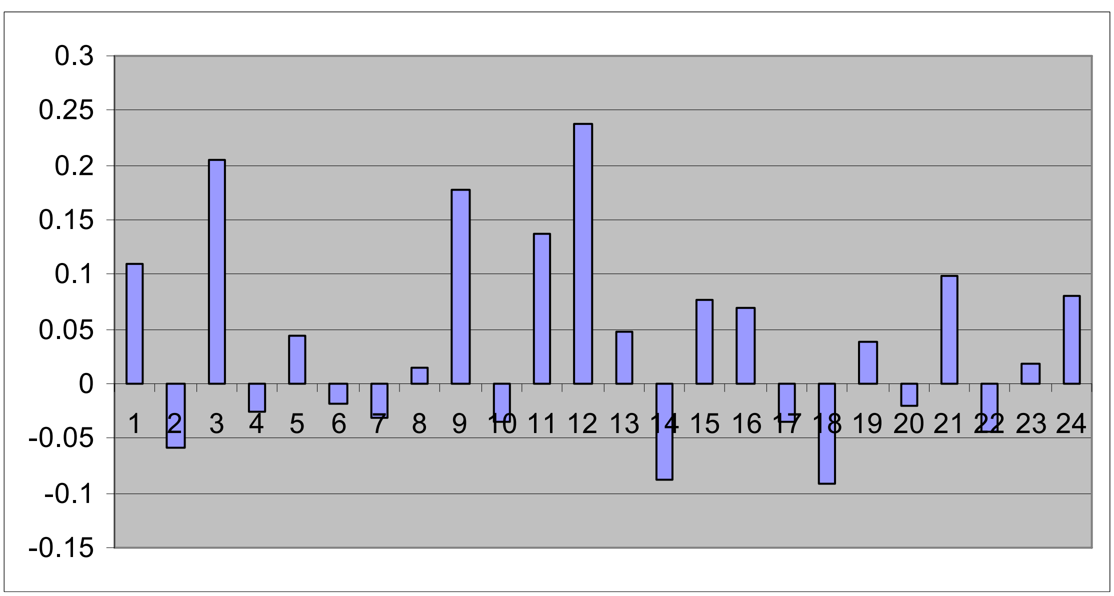


Figure 7.2(b): Partial Correlation Functions of Inflation (π)



In Figure 7.2 all the spikes after twelfth lag, in both Autocorrelation and Partial Correlation Functions, die off so expect again an ARMA (12, 12) for the inflation series. Then we estimate different specification of ARMA model up to AR (12) and/or MA (12) for inflation. The best fitted model is given in table 7.2.

Figure 7.3(a): Autocorrelation Functions of Reserve Money (m)

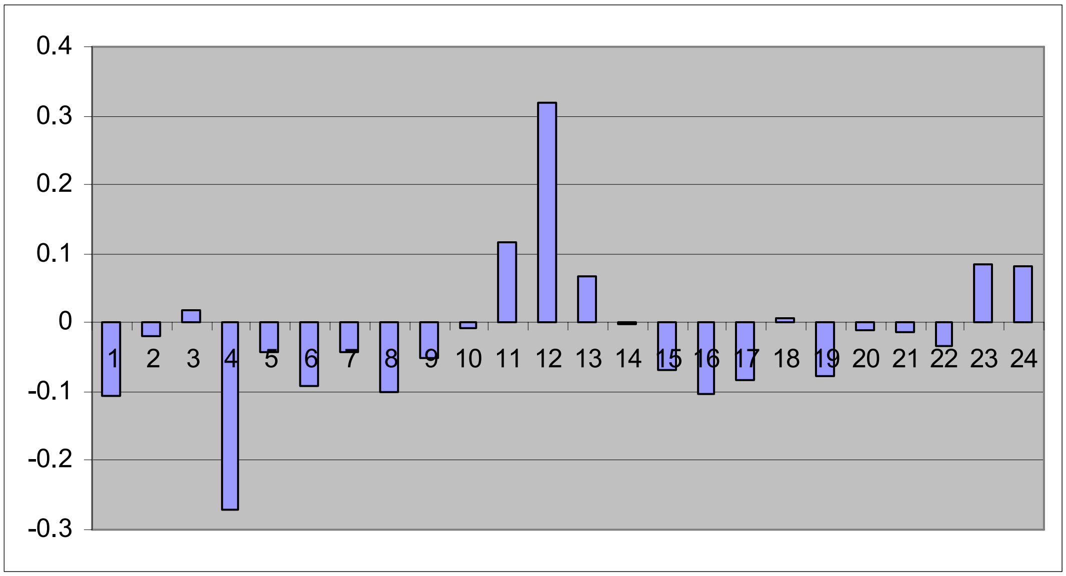
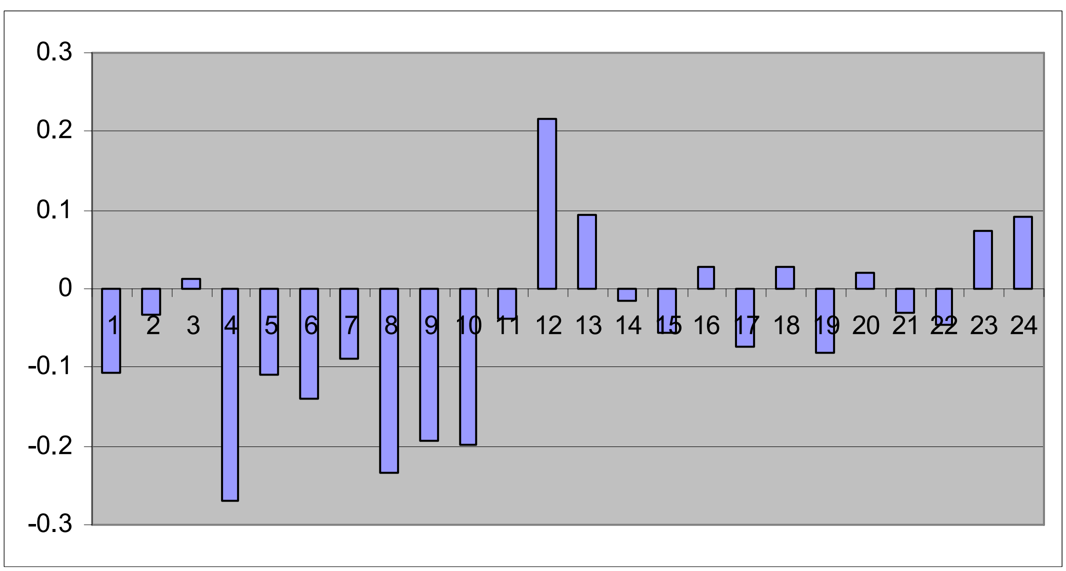


Figure 7.3 (b): Partial Correlation Functions of Reserve Money (m)



As can be seen from Figure 7.3 both Autocorrelation and Partial Correlation Functions vanish after lag 12 which shows that reserve money also follows ARMA (12, 12). So we estimate different specification of ARMA model up to AR (12) and/or MA (12) for reserve money. The best fitted model is presented table in 7.2.

Figure 7.4(a): Autocorrelation Functions of Credit (l)

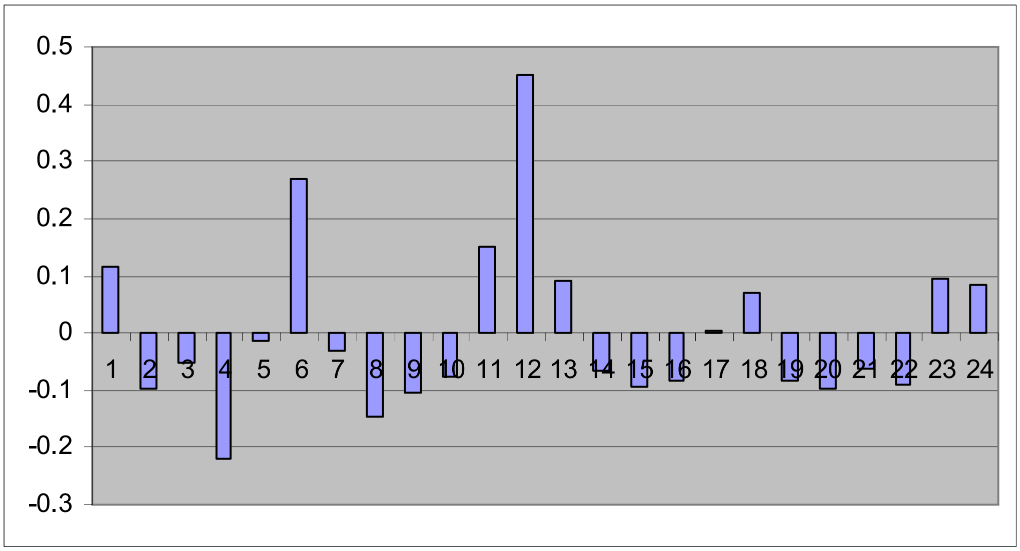


Figure 7.4(b): partial correlation Functions of Credit (l)

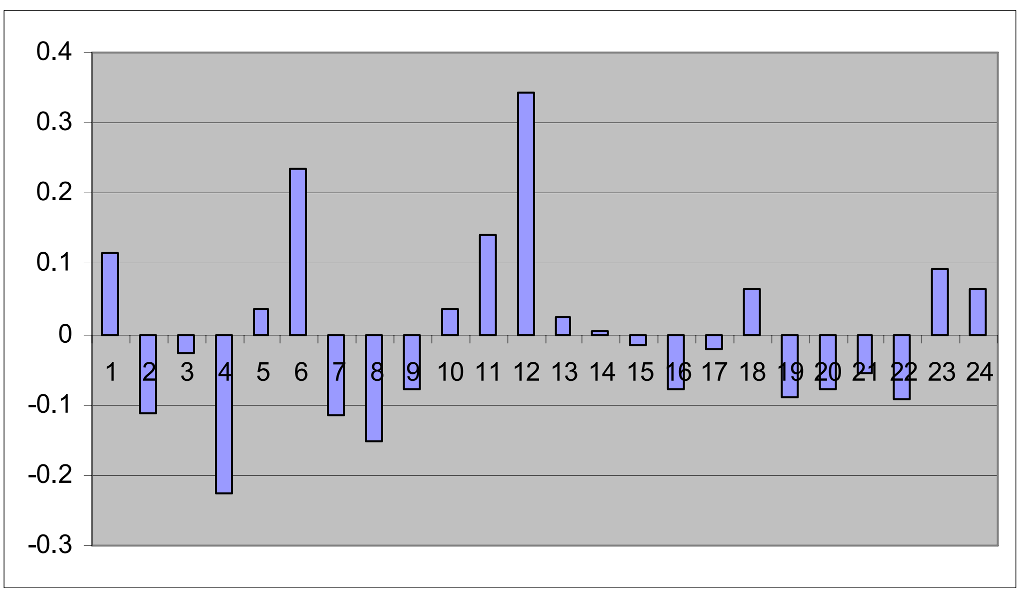


Figure 7.4 shows that spikes, in both Autocorrelation and Partial Correlation Functions, disappear after twelfth lag thus indicating ARMA (12, 12) for the credit series. Then we estimate different versions of ARMA model up to AR (12) and/or MA (12) for this series. The most plausible specification is presented in table 7.2.

Figure 7.5(a): Autocorrelation Functions of Interest Rate (*i*)

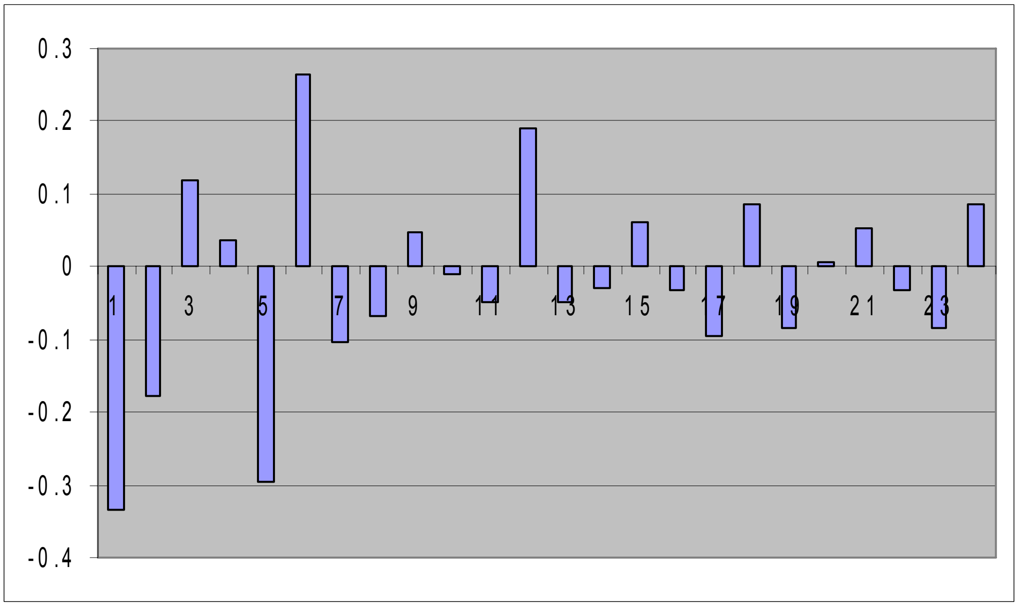
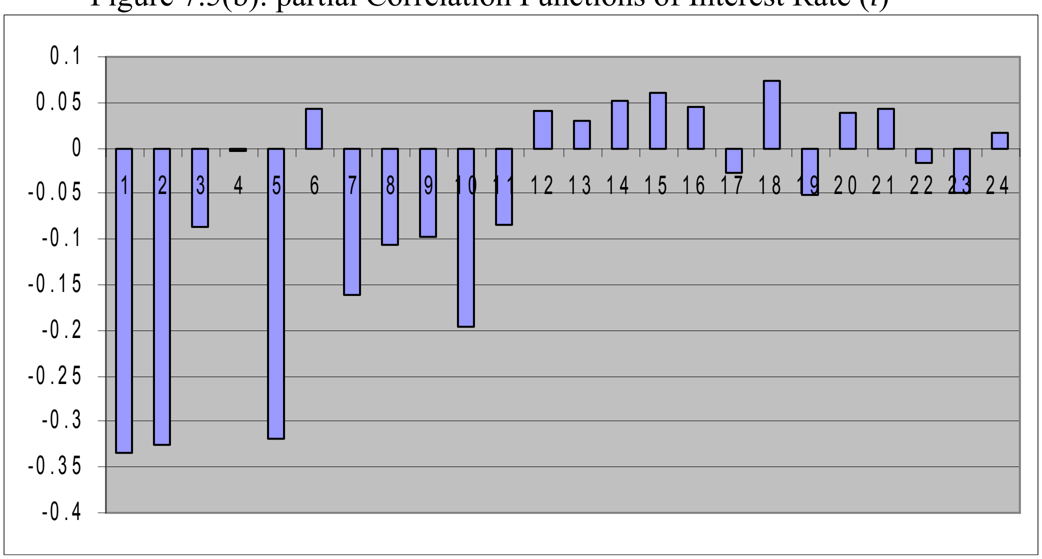


Figure 7.5(b): partial Correlation Functions of Interest Rate (*i*)



In Figure 7.5 all the spikes of Autocorrelation die off after twelfth lag and that of Partial Correlation Functions die off after tenth lag so we expect an ARMA (10, 12) for interest rate series. Then we estimate different specification of ARMA model up to AR (10) and/or MA (12) for this series. The best fitted model is given in table 7.2.

Figure 7.6(a): Autocorrelation Functions of Exchange Rate (*e*)

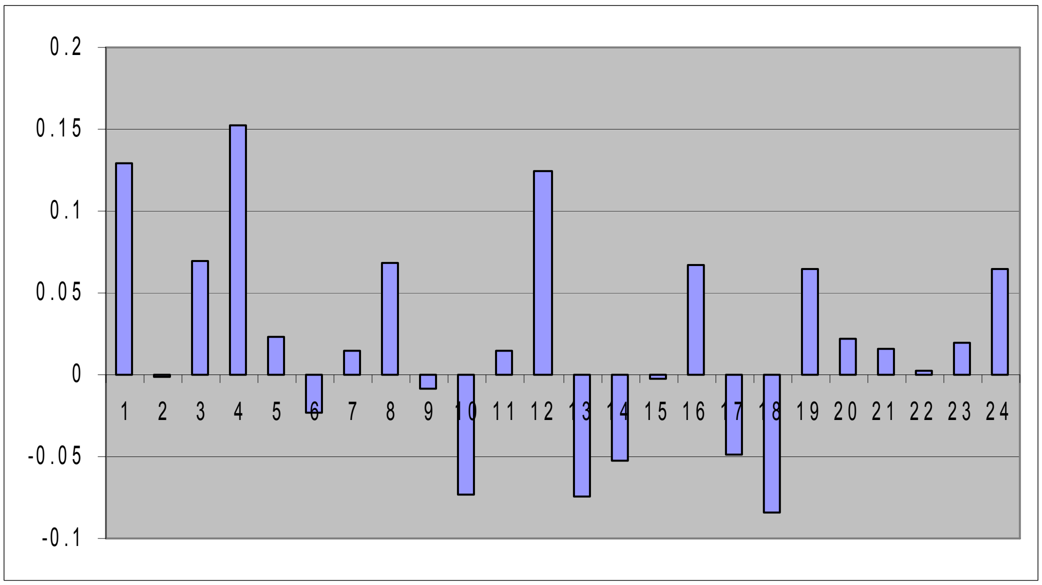
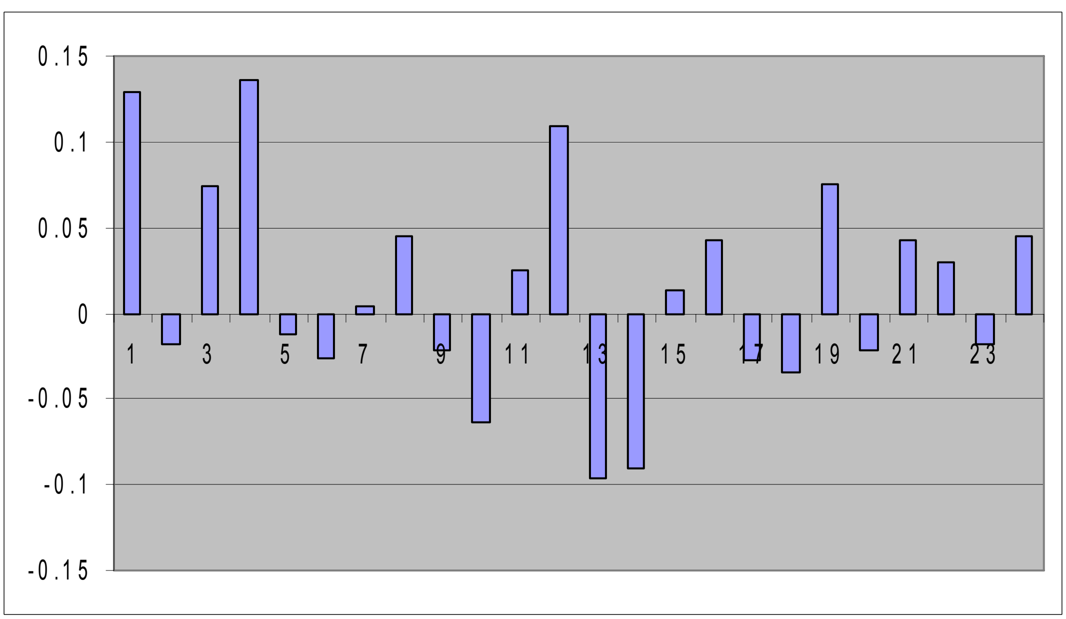


Figure 7.6(b): partial correlation Functions of Exchange Rate (*e*)



As can be seen from Figure 7.6, both Autocorrelation and Partial Correlation Functions die off after lag 12 that means exchange rate also exhibits an ARMA (12, 12). Then we estimate different specification of ARMA model up to AR (12) and/or MA (12) for inflation. The best fitted model is given in table 7.2.

Figure 7.7(a): Autocorrelation Functions of foreign GDP-Growth (y^*)

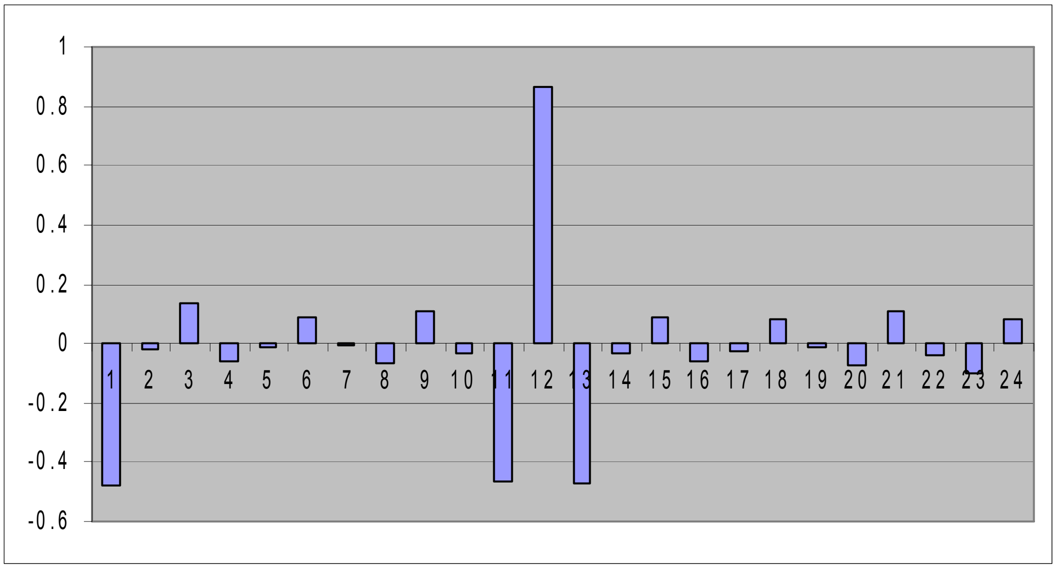


Figure 7.7(b): Partial Correlation Functions of Foreign GDP-Growth (y^*)

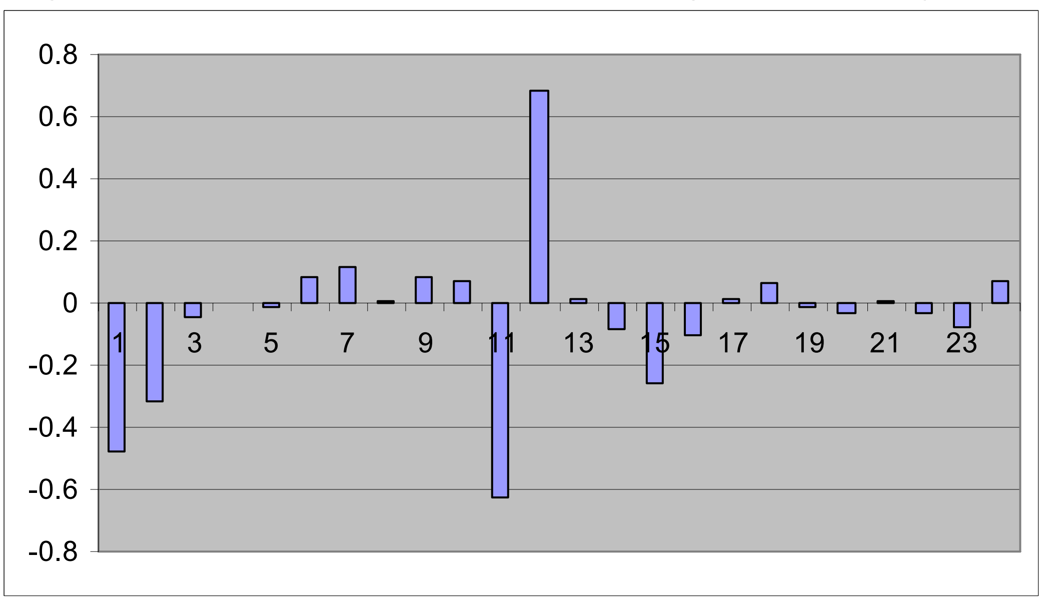


Figure 7.7 shows that spikes, in both Autocorrelation and Partial Correlation Functions, disappear after twelfth lag thus indicating ARMA (12, 12) for the foreign GDP growth series. Then we estimate different versions of ARMA model up to AR (12) and/or MA (12) for this series. The most plausible specification is presented in table 7.2.

Figure 7.8(a): Autocorrelation Functions of Foreign Interest Rate ($i*$)

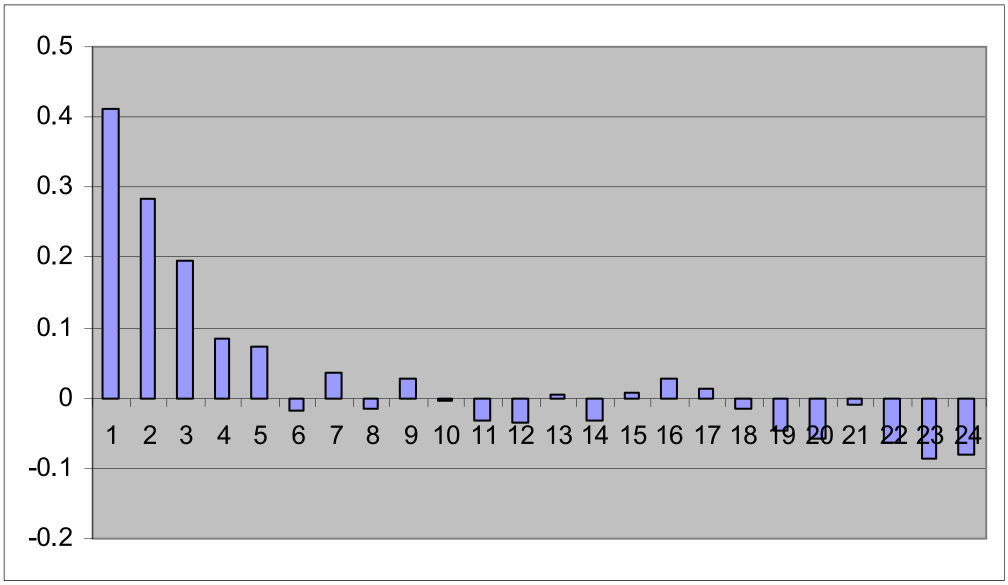
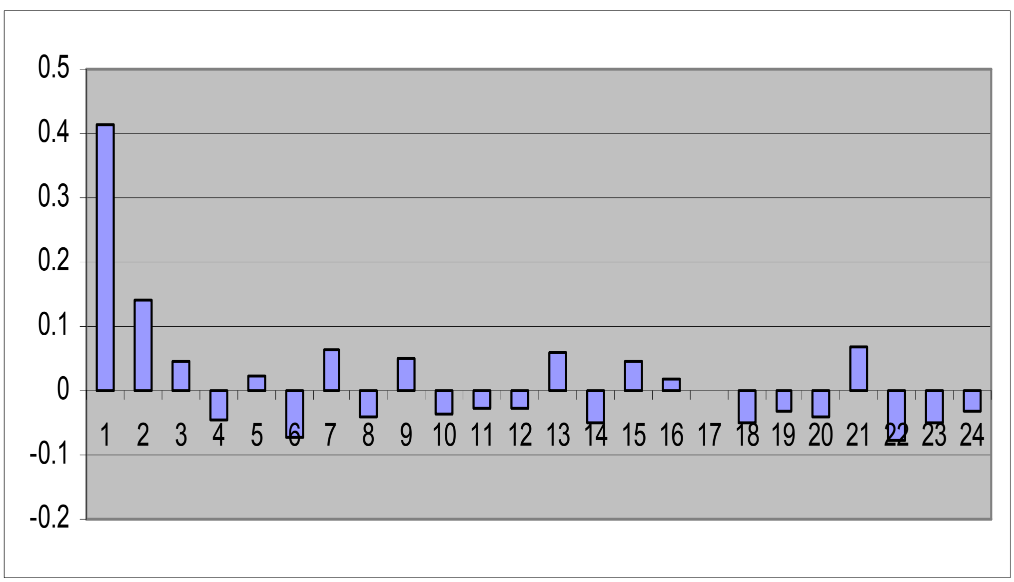


Figure 7.8(b): Partial Correlation Functions of Foreign Interest Rate ($i*$)



In Figure 7.8 all the spikes of Autocorrelation die off after third lag while spikes of Partial Auto-correlation Functions die off after second lag so we expect an ARMA (2, 3) for foreign interest rate series. Then we estimate different specification of ARMA model up to AR (2) and/or MA (3) for this series. The best fitted model is given in table 7.2.

Figure 7.9(a) Autocorrelation Functions of Financial Condition Index (FCI)

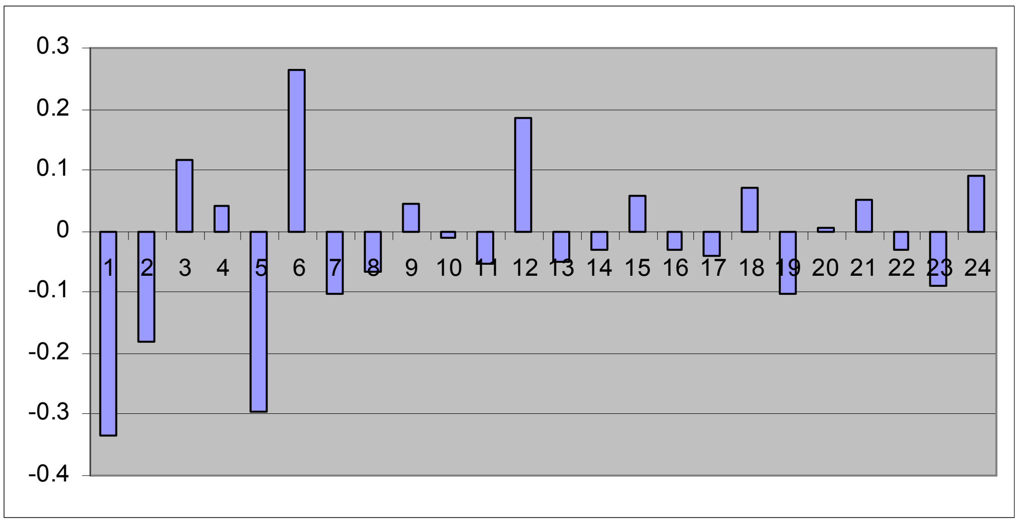


Figure 7.9(b): Partial Correlation Functions of Financial Condition Index (FCI)

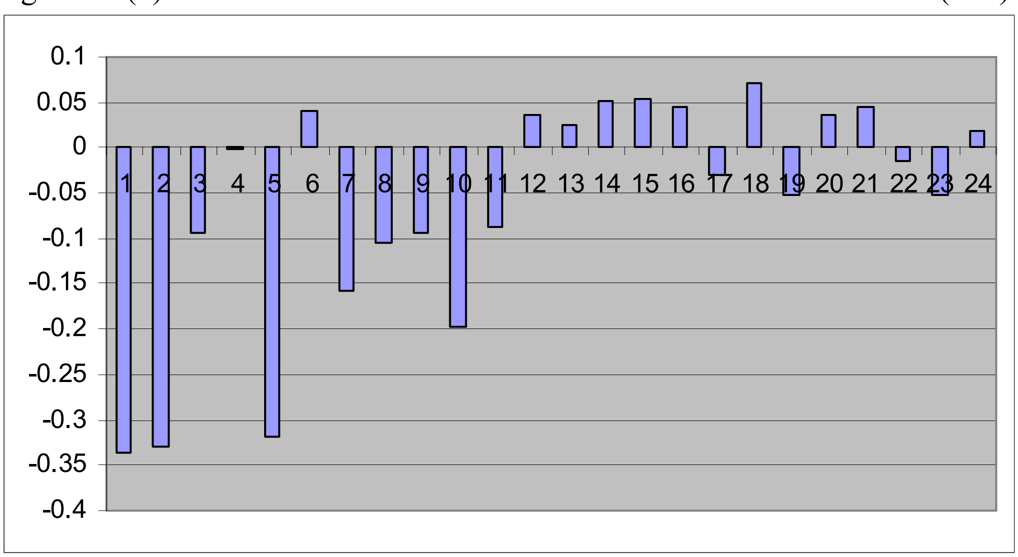


Table 7.1: Autocorrelations and Partial Correlations of Different Series

k	Industrial Production Growth		Inflation Rate		Reserve money growth		Change in advances		Change in interest rate		Change in real exchange rate		FCI	
	ACF	PCF	ACF	PCF	ACF	PCF	ACF	PCF	ACF	PCF	ACF	PCF	ACF	PCF
1	0.073	0.073	0.109	0.109	-0.106	-0.106	0.116	0.116	-0.335	-0.335	0.129	0.129	-0.34	-0.34
2	0.061	0.056	-0.046	-0.059	-0.02	-0.032	-0.097	-0.112	-0.177	-0.326	-0.001	-0.018	-0.18	-0.32
3	0.038	0.03	0.191	0.205	0.019	0.013	-0.053	-0.028	0.119	-0.087	0.07	0.074	0.12	-0.09
4	-0.226	-0.236	0.026	-0.026	-0.27	-0.27	-0.22	-0.227	0.036	-0.002	0.152	0.136	0.04	-0.012
5	-0.316	-0.308	0.017	0.044	-0.043	-0.109	-0.012	0.036	-0.295	-0.318	0.023	-0.012	-0.29	-0.32
6	-0.259	-0.245	0.029	-0.019	-0.092	-0.139	0.27	0.235	0.263	0.042	-0.023	-0.026	0.26	0.04
7	-0.283	-0.289	-0.032	-0.032	-0.042	-0.088	-0.03	-0.114	-0.104	-0.16	0.015	0.004	-0.10	-0.16
8	-0.199	-0.325	0.015	0.015	-0.1	-0.234	-0.148	-0.151	-0.067	-0.107	0.068	0.045	-0.07	-0.11
9	0.076	-0.174	0.18	0.178	-0.051	-0.194	-0.106	-0.078	0.047	-0.097	-0.009	-0.022	0.05	-0.09
10	0.037	-0.332	-0.002	-0.035	-0.009	-0.198	-0.078	0.037	-0.011	-0.196	-0.073	-0.064	-0.01	-0.19
11	0.234	-0.271	0.098	0.137	0.117	-0.039	0.152	0.142	-0.05	-0.085	0.015	0.025	-0.05	-0.09
12	0.603	0.295	0.314	0.237	0.319	0.217	0.45	0.343	0.189	0.04	0.124	0.109	0.19	0.04
13	0.132	0.019	0.081	0.047	0.067	0.094	0.092	0.023	-0.05	0.03	-0.074	-0.096	-0.05	0.03
14	0.151	0.094	-0.055	-0.087	-0.003	-0.014	-0.066	0.004	-0.03	0.052	-0.153	-0.12	-0.03	0.05
15	0.016	0.047	0.135	0.077	-0.069	-0.056	-0.095	-0.016	0.061	0.06	-0.003	0.013	0.06	0.05
16	-0.254	-0.049	0.107	0.069	-0.104	0.027	-0.082	-0.079	-0.031	0.046	0.067	0.043	-0.04	0.04
17	-0.232	0.091	-0.034	-0.035	-0.13	-0.074	0.003	-0.022	-0.114	-0.028	-0.049	-0.028	-0.04	-0.03
18	-0.255	0.049	-0.063	-0.116	0.006	0.029	0.072	0.063	0.138	0.074	-0.084	-0.034	0.07	0.07
19	-0.274	0.044	0.013	0.039	-0.078	-0.082	-0.084	-0.108	-0.104	-0.051	0.065	0.075	-0.10	-0.05
20	-0.166	-0.003	0.02	-0.021	-0.01	0.021	-0.098	-0.079	0.005	0.038	0.022	-0.022	0.01	0.04
21	0.032	-0.06	0.142	0.098	-0.014	-0.03	-0.06	-0.055	0.054	0.042	0.016	0.043	0.05	0.04
22	0.016	-0.118	0.01	-0.043	-0.033	-0.047	-0.11	-0.102	-0.033	-0.016	0.002	0.03	-0.03	-0.01
23	0.095	-0.088	0.011	0.019	0.086	0.074	0.1035	0.093	-0.085	-0.049	0.02	-0.018	-0.09	-0.05
24	0.0456	0.013	0.091	0.081	0.112	0.105	0.1102	0.11	0.17	0.017	0.165	0.14	0.09	0.02

Note: Significance at 5% is $\pm 2/\sqrt{296} = \pm 0.11$

As can be seen from Figure 7.9 all the spikes of Autocorrelation die off after twelfth lag while spikes of Partial Auto-correlation Functions die off after tenth lag so we expect an ARMA (10, 12) for financial condition index. Then we estimate different specification of ARMA model up to AR (10) and/or MA (12) for this series. The best fitted model is given in table 7.2.

Table 7.2: Best Fitted ARMA Models for Different Series

variable	Model	LM Test	variable
y	y_t=-0.10y_{t-4} -0.12 y_{t-10}+0.14 y_{t-11}+0.74 y_{t-12} -0.19ma_{t-5} (5) +0.17ma_{t-5} (9)+0.17ma_{t-10}-0.33ma_{t-12}	χ_1^2	χ_{12}^2
π	π_t=0.97 π_{t-12} + 0.08 ma_{t-3} + 0.10 ma_{t-9} - 0.75 ma_{t-12}	0.002	1.34
m	m_t =0.14m_{t-4}+0.82m_{t-12}-0.36ma_{t-4}-0.55ma_{t-12}	0.003	1.21
l	l_t =0.05l_{t-1}-0.03l_{t-4}-0.04l_{t-6}+0.09l_{t-11}+0.84l_{t-12}-0.08ma_{t-1}-0.08ma_{t-11}- 0.7ma_{t-12}	0.002	1.23
i	i_t =-0.51 i_{t-1}-0.28 i_{t-5}-0.09 i_{t-10}-0.49ma_{t-2}+0.11ma_{t-12}	0.003	1.64
e	e_t =0.58 e_{t-4} -0.56ma_{t-1}+0.14ma_{t-4}-0.17ma_{t-12}	0.001	1.91
y*	y^*_t=-0.02y^*_{t-1}-0.008y^*_{t-11}+0.99y^*_{t-12}-0.83ma_{t-12}	0.003	2.12
i*	i^*_t =0.42 i^*_{t-1}+0.25i^*_{t-2}-0.22ma_{t-2}	0.002	1.21
FCI	fci_t =-0.5 fci_{t-1}-0.50 fci_{t-2}-0.32 fci_{t-3}-0.24 fci_{t-4}0.5fci_{t-5}-0.15 fci_{t-6}+-0.28 fci_{t-7}-0.23 fci_{t-8}-0.19 fci_{t-9}-0.2 fci_{t-10}	0.001	1.02

Note: χ_1^2=0.005 and χ_{12}^2=5.4,

Breusch-Godfrey Serial Correlation LM Test fails to reject the null of no serial correlation in all cases.

7.3 Pre-whitening:

After estimation of best fitted univariate models shown in table 7.2, we pre-whiten all the input and output series by ARMA (p, q) model of each input series. The β_{lm} and α_m are used to denote respectively the pre-whitened output and pre-whiten input series, first subscript with β denotes output while second denotes input series whose ARMA is used to pre-whiten the output series.

7.4 Identification of parameters b, p, q, r, and s:

The delay period "b" is identified on the basis of sample cross-correlations of pre-whitened input and output series. To find the order p and q, we examine the sample auto-correlation function of the residual series obtained as:

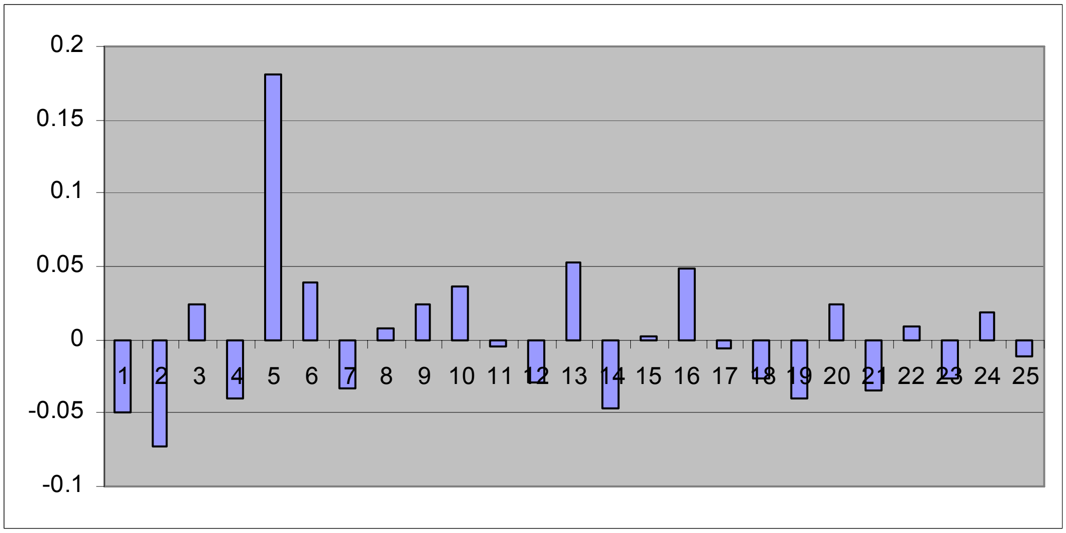
$$\hat{e}_t = \beta_t - \hat{\nu}(B)\alpha_t.$$

Where $\nu(B) = \left[\frac{\omega(B)}{\delta(B)}\right] B^b = \sum_{k=b}^{b+s} \nu_k = \sum_{k=b}^{b+s} \rho_{\alpha\beta}(K)\frac{\sigma_\beta}{\sigma_\alpha}$

And e_t follows an ARMA (p, q) model i.e. $e_t = \left\{ \theta_q(B) \big/ \phi_p(B) \right\} a_t$.

The cross-correlogram between ***GDP*** growth ($\beta_{y\pi}$) and inflation rate (α_π) is shown in figure 710 (a).

Figure 7.10(a): Cross-correlogram between $\beta_{y\pi}$ and α_{π}



As can be see from figure 7.10(a), the only significant spike appears at lag 4 (since graphs are sketched in Excel and it starts from 1 rather than 0, so spike at kth lag here means spike at (k-1)th lag, same is the case for all cross- correlograms) , which implies that b=4.

We then obtained $e_{y\pi}$ for pre-whitened series $\beta_{y\pi}$ and α_{π} as:

$$e_{y\pi} = \beta_{y\pi} - 0.18(0.14/0.16)\alpha_{\pi}(-4)$$

In this case k=4, s=0, σ_{β} =0.14, σ_{α} =0.16, and $\rho_{\alpha\beta}(-4)$ =0.18

The autocorrelation function and partial correlation function of $e_{y\pi}$ are shown in figure 7.10(b & c).

Figure 7.10(b): Auto-correlation function of $e_{y\pi}$

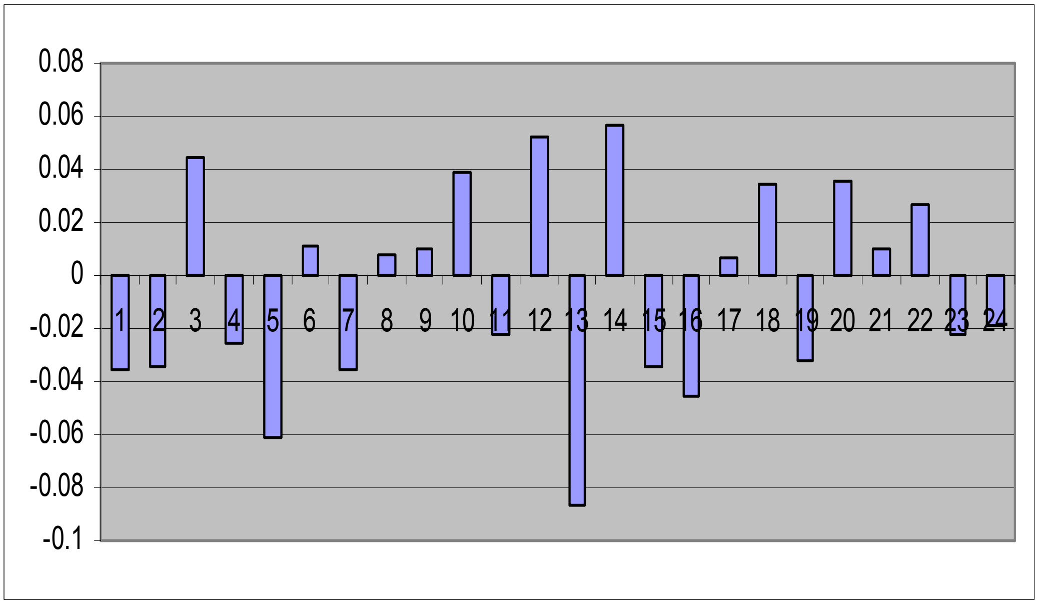
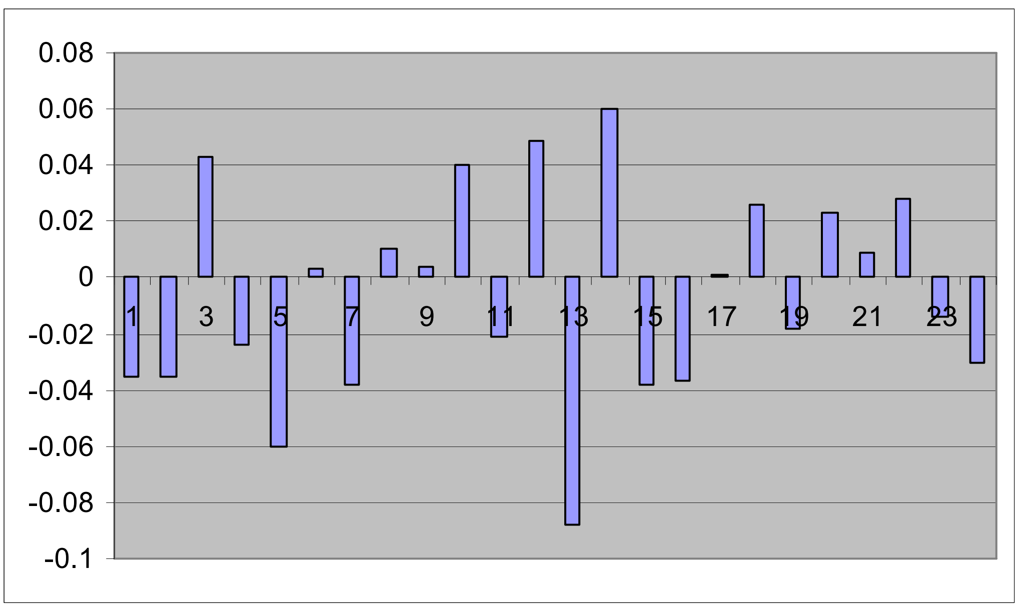


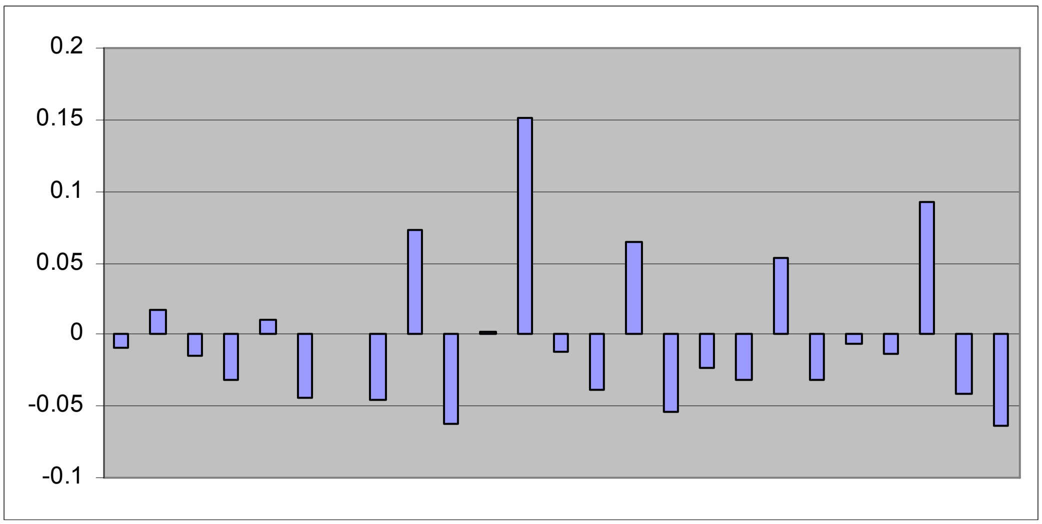
Figure 7.10(c): Partial Auto-correlation function of $e_{y\pi}$



The AFC and PAFC of $e_{y\pi}$ show that $p= q=0$.Therefore $j \geq \max\{p, q\}=0$

The cross-correlogram between GDP growth (β_{ym}) and reserve money growth (α_m) is shown in figure7.11 (a).

Figure 7.11(a): Cross-correlogram Between β_{ym} and α_m



In figure 7.11(a), the first significant spike appears at lag 11, which implies that b=11.

To find order p and q, we examine the sample auto-correlation function of the residual term.

We obtained e_t for pre-whitened series as:

$$e_{ym} = \beta_{ym} - 0.15\alpha_m(-11)(0.12/0.04)$$

In this case k=11 and s=0. σ_β =0.12, σ_α =0.04, and $\rho_{\alpha\beta}(-11)$ =-0.15.

The autocorrelation function and partial correlation function of e_{ym} are shown in figure7.11(b & c).

Figure 7.11(b): Auto-correlation Function of e_{ym}

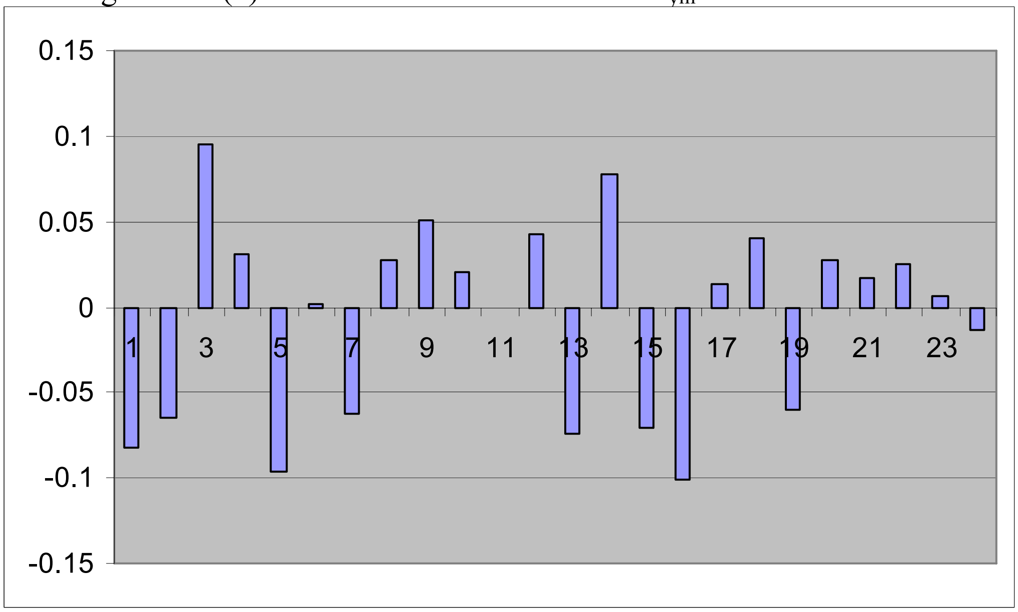
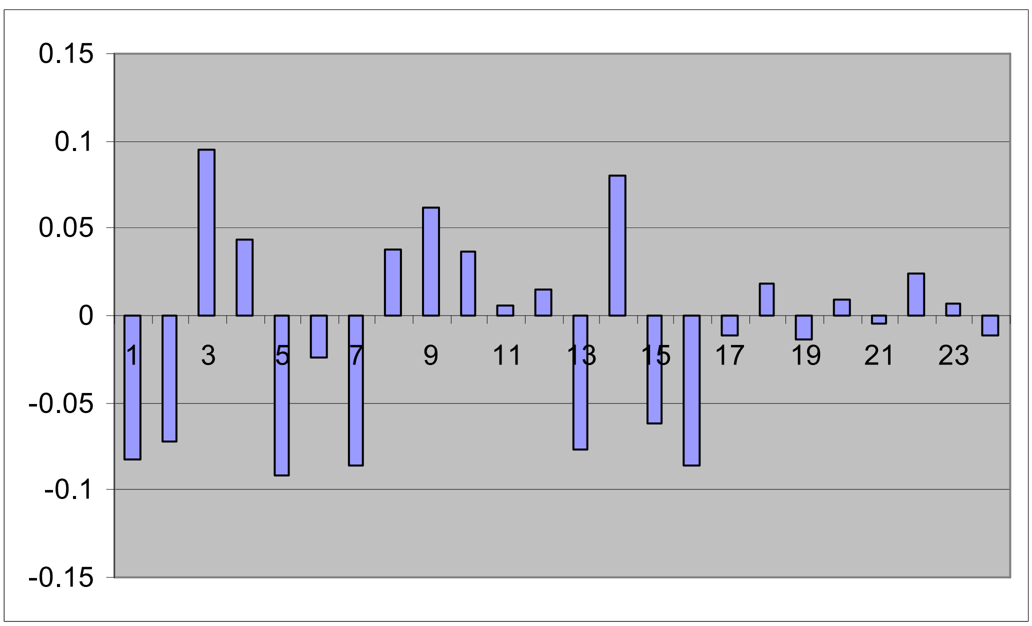


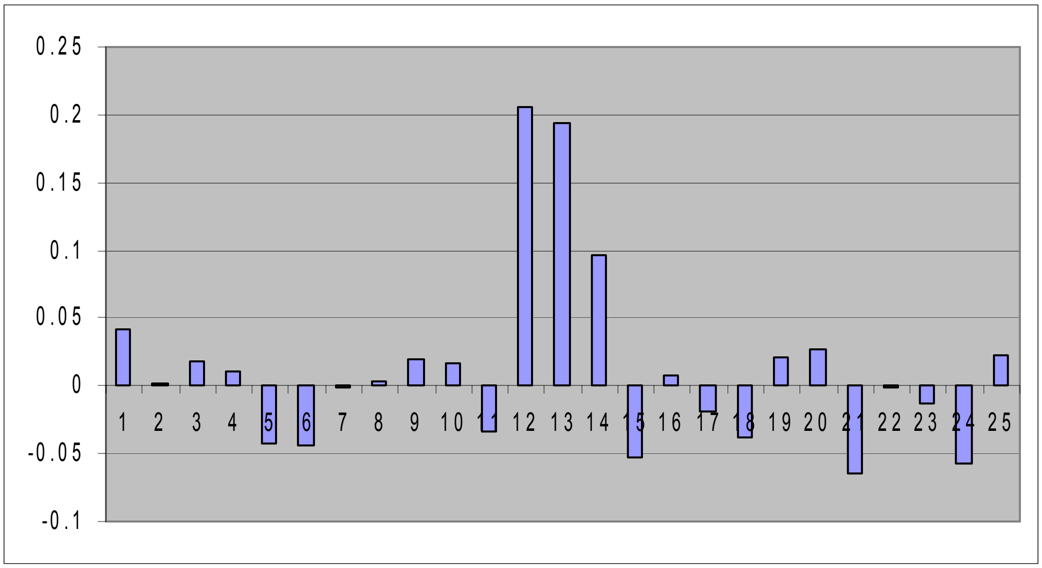
Figure 7.11(c): Partial Auto-correlation Function of e_{ym}



The AFC and PAFC of e_{ym} show that p=q=0. Therefore $j \geq \max\{p, q\}$=0.

The cross-correlogram between Industrial Production growth (β_{yl}) and growth in advances (α_l) is shown in figure 7.12(a).

Figure 7.12(a): Cross-correlogram Between β_{yl} and α_l



In figure 7.12 (a), the first significant spike appears at lag 11, which implies that b=11.

To find the order p and q, we examine the sample auto-correlation function of the residual term. We obtained e_t for pre-whitened series as:

$$e_{yl} = \beta_{yl} - (0.21\alpha_l(-11) + 0.19\alpha_l(-12))(0.14/0.16)$$

In this case k=11 and s=1. σ_β=0.14, σ_α=0.16, $\rho_{\alpha\beta}(-11)$=-0.21, and $\rho_{\alpha\beta}(-12)$=-0.19.

The autocorrelation function and partial correlation function of e_{yl} are shown in figure 7.12(b & c).

Figure 7.12(b): Auto-correlation function of e_{yl}

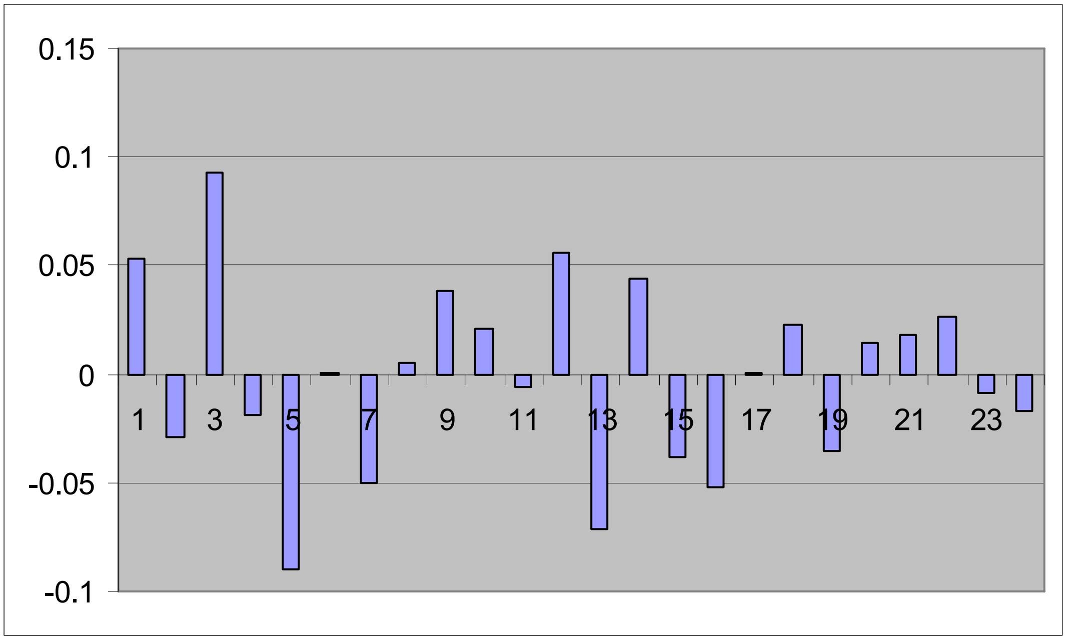
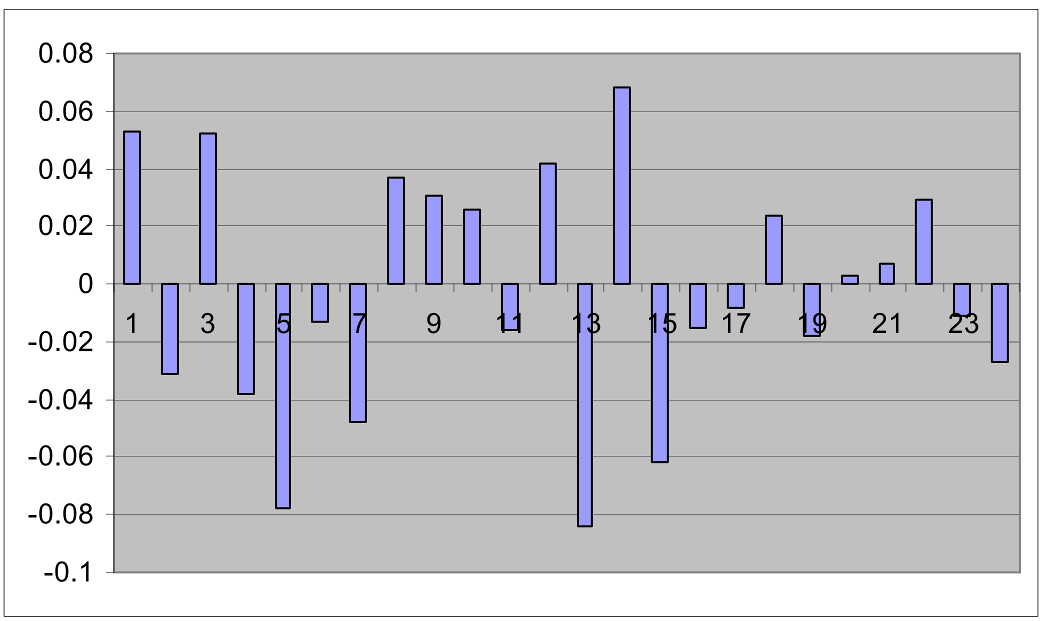


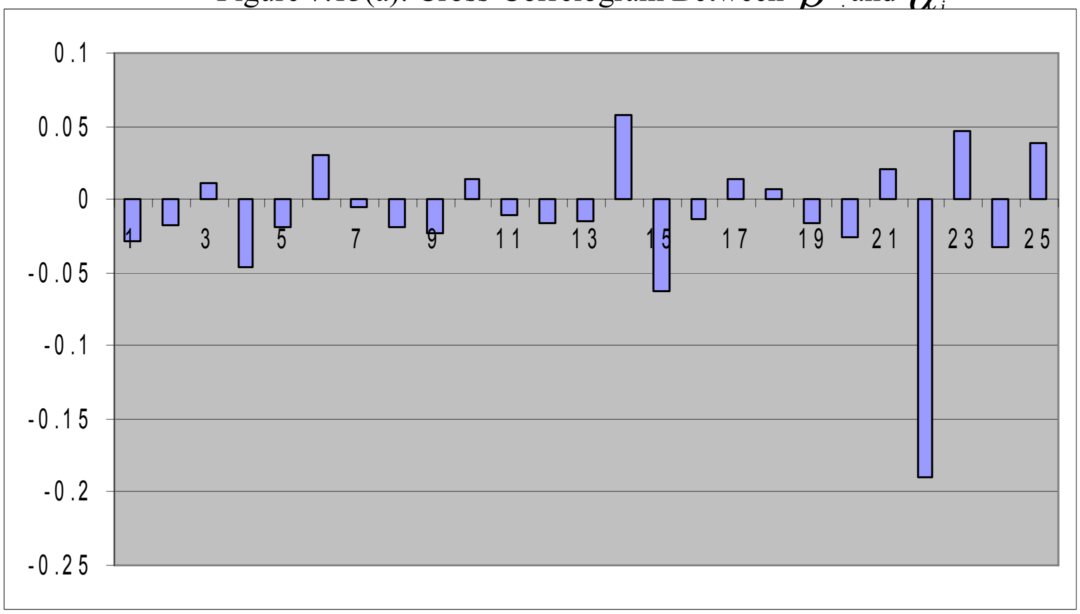
Figure 7.12(c): Partial Correlation Function of e_{yl}



The AFC and PAFC of e_{ys} show that p=0 and q=0. Therefore $j \geq \max\{p,q\}=0$.

The cross-correlogram between Industrial Production growth (β_{yi}) and interest rate (α_i) is shown in figure 7.13(a).

Figure 7.13(a): Cross-Correlogram Between β and α_i



In figure 7.13(a):, the first significant spike appears at lag 21, which implies that b=21

We obtained e_t for pre-whitened series as:

$$e_{yi} = \beta_{ye} - (-0.19\alpha_i(-21))(1.9/2.2)$$

In this case k=21 and s=0. σ_β=1.9, σ_α=2.2, and $\rho_{\alpha\beta}(-21)$=-0.19

The autocorrelation function and partial correlation function of e_{yi} are shown in figure 7.12(b & c).

Figure 7.13(b): Auto-correlation Function of e_{yi}

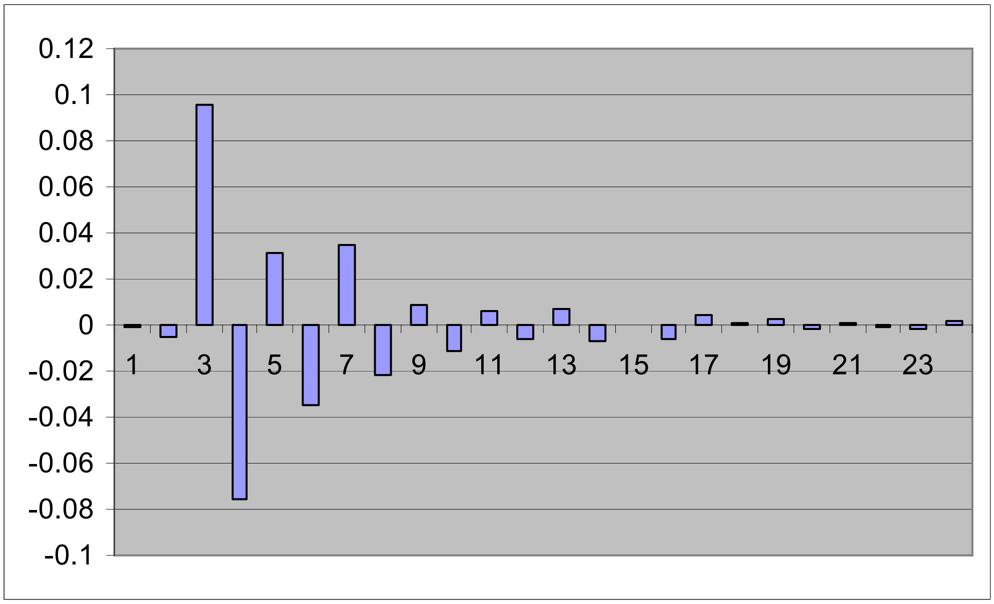
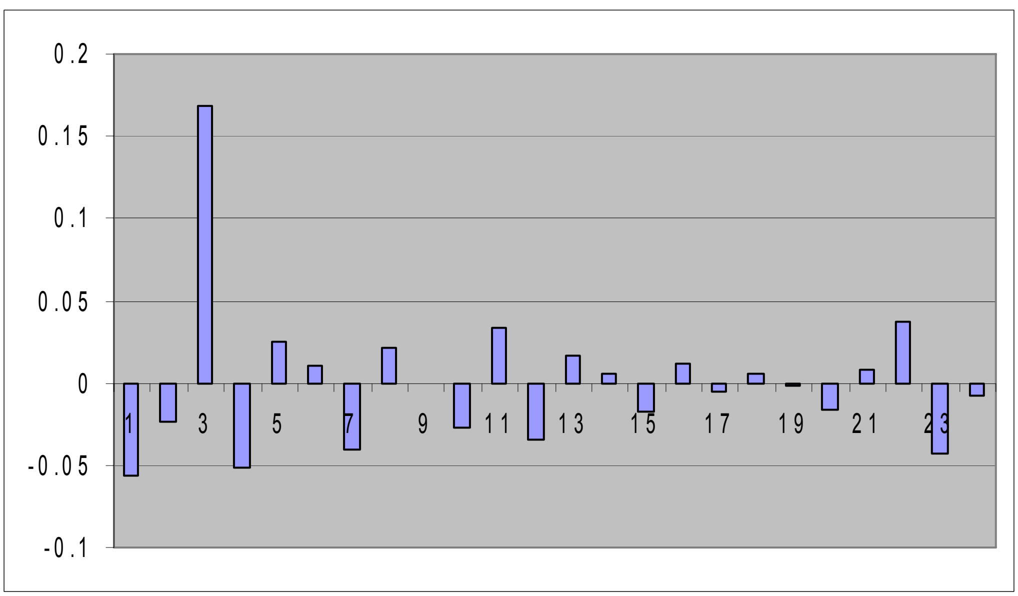


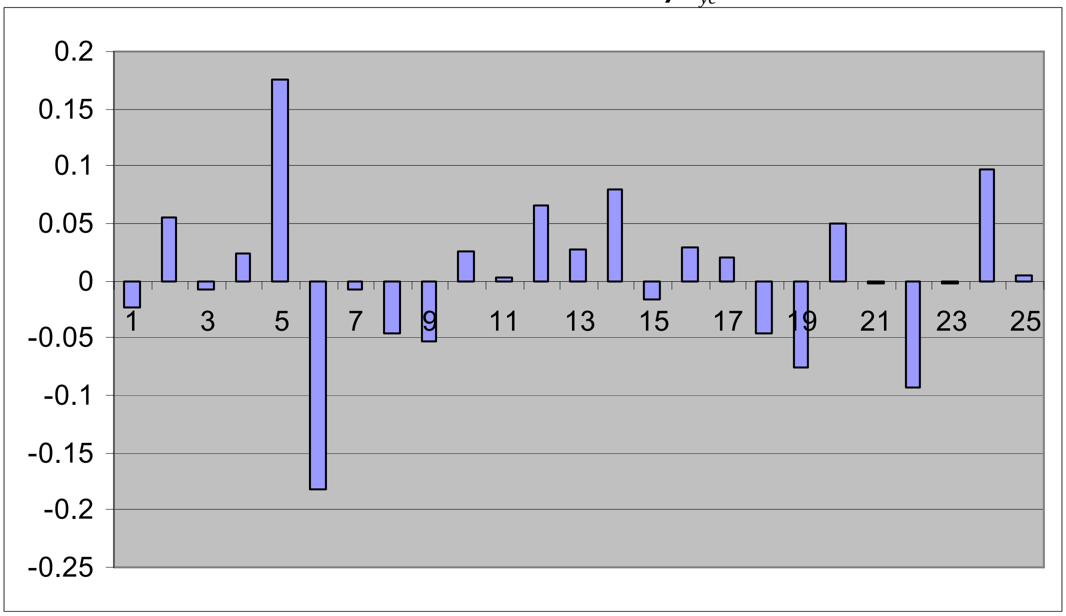
Figure 7.13(c): Partial correlation Function of e_{yi}



The AFC and PAFC of e_{yi} show that p=0 and q=3. Therefore $j \geq \max\{p,q\}=3$.

The cross-correlogram between Industrial Production growth (β_{ye}) and changes in exchange rate (α_e) is shown in figure 7.14(a).

Figure 7.14(a): Cross-correlogram between β_{ye} and α_e



In figure 7.14(a), the first significant spike appears at lag 4, which implies that b=4

We obtained e_t for pre-whitened series as:

$$e_{ye} = \beta_{ye} - (0.18\alpha_e(-4) - 0.17\alpha_e(-5))(0.13/0.0004)$$

In this case k=4, s=1, σ_β=0.13, σ_α =0.0004, $\rho_{\alpha\beta}(-4)$=0.18, and $\rho_{\alpha\beta}(-5)$=-0.17,

The autocorrelation function and partial correlation function of e_{ye} are shown in figure 7.14(b & c).

Figure 7.14(b): Auto-correlation function of e_{ye}

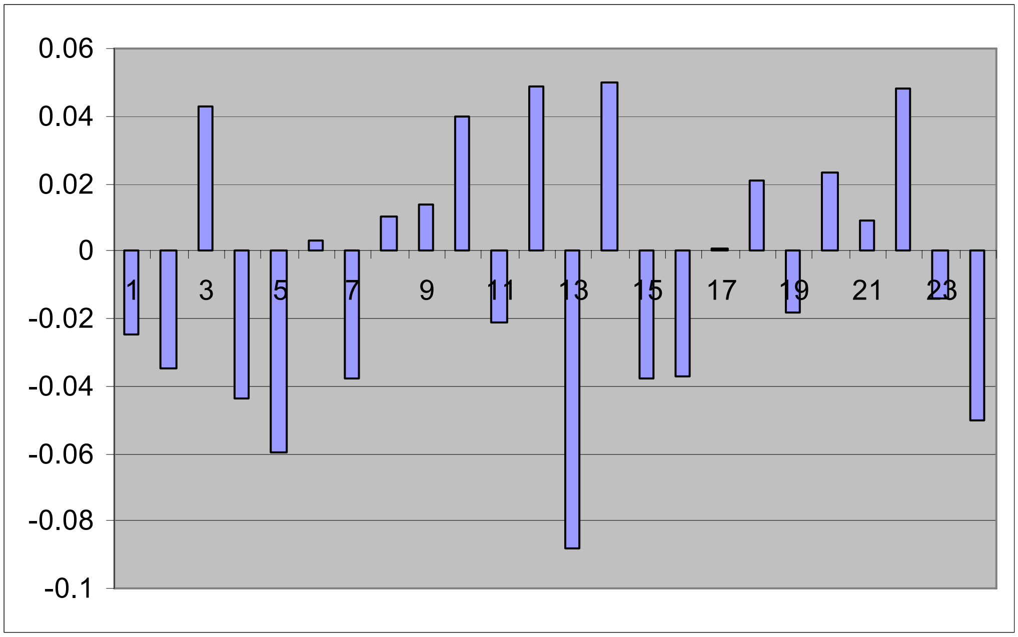
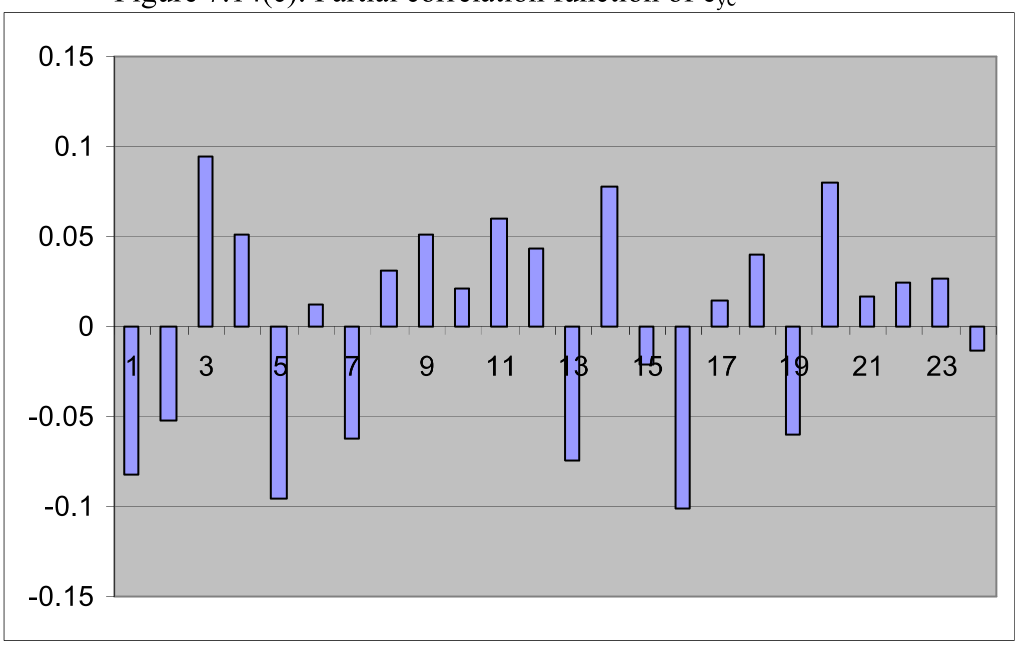


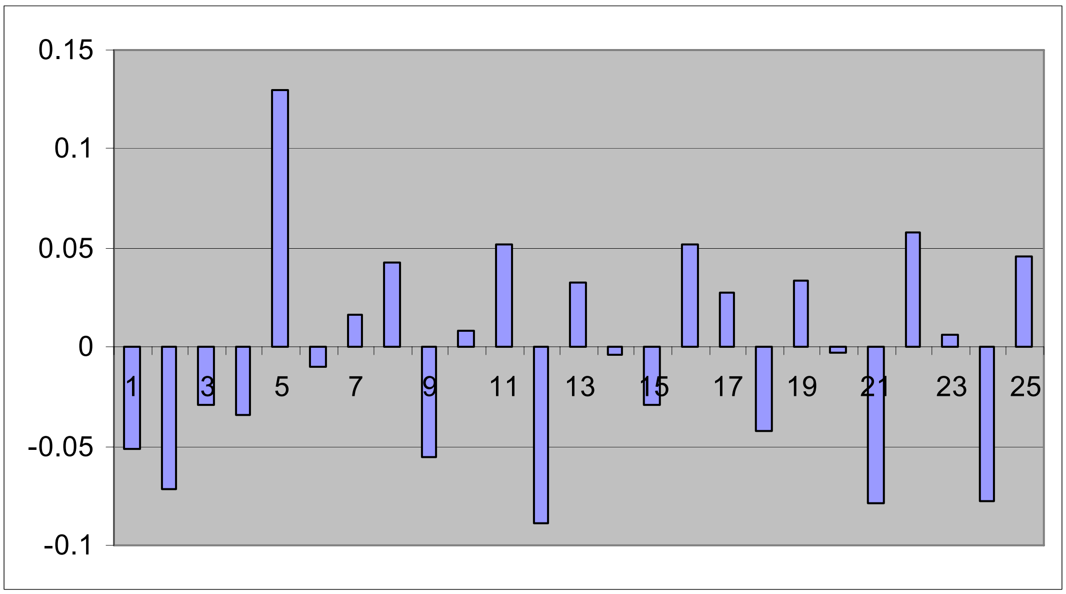
Figure 7.14(c): Partial correlation function of e_{ye}



The AFC and PAFC of e_{ye} show that p=3 and q=3. Therefore $j \geq \max\{p, q\}$=3.

The cross-correlogram between Industrial Production growth (β_{yy*}) and in US IP growth (α_{y*}) is shown in figure 7.15(a).

Figure 7.15(a): Cross-correlogram between β_{yy*} and α_{y*}



In figure 7.14(a), the first significant spike appears at lag 4, which implies that b=4

We obtained e_t for pre-whitened series as:

$$e_{yy*} = \beta_{yy*} - (0.13\alpha_{y*}(-4))(0.15/0.007)$$

In this case k=4 and s=0. σ_β=0.15, σ_α=0.007, and $\rho_{\alpha\beta}(-4)$=0.13

The autocorrelation function and partial correlation function of e_{yy*} are shown in figure 7.15(b & c).

Figure 7.15(b): Auto-correlation function of e_{yy*}

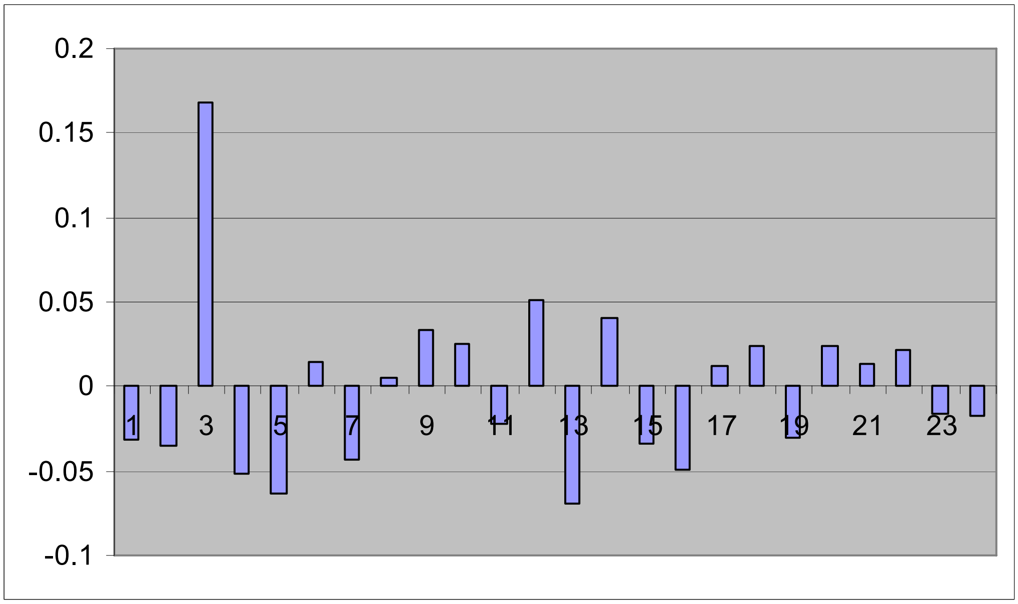
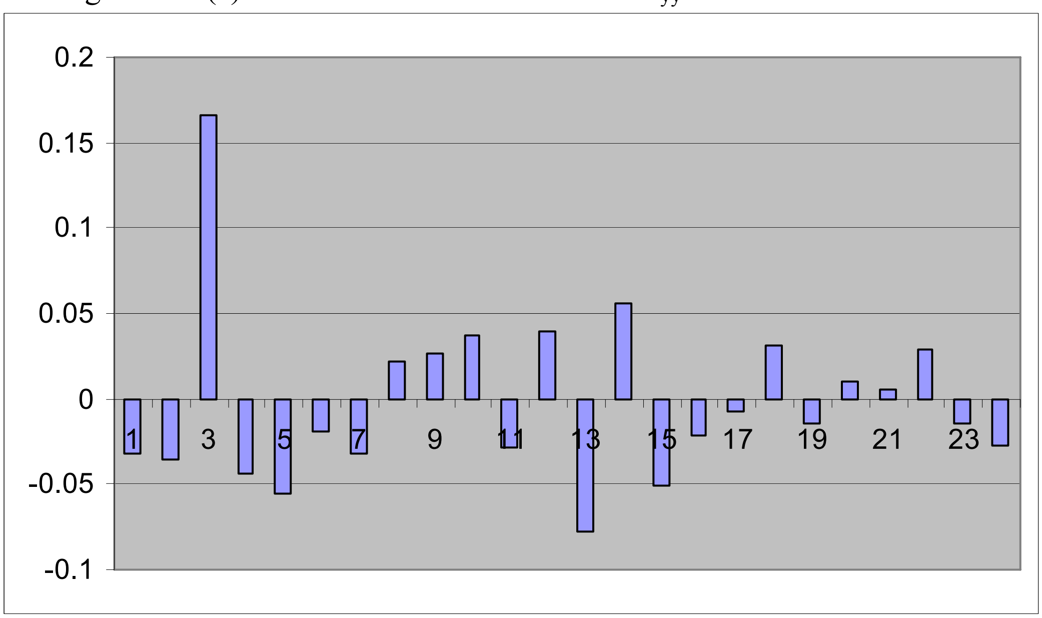


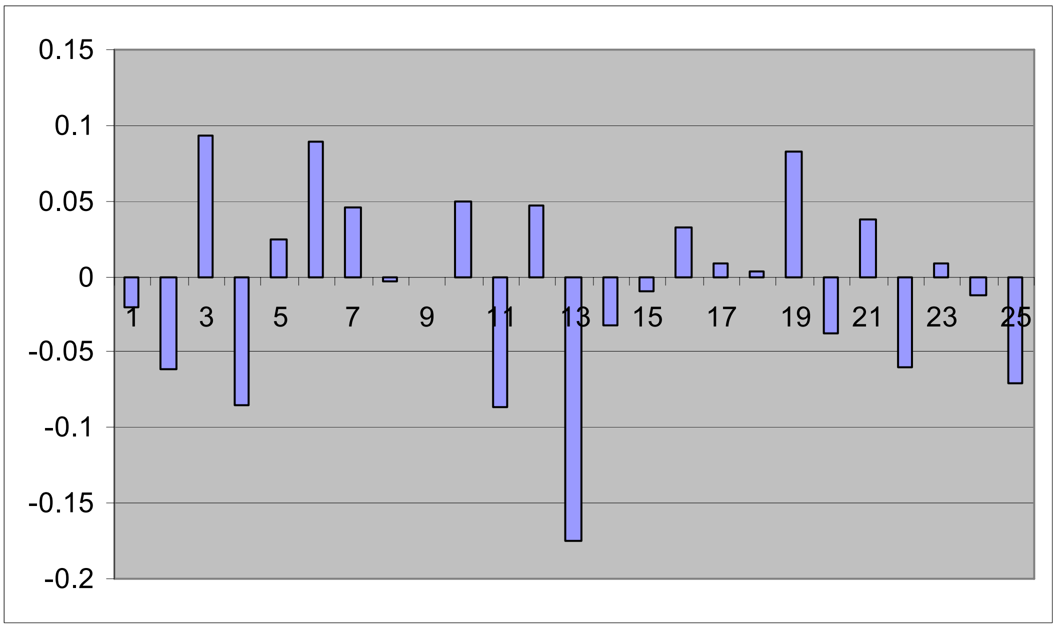
Figure 7.15(c): Partial correlation function of e_{yy*}



The AFC and PAFC of e_{yi} show that p=3 and q=3. Therefore $j \geq \max\{p, q\}$=3.

The cross-correlogram between Industrial Production growth (β_{yi*}) and changes in US interest rate (α_{i*}) is shown in figure 7.16(a).

Figure 7.16(a): Cross-correlogram between β_{yi*} and α_{i*}



In figure 7.16(a), the first significant spike appears at lag 12, which implies that b=12

We obtained e_t for pre-whitened series as:

$$e_{yi*} = \beta_{yi*} - (-0.17\,\alpha_{*i}(-12))(0.12/0.26)$$

In this case k=12, s=0. σ_β =0.12, σ_α =0.26, and $\rho_{\alpha\beta}(-12)$ =-0.17.

The autocorrelation function and partial correlation function of e_{yi*} are shown in figure 7.16(b & c).

Figure 7.16(b): Auto-correlation function of e_{yi*}

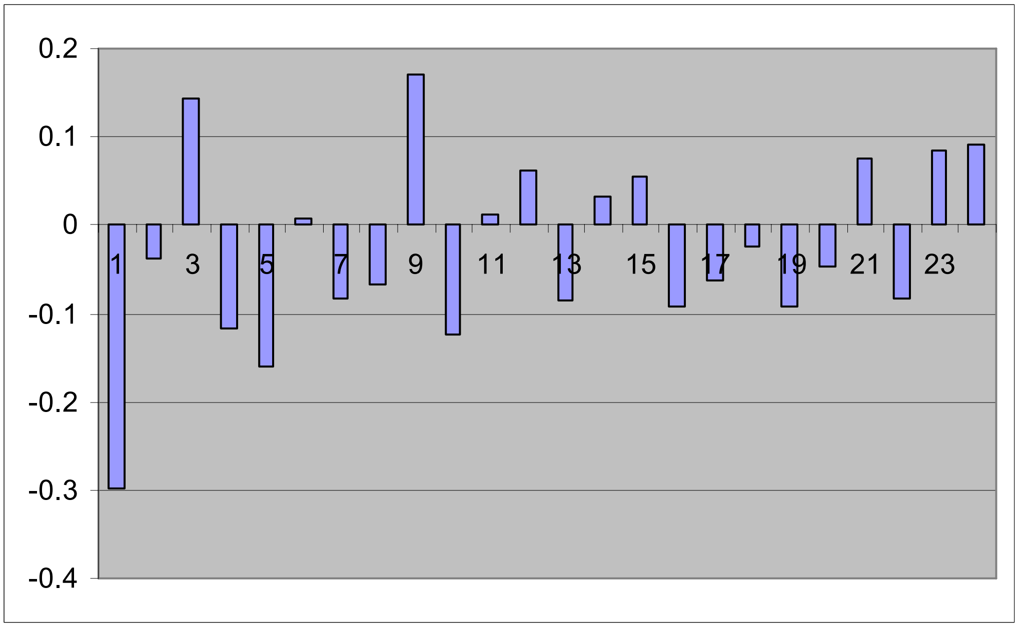
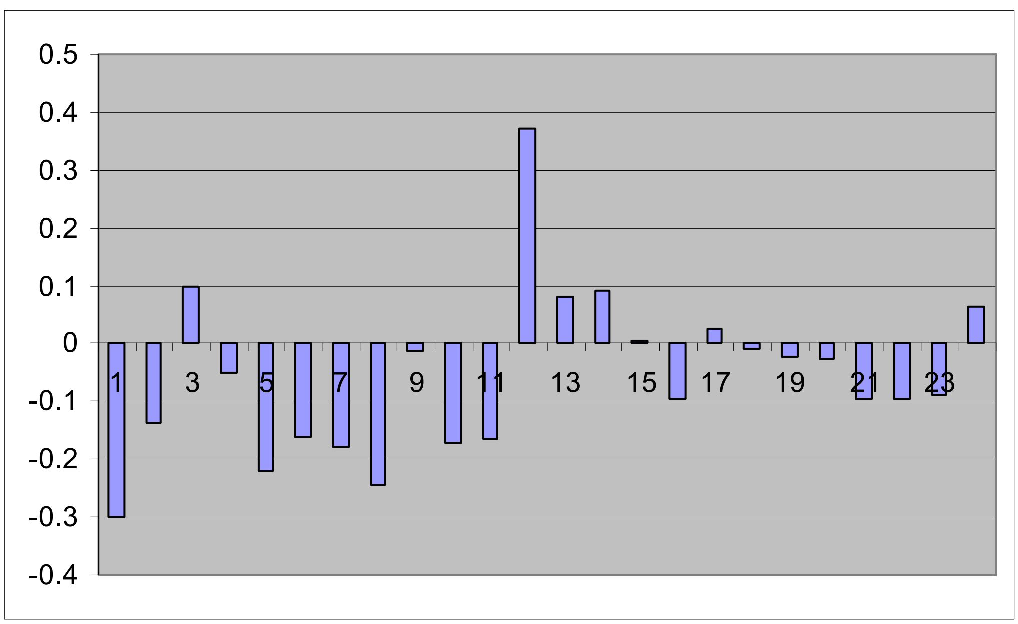
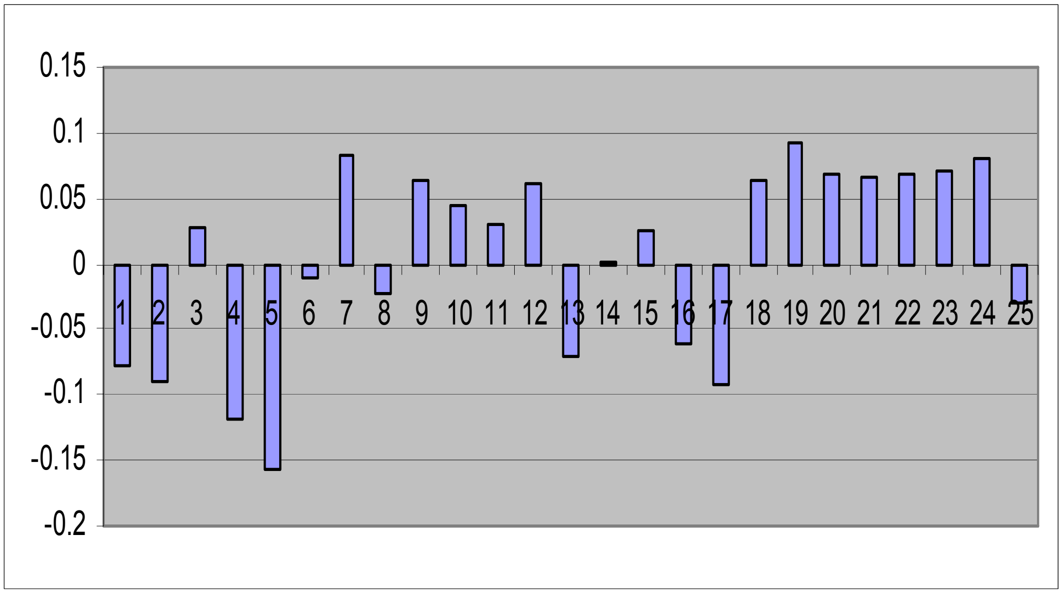


Figure 7.16(c): Partial correlation function of e_{yi*}



The AFC and PAFC of e_{yi*} show that p=3 and q=3. Therefore $j \geq \max\{p,q\}$=3.
The cross-correlogram between Industrial Production growth (β_{yfci}) and MCI (α_{fci}) is shown in figure 7.17(a).

Figure 7.17(a) Cross-correlogram between β_{yfci} and α_{fci}



In figure 7.17(a), the first significant spike appears at lag 3 which implies that b=3

We obtained e_t for pre-whitened series i.e. industrial production growth and mci as:

$$e_{yfci} = \beta_{yfci} - (-0.12\,\alpha_{fci}(-3) - 0.16\,\alpha_{fci}(-4))(0.72/0.47)$$

In this case k=3, s=1. σ_β=0.72, σ_α=0.47, $\rho_{\alpha\beta}(-3$ =-0.12, and $\rho_{\alpha\beta}(-4)$=-0.16
0

Then we obtained the autocorrelation function and partial correlation function of e_{ymci} are shown in figure 7.17(b & c).

Figure 7.17(b): Auto-correlation function of e_{yfci}

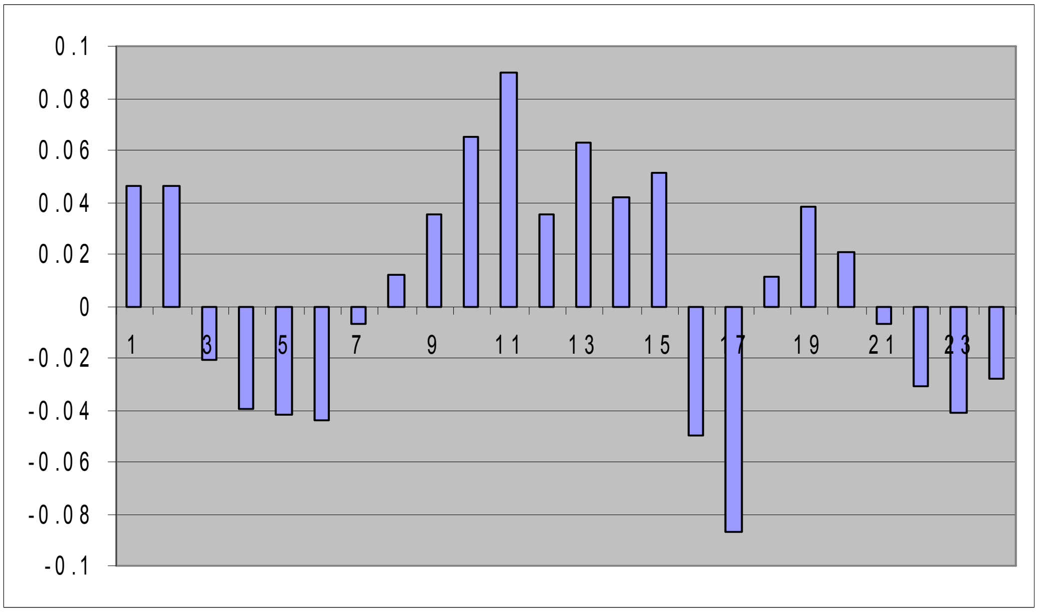
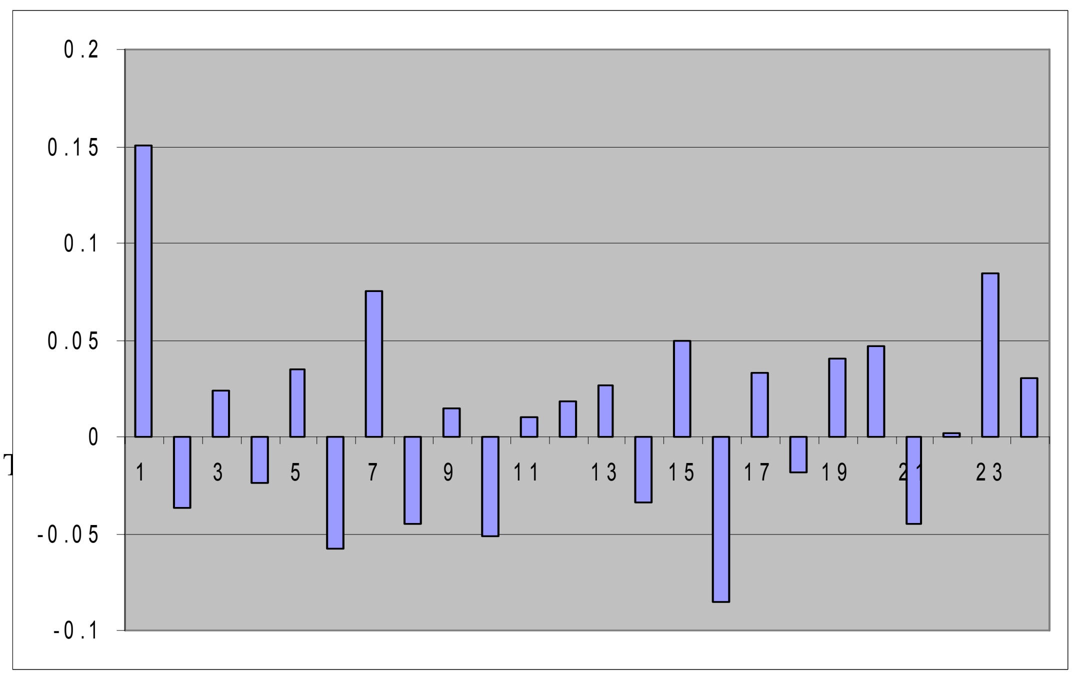


Figure 7.17(c): Partial correlation function of e_{yfci}



After the identification of b, p, and q for different input series, the order r and s are identified using iterative least square procedure and are given in table 7.3

Table 7.3: Identification of r and s for GDP Equation.

	The OLS Estimates of $\delta^{(j)}_{i(m)}$			The OLS Estimates of $\omega^{(j)}_{l(m)}$		
Inputs	i			L		
	m	1	2	0	1	2
π	1	0.06(1.01)	-	2.7(3.7)	-0.5(-0.6)	-
m	1	0.5(0.8)	-	0.6(4.4)	0.2(1.2)	-
l	1	0.5(0.9)	-	0.6(2.6)	0.7(2.6)	-
i	1	0.12(1.96)	-	-0.01(-2.4)	-0.005(-0.2)	-
e	1	0.8(1.4)	-	3.2(2.3)	-3.2(-2.4)	-
y*	1	0.07(1.3)	-	0.7(2.2)	-0.12(-0.4)	-
i*	1	0.08(1.4)	-	-0.4(-1.7)	0.002(0.09)	-
FCI	2	0.46(8.9)	-	-0.02(-2.4)	-0. 01(-1.96)	-
		0.045(7.8)	0.02(0.28)	-0.02(-2.4)	-0.01(-1.98)	0.01(1.2)

Table 7.4: Order b, p, q, r, and s of Different Inputs for GDP Growth as Output.

Output	inputs	b	p	q	r	s
y	π	4	0	0	0	0
	m	11	0	0	0	0
	l	11	0	0	0	1
	i	21	0	3	1	0
	e	4	3	3	0	1
	y*	4	3	3	0	0
	i*	12	3	3	0	0
	fci	3	1	0	1	1

Now that the transfer function model stands identified, we use the Gauss Newton algorithm to estimate the coefficient ω_j and δ_i for the inputs of each equation. Results of estimation are presented in table 7.5 below.

Table 7.5:Estimates of coefficients for GDP equation

Output	inputs	ω_0	ω_1	δ_1
y	π	2.5(3.1)	---	---
	m	0.5(3.4)	---	---
	l	0.7(2.2)	0.5(2.1)	--------
	i	-0.014(-2.2)	---	0.13(2.1)
	e	2.9(2.5)	-3.5(-2.6)	-------
	fci	-0.02(-2.5)	-0.01(-1.89)	0.41(7.9)
	y*	0.06(2.1)	-------	-------
	i*	-0.3(-1.8)	--------------	--------------

Note: t-statistics are in parenthesis

7.5 Relationship of output with other variables: Results

The different steps described above yield the following transfer function for GDP growth.

$$y_t = 2.57\,\pi_{t-4} + 0.5\,m_{t-11} + (0.7+0.5B)l_{t-11} - \frac{0.014}{1-0.13B}i_{t-21} - (2.9+3.5B)e_{t-4} - \frac{0.02+0.01B}{1-0.41B}fci_{t-3}$$
$$+0.06\,y_{t-4}* - 0.3\,i*_{t-12}$$

The results obtained from above equation are discussed below:

1. GDP growth responds to changes in inflation with a delay of 4 months. The coefficient is positive which shows that an increase in inflation results into higher

GDP growth. The effect is approximately twice the change in inflation rate, however the effect disappears suddenly.

2. Changes in reserve money growth affect the GDP growth with a lag of 11 months; the relation is positive which means that an increase in money supply will result into higher GDP growth. The lags involved in transmitting the effects of changes in monetary policy to output are long. It takes about one year for money supply changes to effect GDP growth.
3. Changes in lending growth take 11 months to affect the GDP growth and the relationship is positive. However, the effect dies off after one month.
4. Interest rate changes take relatively longer time — 21months to affect the GDP growth. The impact is negative and very small in magnitude. This shows that investment is less sensitive to interest rate in Pakistan. The view is also supported by Khan and Khan (2007).
5. Exchange rate appreciations affect GDP growth after four months. The impact is initially positive but it becomes negative in the next month. This is in conformity with the view that agents respond sluggishly to changes in exchange rate. The change in the exchange rate generates two kinds of effects; the "price effect" and the "volume effect". The price effect implies that currency depreciation will cause imports to be more expensive and domestic exports to be cheaper for foreign buyers at least in the short run. Given variety of rigidities the volume of goods imported and exported may not change drastically in the short run, therefore initially the trade balance is likely to deteriorate. However, the volume of trade changes eventually in response to the depreciation. In other words, the price effect

is generally believed to dominate the volume effect in the short run but in the long run the volume effect exhibits dominance.

6. The stance of monetary Policy depicted by financial condition index also affects the GDP growth with a delay of 3 month. The effect is negative which shows that contractionary monetary policy reduces GDP growth. The effect remains for two months but the size of effect is quite small. The result is in conformity with the theory.
7. Changes in foreign GDP growth effects domestic GDP growth positively. This shows that increase in purchasing power abroad increases the demand for domestic goods. Our results show that the effect is very small. The reason for small effect could be that our exports are less elastic as well as less competitive.

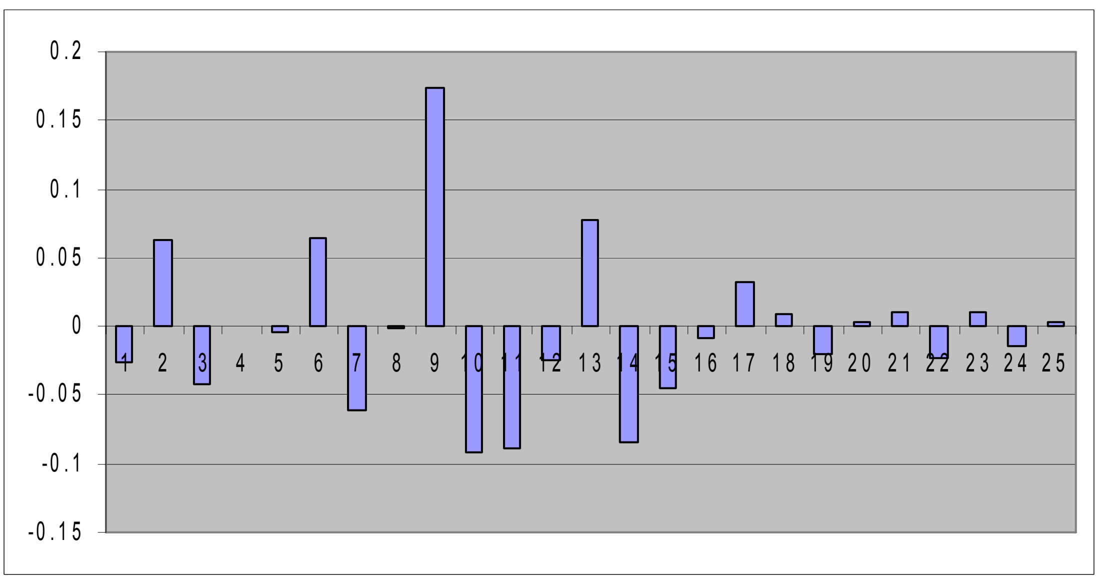
8 Impacts of Monetary Policy on Inflation, its Channels and Lags

In this chapter we analyze the impact of monetary policy on inflation- one of the main objectives of central bank. On the basis of univariate analysis in previous chapter we use the prewhitened series to investigate the strength lags of different channels through monetary policy propagates its impacts on inflation.

8.1. Identification of parameters b, p, q, r, and s

The cross-correlogram between pre-whitened inflation rate ($\beta_{\pi y}$) and GDP growth (α_y) is shown in figure 8.1(a)

Figure 8.1(a): Cross-correlogram between $\beta_{\pi y}$ and α_y



In figure 8.1(a), the first significant spike appears at lag 8, which implies that b=8

We obtained e_t for pre-whitened series i.e. change in inflation and GDP growth as:

$$e_{\pi y} = \beta_{\pi y} - (0.17\alpha_y(-8))(0.07/0.17)$$

In this case k=8 and s=0. σ_β=0.07, σ_α=0.17, and $\rho_{\alpha\beta}$=0.17

The autocorrelation function and partial correlation function of e π y are shown in figure 8.1(b & c).

Figure 8.1(b): Auto-correlation function of e π y

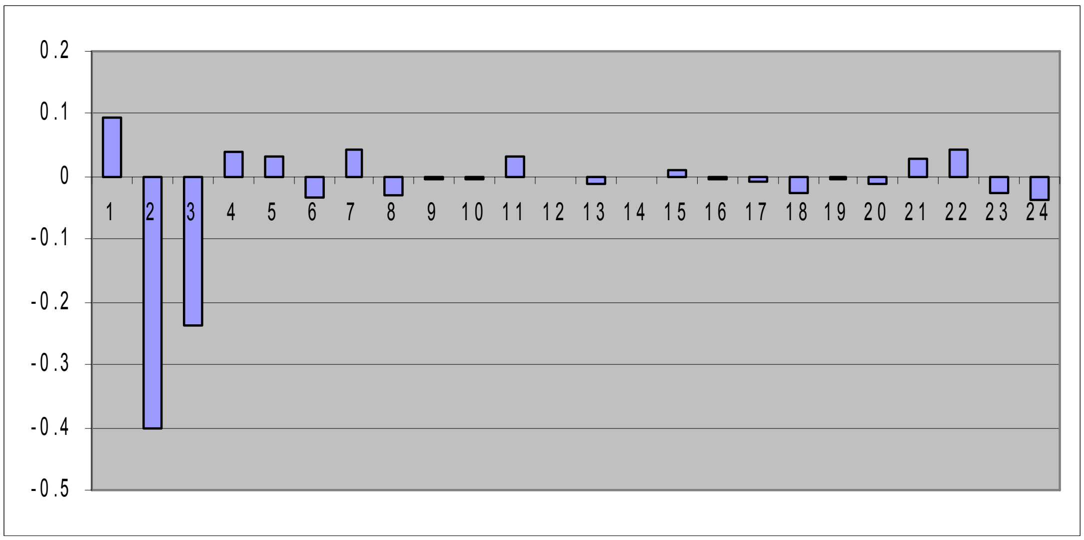
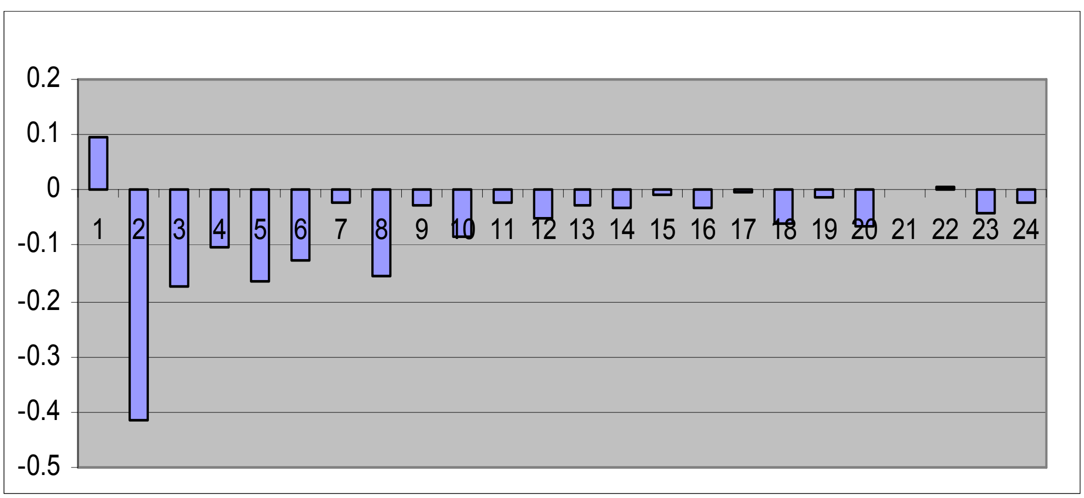


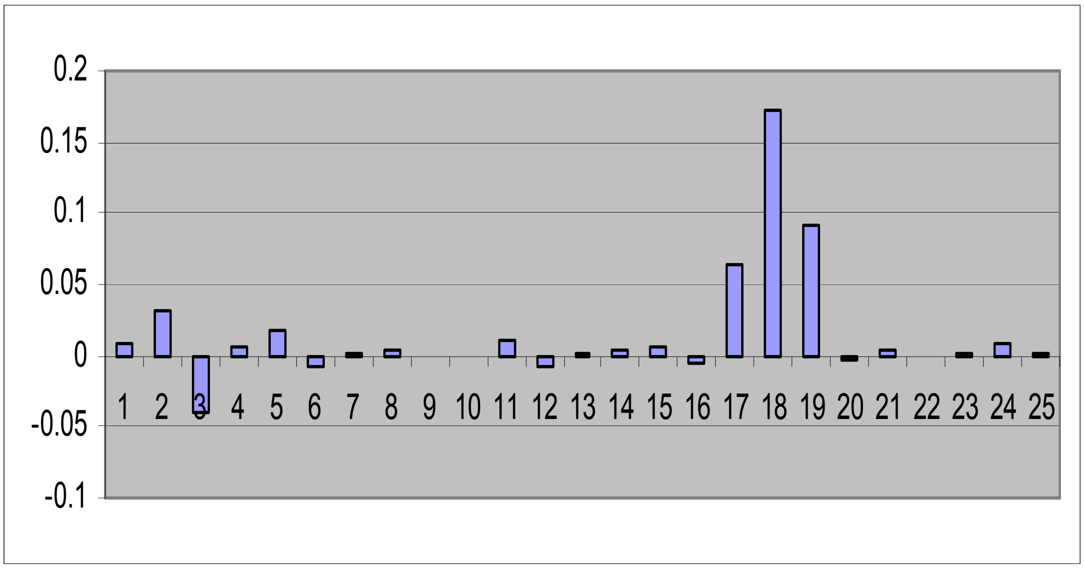
Figure 8.1(c): Partial correlation function of e π y



The AFC and PAFC of e πy show that p=7 and q=7. Therefore j$\geq$max$\{p,q\}$=7.

The cross-correlogram between pre-whitened inflation rate ($\beta_{\pi m}$) and reserve money growth (α_m) is shown in figure 8.2(a).

Figure 8.2(a) Cross-correlogram between $\beta_{\pi m}$ and α_m



In figure 8.2(a), the first significant spike appears at lag 17 which implies that b=17

We obtained e_t for pre-whitened series:

$$e_{\pi m} = \beta_{\pi m} - (0.17\alpha_m(-17))(0.09/0.04)$$

In this case k=17 and s=0. σ_β=0.09, σ_α=0.04, and $\rho_{\alpha\beta}$=0.17

The autocorrelation function and partial correlation function of $e_{\pi m}$ are shown in figure 8.2(b & c).

Figure 8.2(b): Auto-correlation function of e π m

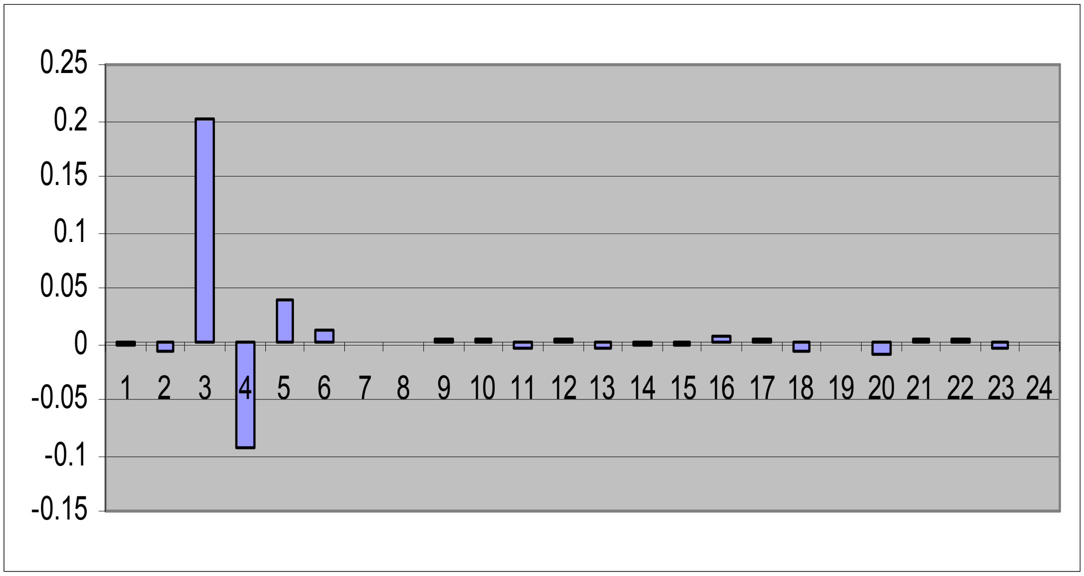
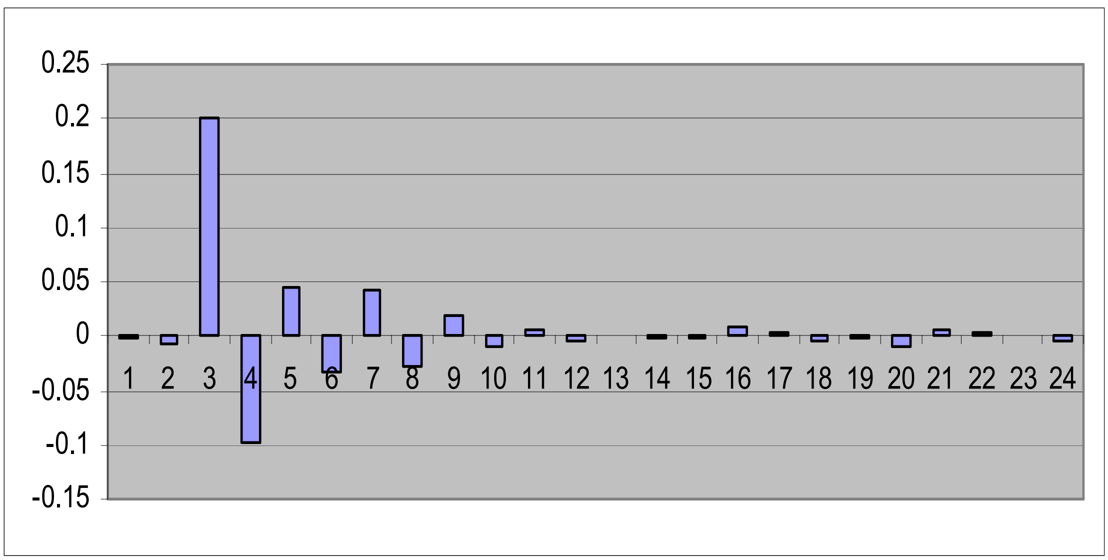


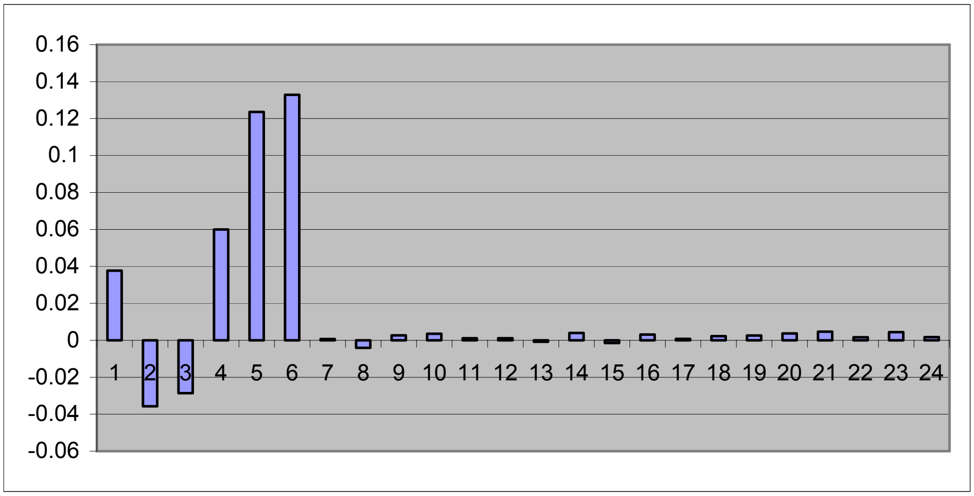
Figure 8.2(c): Partial correlation function of e π m



The AFC and PAFC of e πm show that p=q=3.Therefore j $\geq \max\{p,q\}$=3.

The cross-correlogram between pre-whitened inflation rate ($\beta_{\pi l}$) and growth in banks lending (α_l) is shown in figure 8.3(a).

Figure 8.3(a) Cross-correlogram between $\beta_{\pi l}$ and α_l



In figure 8.3(a), the first significant spike appears at lag 4, which implies that b=4

We obtained e_t for pre-whitened series:

$$e_{\pi l} = \beta_{\pi l} - (0.12\alpha_l(-4) + 0.13\alpha_l(-5))(0.11/0.16)$$

In this case k=4, s=1, σ_β =0.16, σ_α =0.11, $\rho_{\alpha\beta}(-4)$ =0.12, and $\rho_{\alpha\beta}(-5)$ =0.13

The autocorrelation function and partial correlation function of $e_{\pi 1}$ are shown in figure 8.3(b & c).

Figure 8.3(b): Auto-correlation function of $e_{\pi 1}$

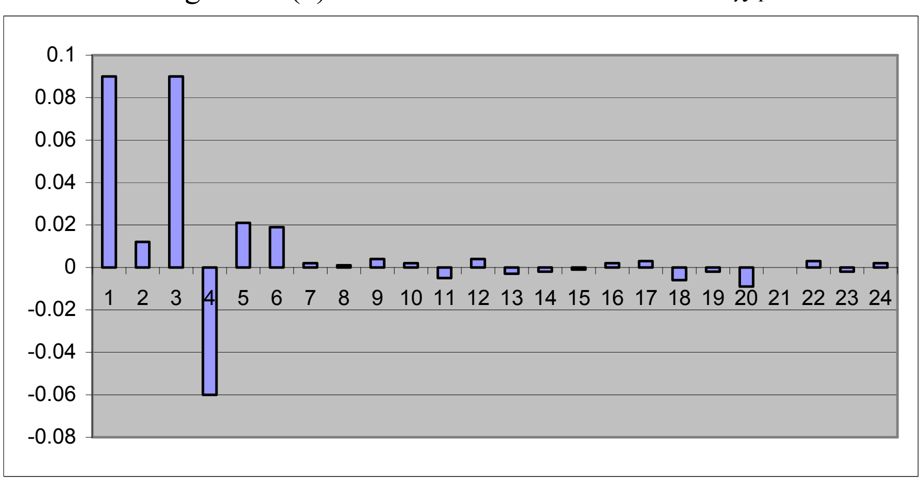
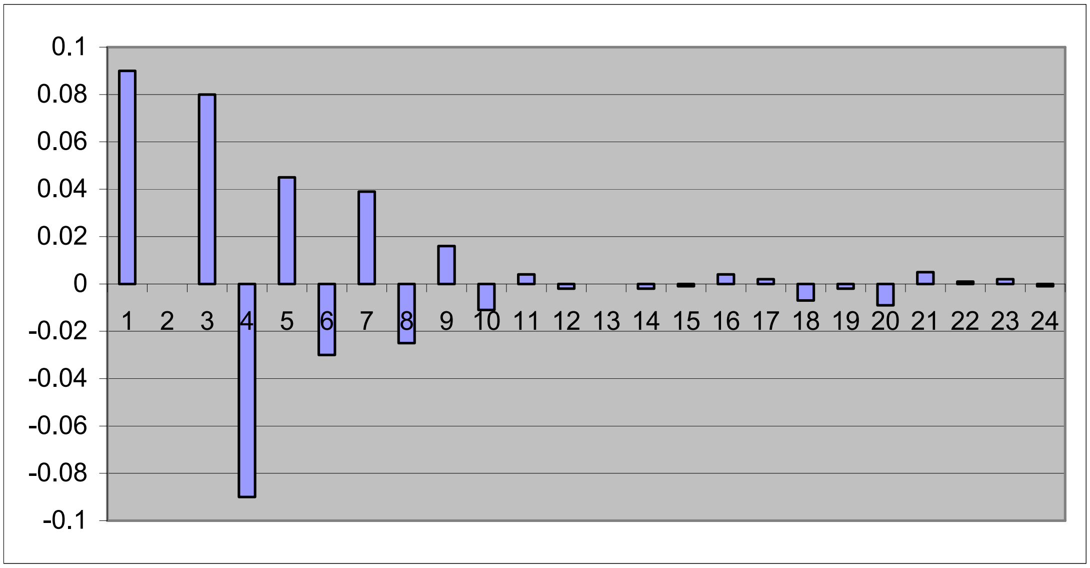


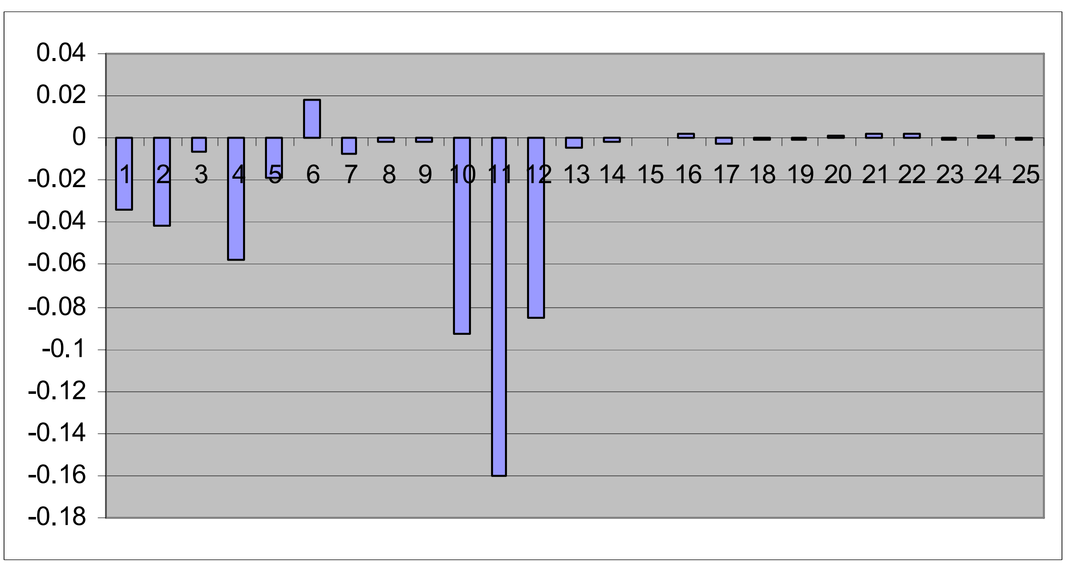
Figure 8.3(c): Partial correlation function of $e_{\pi l}$



The AFC and PAFC of $e_{\pi s}$ show that p= q=0.Therefore j $\geq$ max $\{p,q\}$=0.

The cross-correlogram between pre-whitened inflation rate ($\beta_{\pi i}$) and interest rate (α_i) is shown in figure 8.4(a).

Figure 8.4(a): Cross-correlogram between $\beta_{\pi i}$ and α_i



In figure 8.4(a), the first significant spike appears at lag 10, which implies that b=10

We obtained e_t for pre-whitened series as:

$$e_{\pi i} = \beta_{\pi i} - (-0.16\alpha_i(-10))(1.8/2.2)$$

In this case k=10, s=0. σ_β =1.8, σ_α =2.2, and $\rho_{\alpha\beta}(10)$ =-0.16.

The autocorrelation function and partial correlation function of $e_{\pi i}$ are shown in figure 8.4(b& c).

Figure 8.4(b) Auto-correlation function of $e_{\pi i}$

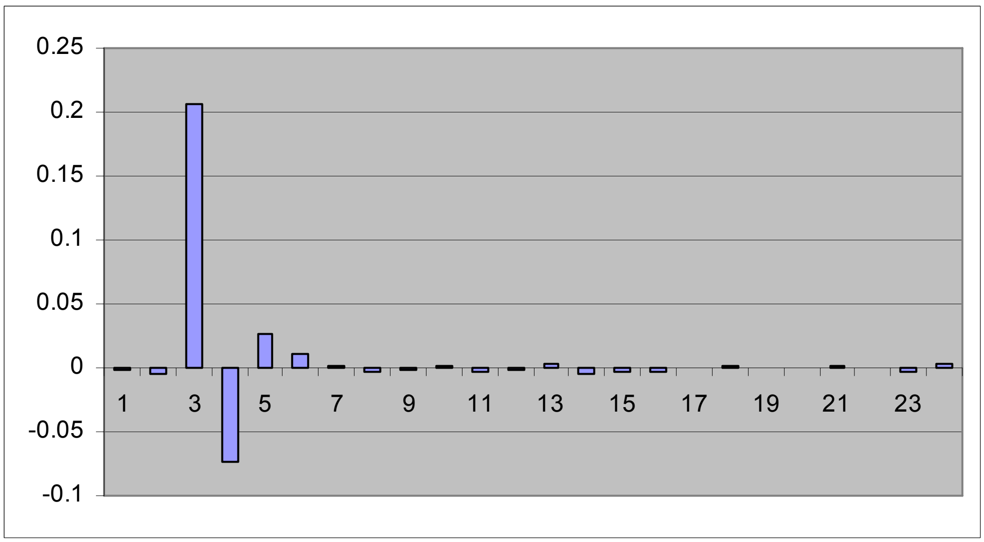
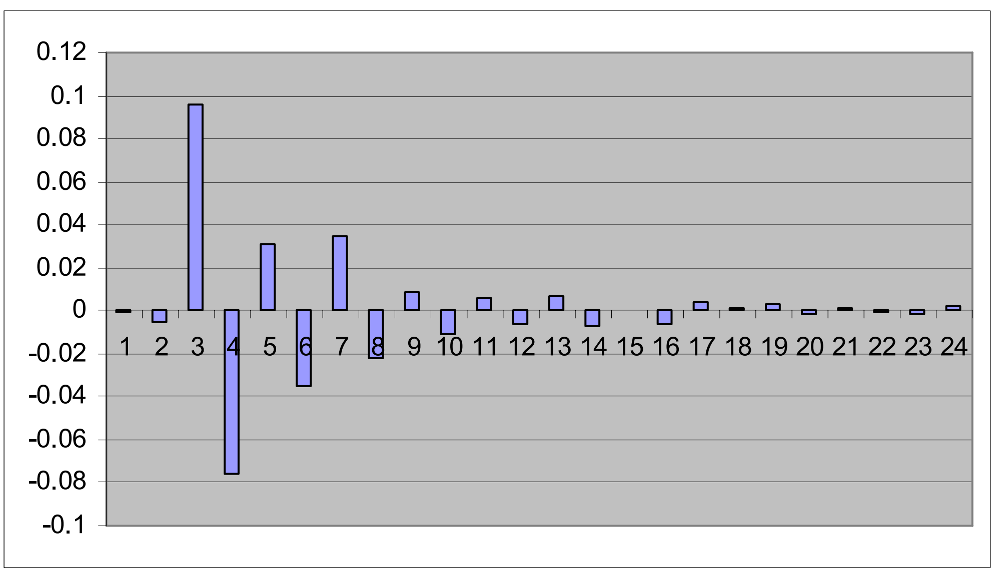


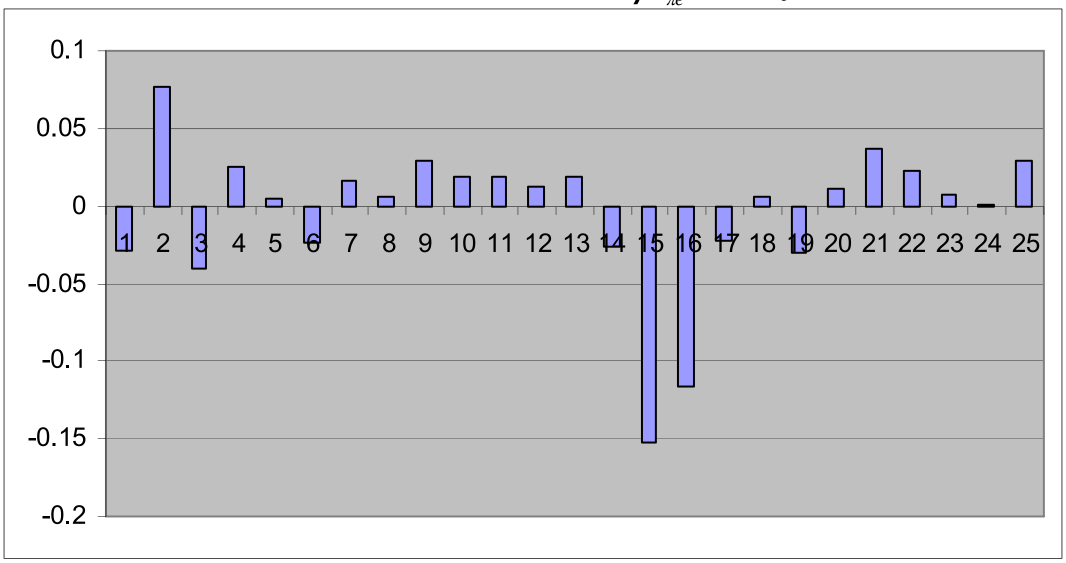
Figure 8.4(c) Partial correlation function of $e_{\pi i}$



The AFC and PAFC of $e_{\pi e}$ show that p=0 and q=3. Therefore $j \geq \max\{p, q\}$=3.

The cross-correlogram between pre-whitened inflation rate ($\beta_{\pi e}$) and changes in exchange rate (α_e) is shown in figure 7.22(a).

Figure 8.5(a): Cross-correlogram between $\beta_{\pi e}$ and α_e



In figure 8.5(a), the first significant spike appears at lag 14, which implies that b=14

We obtained e_t for pre-whitened series as:

$$e_{\pi e} = \beta_{\pi e} - (-0.15\alpha_e(-14) - 0.12\alpha_e(-15))(0.03/0.0004)$$

In this case k=14, s=1, σ_β=0.03, σ_α=0.0004, $\rho_{\alpha\beta}(-14)$=-0.15 and $\rho_{\alpha\beta}(-15)$=-0.12

The autocorrelation function and partial correlation function of $e_{\pi e}$ are shown in figure 8.5(b & c).

Figure 8.5(b) Auto-correlation function of e π e

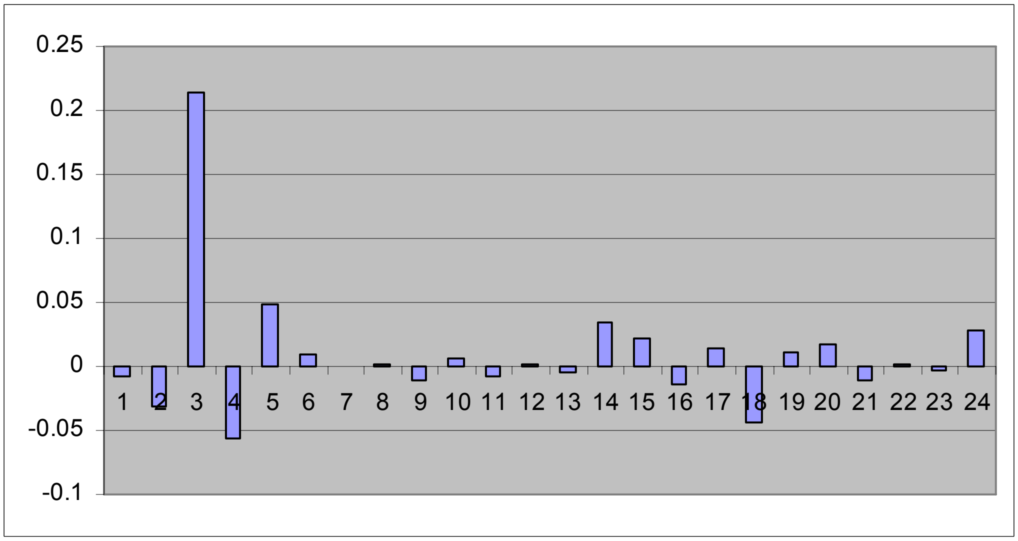
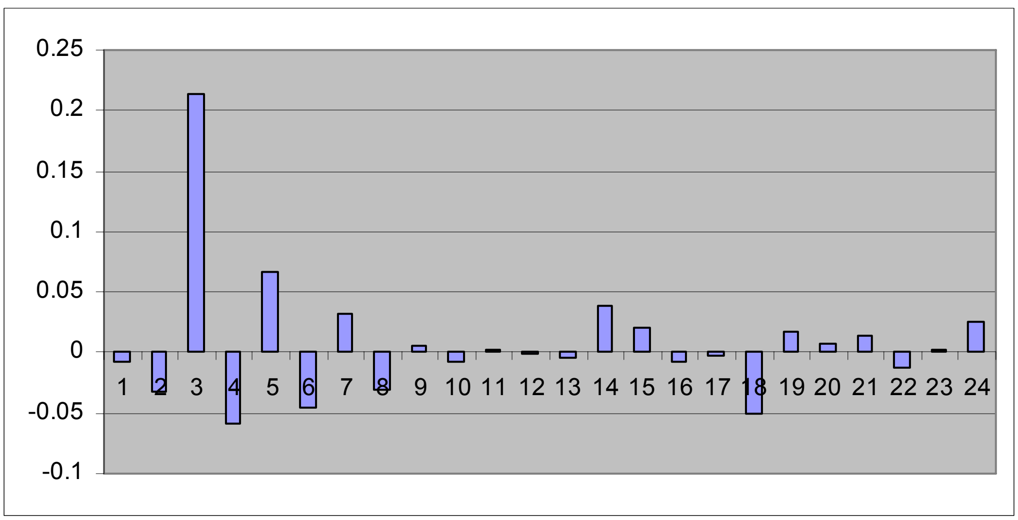


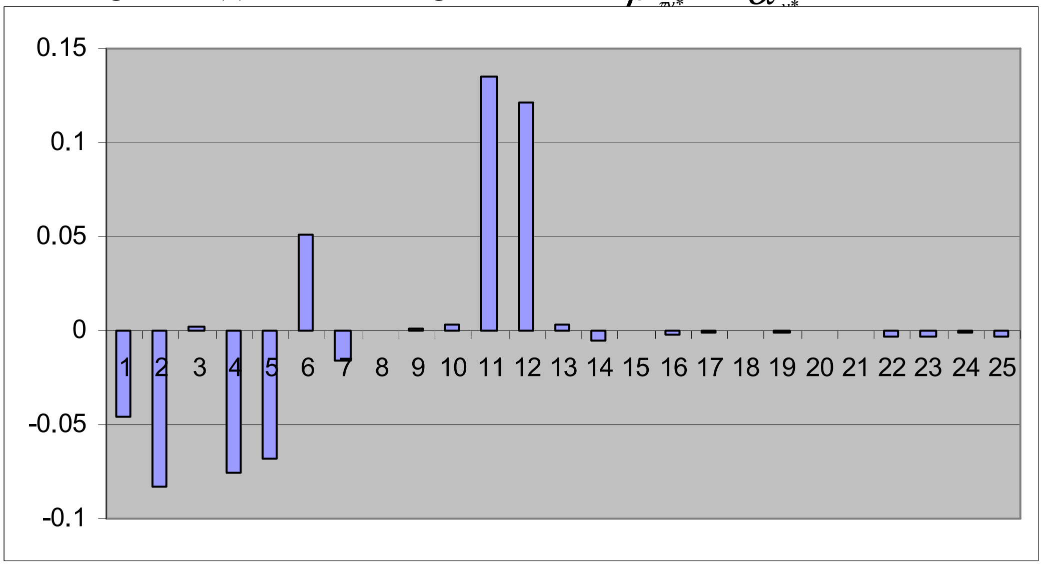
Figure 8.5(c) Partial correlation function of e π e



The AFC and PAFC of e π i show that p= q=3 Therefore j $\geq \max\{p,q\}$=3.

The cross-correlogram between pre-whitened inflation rate ($\beta_{\pi y*}$) and foreign GDP growth (α_{y*}) is shown in figure 8.6(a).

Figure 8.6(a) Cross-correlogram between $\beta_{\pi y*}$ and α_{y*}



In figure 8.6 (a), the first significant spike appears at lag 10, which implies that b=10
We obtained e_t for pre-whitened series as:

$$e_{\pi y*} = \beta_{\pi y*} - (0.13\alpha_{y*}(-10) + 0.12\alpha_{y*}(-11))(0.13/0.007)$$

In this case k=10, s=0. σ_β=0.13, σ_α=0.007 $\rho_{\alpha\beta}(-10)$=0.13, and $\rho_{\alpha\beta}(-11)$=0.12

The autocorrelation function and partial correlation function of $e_{\pi y*}$ are shown in figure 8.6(b & c).

Figure 8.6(b) Auto-correlation function of $e_{\pi y*}$

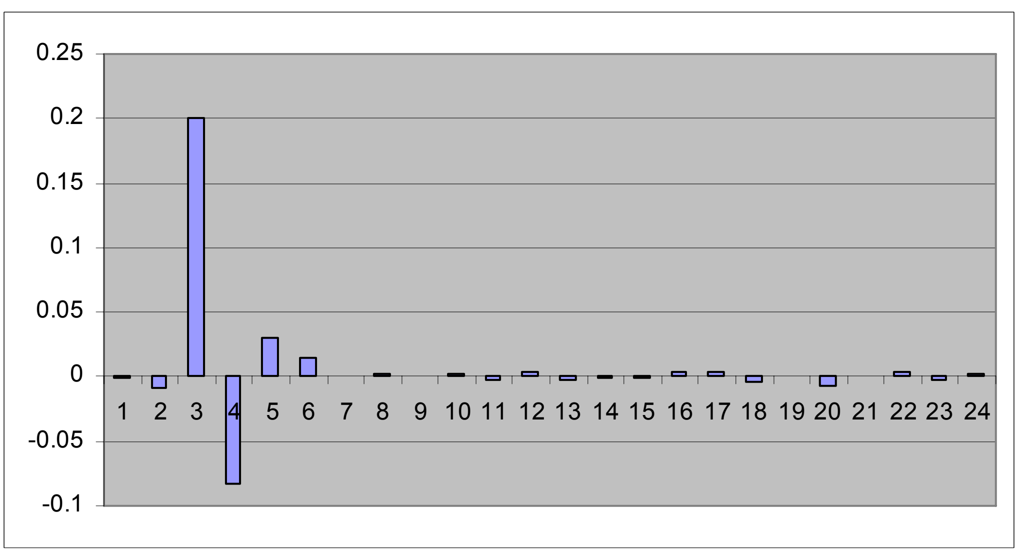
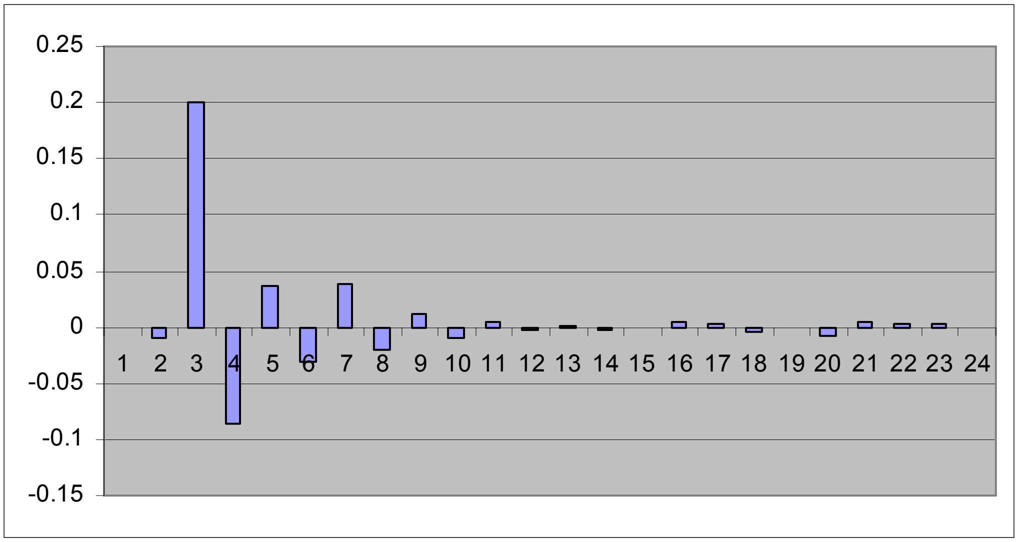


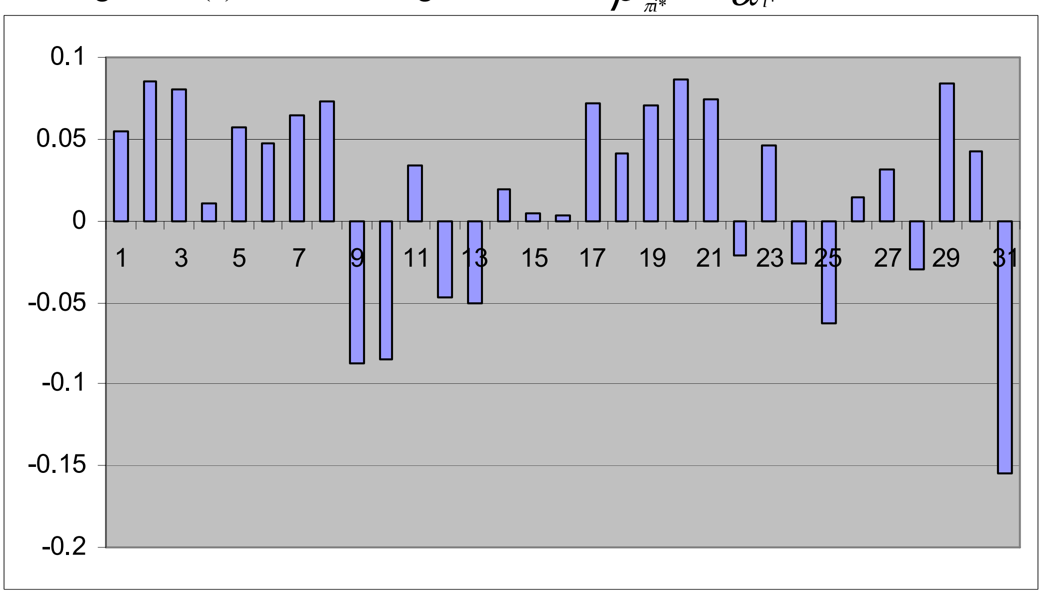
Figure 8.6(c) Partial correlation function of e π y*



The AFC and PAFC of e π i show that p= q=3 Therefore j $\geq \max\{p, q\}$=3.

The cross-correlogram between pre-whitened inflation rate ($\beta_{\pi i^*}$) and changes in foreign interest rate (α_{i^*}) is shown in figure 8.7(a).

Figure 8.7(a) Cross-correlogram between $\beta_{\pi i^*}$ and α_{i^*}



In figure 8.7(a), the first significant spike appears at lag 30, which implies that b=30

We obtained e_t for pre-whitened series as:

$$e_{\pi i*} = \beta_{\pi i*} - (-0.15\alpha_{i*}(-30)(0.4/0.26)$$

In this case k=18, s=0. σ_β=0.04, σ_α=0.26, and $\rho_{\alpha\beta}(-30)$=-0.15

The autocorrelation function and partial correlation function of $e_{\pi i*}$ are shown in figure 8.7(b & c).

Figure 8.7(b): Auto-correlation function of $e_{\pi i*}$

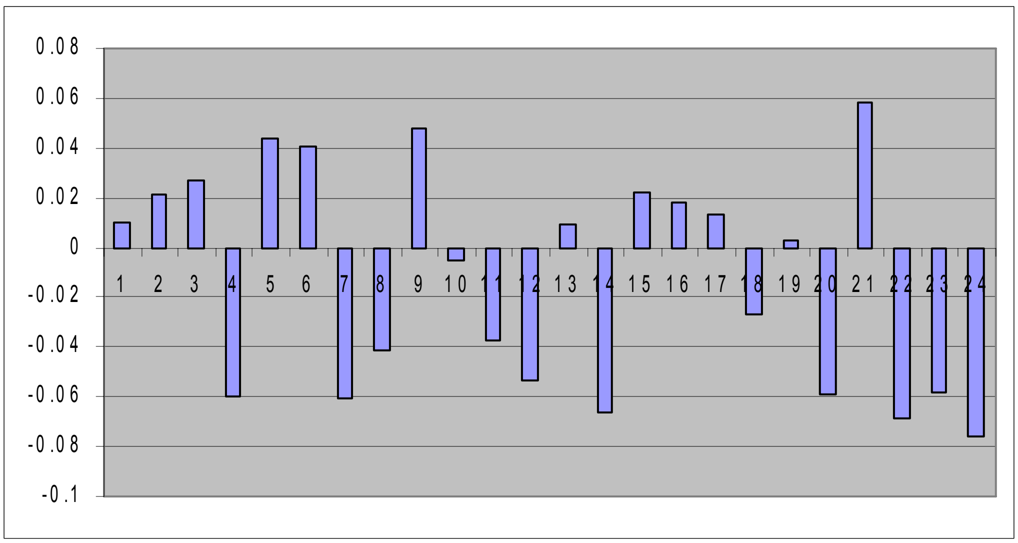
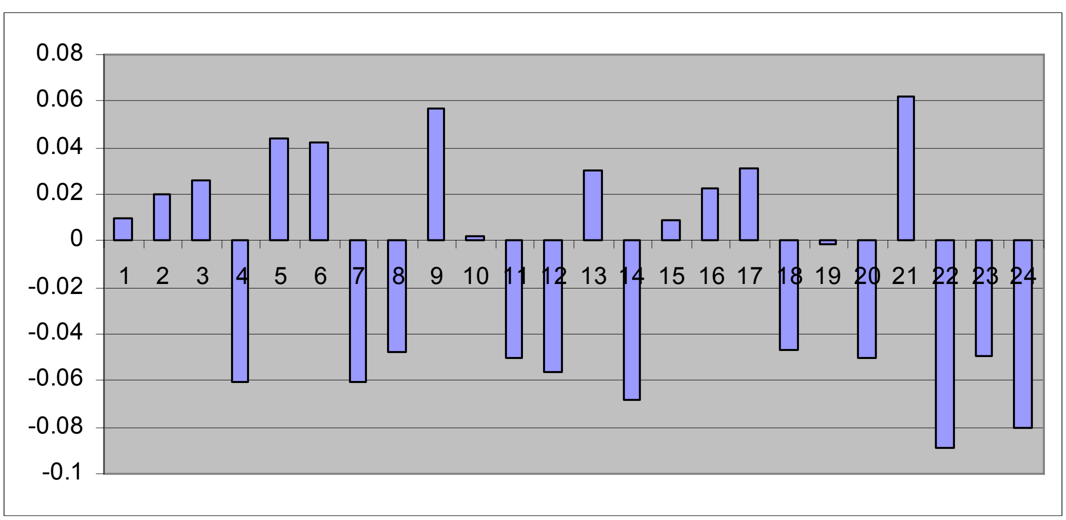


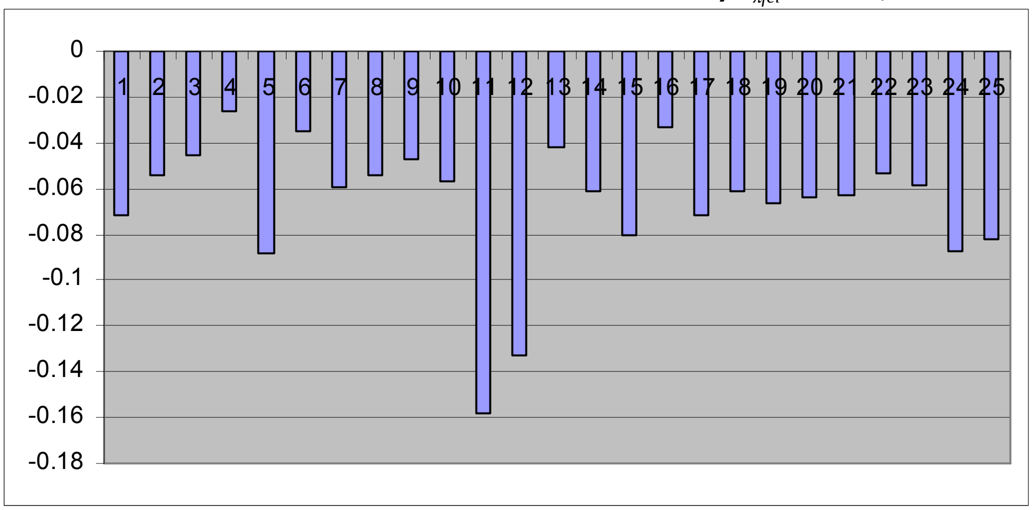
Figure 8.7(c): Partial correlation function of $e_{\pi i*}$



The AFC and PAFC of $e_{\pi i}$ show that p=q=0 Therefore $j \geq \max\{p,q\}$=0.

The cross-correlogram between pre-whitened inflation rate ($\beta_{\pi fci}$) and MCI (α_{fci}) is shown in figure 8.8(a).

Figure 8.8(a): Cross-correlogram between $\beta_{\pi fci}$ and α_{fci}



In figure 8.9(a), the first significant spike appears at lag 10, which implies that b=10

We obtained e_t for pre-whitened series as:

$$e_{\pi fci} = \beta_{\pi fci} - (-0.16\,\alpha_{fci}(-10) - 0.13\,\alpha_{fci}(-11))(0.07/0.47)$$

In this case k=10, s=1, σ_β=0.07, σ_α=0.47, $\rho_{\alpha\beta}(-10)$=-0.16, and $\rho_{\alpha\beta}(-11)$=-0.13

The autocorrelation function and partial correlation function of $e_{\pi fci}$ are shown in figure 8.8(b & c).

Figure 8.8(b): Auto-correlation function of $e_{\pi \text{ fci}}$

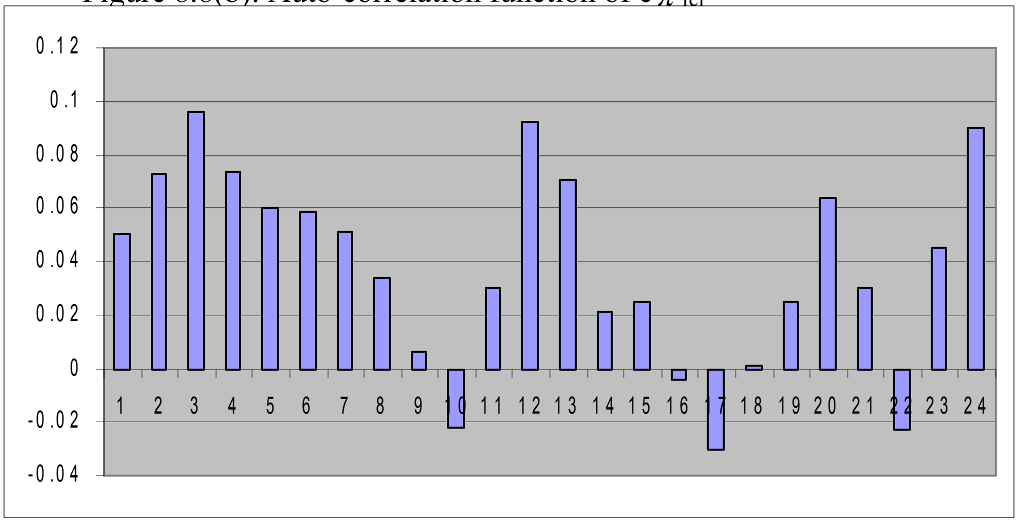
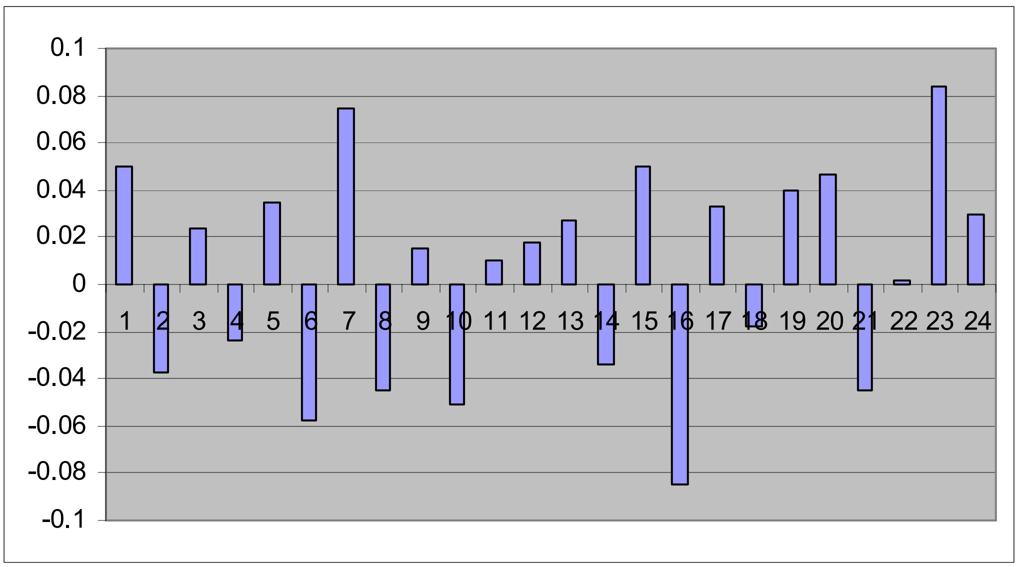


Figure 8.8(c) Partial correlation function of $e_{\pi \text{ fci}}$



The AFC and PAFC of $e_{\pi \text{ fci}}$ show that p=0 and q=0. Therefore $j \geq \max\{p, q\}=0$. After the identification of b, p, and q for different input series, the order r and s are identified using iterative least square procedure, results are presented in table 8.1

Table 8.1: Identification of r and s for inflation equation.

		The OLS Estimates of $\delta^{(j)}_{i(m)}$		The OLS Estimates of $\omega^{(j)}_{l(m)}$		
Inputs		i		L		
	m	1	2	0	1	2
y	1	0.5(0.8)		0.02(3.4)	0.002(0.4)	
m	1	0.4(1.5)		0.6(4.7)	0.02(1.08)	
l	1	0.4(4.3)		0.10(5.2)	0.04(2.2)	
	2	0.3(3.9)	0.13(2.3)	0.09(4.7)	0.04(1.97)	0.005(0.3)
i	1	0.5(1.3)		0.0003(1.8)	-0.00001(-0.06)	
e	1	0.5(1.2)		-2.0(-1.8)	0.7(0.6)	
y*	1	0.05(1.4)		0.13(5.4)	0.06(1.3)	
i*	1	0.5(4.3)		-0.01(-4.2)	0.003(2.1)	
	2	0.4(3.7)	0.2(3.2)	-0.01(-3.9)	-0.004(2.7)	-0.003(-1.03)
FCI	1	0.8(6.7)		-0.001(-1.9)	0.0009(-1.8)	
	2	0.8(3.6)	0.2(3.2)	-0.001(-1.9)	-0.0009(-1.8)	-0.00005(-0.06)

Table 8.2: Order b, p, q, r, and s of different inputs for change in inflation as output.

Output	inputs	b	p	Q	r	s
π	y	8	7	7	0	0
	m	17	3	3	0	0
	l	4	1	0	1	1
	i	10	3	3	0	0
	e	14	3	3	0	0
	y*	10	3	3	0	0
	i*	30	0	0	2	1
	fci	10	0	0	2	1

Now that that the transfer function model has been identified, we use the Gauss Newton algorithm to estimate the coefficient ω_j and δ_i for the inputs of each equation. Results of estimation are presented in table 8.3 below.

Table 8.3: Estimates of coefficients for inflation equation

Output	inputs	ω_0	ω_1	δ_1	δ_2
π	y	0.02(3.4)			
	m	0.6(4.7)	-------		-------
	l	0.09(4.5)	0.04(4.6)	0.3(3.1)	
	i	0.0003(1.81)			---------
	e	-0.2(-1.98)	-------		
	y*	0.13(5.4)			
	i*	-0.01(-3.9)	-0.004(-2.7)	0.4(3.7)	0.2(3.2)
	fci	-0.001(-1.9)	-0.0009(-1.9)	0.8(3.6)	0.2(3.2)

Note: t-statistics are in parenthesis

8.2. Relationship of inflation with other variables: Results

We find the following transfer functions for inflation:

$$\pi_t = 0.2\,y_{t-8} + 0.6\,m_{t-17} + \frac{(0.09+0.04B)}{1-0.3B}\,l_{t-4} + 0.0003\,i_{t-10\,t} - 0.2\,e_{t-14} - \frac{(0.001-0.0009B)}{1-0.8B-0.2B^2}\,fci_{t-10}$$
$$+0.13\,y^*_{t-10} - (0.01+0.004B)\frac{(0.01+0.004B)}{1-0.4B-0.2B^2}\,i^*_{t-30}$$

The results obtained from above equation are discussed below:

1. Inflation rate responds to changes in GDP growth with a lag of 8 months and the relationship is positive, which shows that as GDP growth increases, prices increase as well. The result is in conformity with the theory.
2. Changes in reserve money growth affects inflation with a delay of 17 months. The sign of coefficient is positive. This shows that money supply growth influences inflation growth impact occurs after about one and a half year.
3. Bank lending changes are transmitted to inflation after 4 months. The effects are positive, though smaller in size. The effect vanishes after fifth month.

4. Interest rates changes generate a positive impact on inflation (phenomenon known as price puzzle in literature [e.g. Sim (1990)].The delay period is 10 months. The effect is very small in magnitude. The reason for positive effect could be that higher interest rate causes the production cost to rise. The result also implies that supply side effects have dominance over demand side effects. Therefore the inflation rather than decreasing increases with the increment in interest rate (cost push inflation). This result is in line with Ahmed et. al. (2005), who also found positive impact of interest rate on inflation. Furthermore, Khan(2008) also support this result.

5. The inflation responds to changes in exchange rate with a lag of fourteen months. The inflation reduces with an appreciation of exchange rate.

6. Changes in monetary policy stance negatively affect inflation after 10 months, but the magnitude of impact is very small. The affect dies off after two months. The smaller size of the coefficient indicates that monetary policy is less effective in controlling inflation.

7. Changes in foreign output growth generate positive impact on inflation after 10 months, while foreign interest rate affects domestic inflation negatively and with a lag of 30 months.

To summarize the results in chapters 7 and 8, we may say that GDP growth responds relatively more quickly (3-month lag) to monetary policy stance than the time taken by inflation (10-month lag). Money supply also affects the GDP growth much earlier (11-months lag) than it casts impact upon inflation rate (17 months lag). This implies that monetary policy can affect output in the short run, as is commonly believed.

The inflation responds faster (four months lag) than output (eleven months lag) to changes in banks lending and has a positive impact on inflation as well as output. The impact is smaller in case of inflation.

An increase in interest rate results into higher inflation but reduces GDP growth and lags involved are 10 and 21 months respectively. This shows that supply side forces are dominant for inflation determination in Pakistan. These influences are, however, very small which lends support to the view that investment, in Pakistan, is less sensitive to interest rate changes. On the other hand exchange rate changes have strong impact on GDP growth and inflation, with lag structure of 4 and 14 months respectively.

These results imply that bank lending channel is more powerful than interest rate channel in the monetary policy transmission. This also supports the view that it is the availability of funds rather than cost of funds that matters. The response of inflation to change in bank lending is swifter as compared to response to output. A possible reason could be that banks have experienced excessive liquidity in the post-2003 period and leading to a soft bank lending e.g. Auto leasing car and housing finance that may have contributed significantly to inflation rather than to output in real term. Another reason for the swift response is that the lack of alternative sources of borrowing that makes the demand for credit inelastic.

The appreciation of domestic currency results into lower inflation, the appreciation boosts output initially but reduces it later on. Though exchange rate channel seem stronger in amplifying the impact of monetary policy on both inflation and output the results may be taken with cautions. Because it may be disadvantageous, because volatility in exchange rate could results into volatility in these variables causing uncertainty and makes monetary policy more complicated. Furthermore even if exchange rate is stable against US dollar, but it may lose its value against major currencies as has been the case since late 2004. Though rupee was stable against US dollar but as US dollar was losing its value against major currencies, hence rupee was weakening also. Under flexible exchange rate regime it will be unwise to use exchange rate as an instrument until domestic currency is stabilized in the world market. However exchange rate stabilizing measures will help stabilizing output and inflation.

The interest rate may not be helpful in controlling inflation because if the authority's objective is to stabilize prices or cut down the inflation rate, then any increase in interest rate will worsen the situation further, because higher interest rate will increase the cost of production and hence results into higher inflation. Besides, the impact of foreign GDP growth on domestic inflation is larger as compared to the influence domestic GDP growth on inflation. This implies that a significant part of inflation constitutes imported inflation. It is this reason why the monetary policy is not likely to be very effective in controlling inflation.

9 Conclusions

The emerging consensus towards considering a monetary policy as a powerful tool for achieving the objectives of a stable economic growth and low inflation as well as the study of the channels that transform the monetary policy changes into policy goals is gaining momentum. Friedman (1961) suggested that the policy-induced changes are quite often transmitted to output and inflation with lags, which may be long and variable. This means that it is not only the current policy changes which affect output and inflation, but actions taken in the past (pipeline effects) can also change the course of economy. Furthermore, the speed of the propagation through different channels may be different i.e. the policy-induced changes through one channel may reach faster to goals than through other channels. Therefore, a successful implementation of a monetary policy requires an accurate assessment of how fast the effects of policy changes propagate to policy goals and how large these affects are. This requires a thorough understanding of the mechanism through which monetary policy affects the economic activities.

Besides examining the importance of different channels, a measure of policy stance is needed to obtain the quantitative estimates of the monetary policy changes on output and inflation, and to evaluate the performance of different channels of the monetary policy transmission. This study attempted to analyze:

1. The relevance of different monetary policy measures in designing the monetary policy.
2. The effectiveness of a monetary policy in achieving its macroeconomic goals.
3. The relative importance of different channels of monetary transmission mechanism.

4. The lags involved in transmission of the affects of monetary policy through different channels.
5. The extent to which Pakistan's economy - being a small open economy - is affected by the external shocks.

In this study, we have constructed two monetary policy measures, namely: the monetary condition Index (MCI) and the financial condition index (FCI). We compared the two constructed indices on the basis of performance criterion i.e. the consistency of the estimated weights with the economic theory and the dynamic correlation with output and inflation. The results show:

1. The estimated weight for both measure are consistent with the theory.
2. The overall FCI has negative and stronger correlations with the output-growth at different lags though MCIs show a higher correlation with the output-growth and change in inflation at some of the lags.
3. The FCI and MCI both perform well as upturns of the output-growth match with downturns of these measures after 1992 and vice versa. This implies that the higher output-growth is associated with expansionary policy while the lower output-growth is associated with a tighter monetary policy. Similar conclusion is true for inflation.
4. In 23-year period (from 1984 to 2006), the demand shocks are dominant for about 13 years. The MCI can explain three of these demand shocks which include the shocks occurring in 1995-96, 1996-97 and 2001-02. (The analysis assumes that the policy affects the economy with a lag of 1-year); the FCI explains 9 out of 13 demand shocks

referred above. These include the shocks occurring in 1994-95, 1995-96, 1996-97, 1998-99, 2001-02, 2002-03, 2004-05 and 2005-06.

5. MCI as well FCI failed to capture the pre-1991 demand shocks.

An important conclusion emerging from the foregoing is that the FCI plays an important role in determining output and inflation when the economy is not dominated by the supply shocks. This implies that the State Bank of Pakistan (SBP) may consider a larger set of financial variables to measure the stance of the policy rather than focusing only on the interest rate and the money supply.

To achieve the remaining objectives of this study, listed above, we used the transfer function methodology. The methodology is employed to estimate the (i) impact of policy-induced changes on the goals of the monetary policy, (ii) the strength of different channels and (iii) the possible delay in transmission of external shocks on the domestic economy. The results are as follows:

- Output responds faster than inflation to change in the monetary policy stance, measured by the financial condition index.
- The increase in money supply results into higher inflation as well as output growth however the response of output to money supply changes is quicker as compared to inflation.
- The response of inflation to change in bank lending is swifter as compared to response of the output.
- The interest rate affects inflation positively, perhaps by increasing the cost of production. This shows that the supply side forces are dominant in explaining inflation in Pakistan.

- The impact of interest rate changes on output and inflation is very small. This lends support to the view that investment is less sensitive to interest rate in Pakistan. The reason could be that non-economic factors are more important for agents while making decision regarding consumption, saving and particularly about investment.
- The exchange rate changes have a strong impact on the output and inflation. The appreciation of the domestic currency results into lower inflation. The output increases initially and reduces afterwards. The reverse holds true for depreciation of the Rupee.
- The results show that the bank lending and the exchange rate channels are more powerful than the interest rate channel in transmitting the affects of the monetary policy changes. The finding supports the view that it is the availability of funds rather than the cost of funds that matters.
- The domestic inflation responds more to the foreign output as compared to the domestic output. This implies that a significant part of inflation constitutes imported inflation, which in turn implies that a monetary policy is less likely to be effective in controlling inflation.

The main policy implications that may be drawn from this study are the following:

- The SBP may take into account the movements in exchange rate and other financial variables, such as assets prices and the banking system liquidity instead of relying solely on the interest rate, while considering its policy stance. Because it will provide true picture of the economy, as is evident from recent situation. Different variables were moving in conflicting direction, for example, the SBP was pursuing tight policy by raising interest rate but the exchange rate was depreciating and there was a boom in stock market and housing prices were sky rocketing.

- That the State Bank of Pakistan may focus directly on the liquidity in the economy rather than the interest rate because the bank lending as compared to interest rates seems more effective in transmitting the policy changes to the goals. This implication is also supported by a positive impact of the reserve money on policy goals and very small impact of the interest rate on the goals, reflecting lesser sensitivity of the economy to interest rate. However, the money channel works through consumption rather than investment and hence the results in consumption led growth. Besides, as banks have had the excess liquidity, they may not follow the strict 'credit screening' process in extending consumer loans as well as commercial loans that lead to high default rate and NPLS etc. Considering such factors, the SBP may put in place more prudential regulatory measures to ensure the soundness of the financial sector. Based on the finding of this study that the interest rate positively influences inflation, the interest rate may not be a good instrument for controlling the inflation. One reason for the positive relationship could be the lack of credibility of SBP on the face of its commitment to fight inflation. Theoretically, the interest rate increases control the inflationary pressure when the increase curbs inflationary expectations in addition to the demand for goods. The success of the central bank to keep the inflation low depends on its ability to manage the future expectations of the agents as well. Besides, the nature of inflation is important for the monetary policy to be effective or ineffective in curbing inflation. For example, whether inflation hike is due to cost factors or demand factors matters for the success of a monetary policy in taming the inflation. If it is due to cost factors then tightening the policy will even worsen the situation, as it will increase the cost of production and price will increase further accompanied by lower output growth. Another issue is whether inflation is the result of increase in domestic prices or prices of imported goods. If it is because of increase in the prices of imported goods, as evident from results in this study, then the monetary policy will be less likely to influence inflation. The continuous increase in the prices of oil and imported food items will make it difficult to control inflation by increasing interest rate as is the case in Pakistan.

The study, notwithstanding its importance for designing a better monetary policy, has a few limitations: one, we could not include some other transmission channels in this study, especially the assets price channel which may enjoy importance in monetary transmission. The reason is that the data on assets prices are not available. Two, the analysis could not be undertaken for different shorter sub-spans to examine the impact of structural shifts, if any. The reason we could not undertake such an analysis is the methodology used in this study requires longer data span. Three, as mentioned earlier that the changes in the industrial production (IP) index may entirely be appropriate proxy for GDP growth. There may be shocks that appear in IP index but not transmitted to overall economy. So, the use of quarterly data (as the estimate of the quarterly GDP series is available) instead of monthly data used in this study may provide a clearer picture of the working of different channels in Pakistan. These issues are left open for further research.

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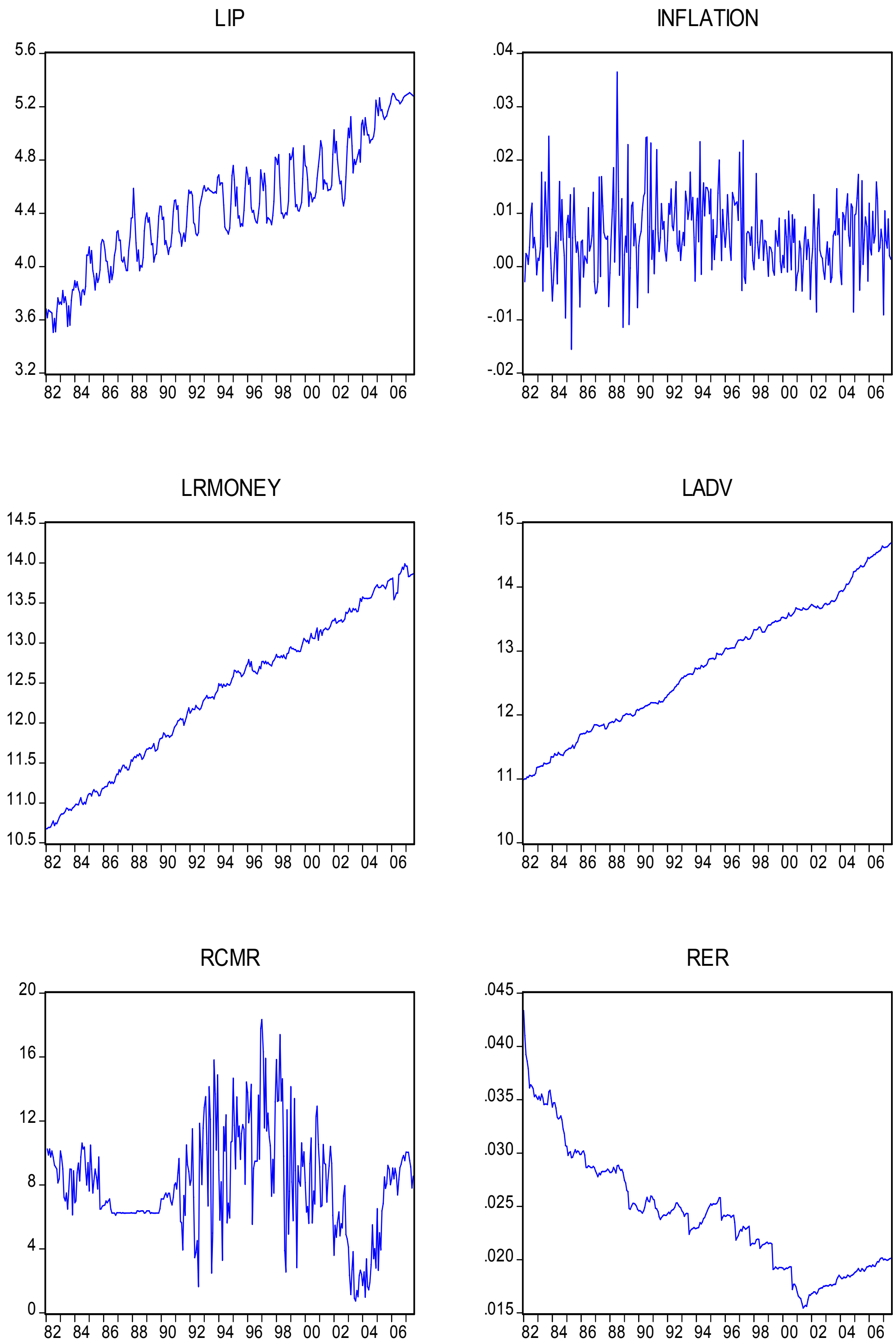
Appendix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Here,

Lip = Indutrial Productio Index in log form.
Lrmoney= Reserve Momey in log form.
Ladv =Bank Advances in log form.
Rcmr =Real Call Money Rate.
Rer = Real Exchange Rate.

Annual GDP & IPI