Impact of Monetary Policy on Food Prices: A Case Study of Pakistan

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CERTIFICATE

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Dedicated to my Parents

Who always supported me throughout all the wrongs and rights of my life

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Abstract

This study investigates the potential impact of monetary policy on food prices in case of Pakistan in long run and short run by using Johansen cointegration technique and vector error correction model respectively. Monthly time series data from July 1991 to December 2010 on four variables namely Money Supply (M_2), Nominal Exchange Rate, Food Prices, Manufacturing Goods Prices has been used. This study found that there exist significant long run relationship between food prices and money supply. Money supply positively affects food prices in the long run in case of Pakistan. Study also found that the seasonal variations are responsible for short variations in the food prices.

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1. Introduction

In 1947, Pakistan was an agrarian economy, but with the passage of time industrialization has turned Pakistan into a more diverse economy. Although the share of agriculture in the gross domestic product (GDP) of Pakistan had decreased significantly since 1947 but the role of the agricultural sector in the economic development of Pakistan cannot be denied and Pakistan is still pretty much characterized as an agrarian economy.

The agriculture sector is of great importance for the economy and it has major involvement in the economic development of Pakistan. After servicing sector, Agriculture has the largest contribution to the GDP. Its share in the GDP is more than 21 percent (GoP, 2009/10). Hence, to increase the GDP of the economy, agriculture can play a pivotal role. It is the most dominant source of employment, absorbing 45 percent of employment (GoP, 2009/10). Agriculture is a great source of livelihood as nearly 62 percent of the population of Pakistan depends on agriculture for livelihood and more than 90 percent of rural residents of Pakistan are directly or indirectly linked to agriculture (GoP, 2009/10). Besides directly contributing to the betterment of the economy, the agriculture sector is also playing an indirect role by providing raw material for other industries. For example textile, leather, sugar and sports goods industries are entirely dependent on agriculture, it is also a large market for industrial products such as fertilizer, pesticides, tractors and agricultural implements. About 27 percent of the total exports consist of raw and processed agricultural produce and 64 percent are based on agricultural raw materials. (GoP 2009/10). This way, agriculture is helping the country to earn foreign exchange through exports.

The growth originating in agriculture is four times more effective in reducing poverty than the growth coming from non-agriculture sectors (World Development Report 2008). Report further suggests that in the emerging countries (like Pakistan) the agricultural agenda should focus on reducing the disparity between rural and urban incomes and raising the incomes of the rural poor. We would like to quote the acceptance speech of "Theodore Schultz" for the 1979 Nobel Prize in Economics observing: "Most of the people in the world are poor, so if we knew the economics of being poor we would know much of the economics that really matters. Most of the world's poor people earn their living from agriculture, so if we knew the economics of agriculture we would know much of the economics of being poor" (Shultz, 1979).

So far, we emphasis on agricultural sector but one question that naturally comes into mind is, through which mechanism does the agricultural sector play such an immensely important role in Pakistan's economy (GoP, 2009/10). That mechanism is none other than agricultural prices. These agricultural prices are as important for Pakistan economy as the agricultural sector itself. Agriculture prices are important for maintaining agricultural growth, farmers' living standard and investment decisions (Kargbo, 2005). Since almost 65 percent population of Pakistan is directly or indirectly linked with agriculture therefore any volatility in prices of this sector effects more than half people of the country. Thus factors that influence the agricultural prices are of fundamental importance for a developing country like Pakistan. The issue is important because policies to stabilize agricultural prices must consider the sources of volatility in the Economy. The emphasis on agricultural price policy started since 1960, with Todaro's model prediction that both agricultural and industrial sector should be in balance in order to sustain and long term growth and ultimately development (Martini & Ahmad, 2000).

Schuh (1974) was among the first to suggest that the magnitude of the exchange rate (an important monetary variable) could have important implications for agricultural prices. Since then interest has continued in the possible effects of monetary policy on agricultural prices with Tweeten (1980) and Bordo (1980) making important contribution. With the passage of time, this interest in exchange rates led researchers to investigate the relationship between other monetary variables (like money supply and interest rate) and volatility of agricultural prices. The latest studies on agricultural economics such as Saghaian et.al (2002), Peng et.al (2004) and Asfaha & Jooste (2007) examined that monetary policy is now as important for agriculture as price support and sector specific microeconomics policies.

Hye (2009) investigate casual relationship between money supply and agricultural commodity prices in case of Pakistan. By employing Johanson cointegration he confirmed that there exist a long run relationship between money supply and agricultural prices and long run elasticity of agricultural prices with respect to money supply is 0.79. Hye (2009) did not incorporate exchange rate into his analysis and hence missed the dynamics of open economy. Since Pakistan's Economy is better known as small open economy, so there is a need to incorporate exchange rate into analysis. In this study we incorporate exchange rate and manufacturing goods prices along with food prices and money supply to check the impact of monetary policy on food prices as suggested by Saghaian et.al (2002).

1.1 Objectives

The objective of this study is to investigate the impact of monetary policy on food prices in short run and long run.

1.2 Hypothesis

Agriculture is a competitive sector and prices of agricultural commodities are determined in competitive circumstances, hence they are flexible (in the absence of government intervention) while prices of most other goods and services in the Wholesale Price Index (WPI), for example manufacture prices are sticky as they have some sort of monopoly power (Robertson & Orden, 1990 and Barnett, *et. al,* 1983). Hence in case of monetary expansion agricultural prices will increase and has real effect on the farmer's income, well being and living standard (Saghaian et.al, 2002). According to our objectives we will check the impact of monetary policy on food prices in short run and long run. More specifically we will check following two hypotheses.

- **H_0^1:** Money supply positively affects food prices in long run.
- **H_1^1:** Money supply has no affect on food prices in long run.
- **H_0^2:** Money supply positively affects food prices in short run.
- **H_1^2:** Money supply has no affect on food prices in short run.

1.3 Methodology

We first apply Augmented Dicky-Fuller (ADF) test to check the time series properties of our variables. If, we find that all series are integrated of order one I(1). We employ Johanson maximum likelihood method to estimate the long run relationship between our variables. We also estimate Error Correction Mechanism (ECM) to find short run relationship between our variables.

1.4 Data

In this study we use monthly time series data over the period from July 1991 to December 2010 for four variables, which are; food prices, manufacturing goods prices, money supply and exchange rate.

1.5 Plan of the study

This study is organized as follows. Chapter 2 reviews the existing literature relevant to "impact of monetary policy on food prices". In Chapter 3 theoretical and econometric methodology has been discussed along with brief description of data. Chapter 4 empirically estimates the impact of monetary policy on food prices in Pakistan. Summary, conclusion and policy recommendations are provided in Section 5.

2. Review of Literature

This section provides a brief review of the literature of various previous empirical and theoretical studies. The empirical studies that have been conducted for different regions or set of regions explain that there is ambiguity over the impact of monetary policy on agricultural prices in short run and long run. Keeping objectives of the study in mind we can divide previous literature related to "monetary policy and agricultural prices" into three categories. (a) Studies which totally support both hypotheses that monetary policy significantly affect food prices both in short run and long run, (b) Studies which partially support that monetary policy affect prices in short run and there is long run monetary neutrality in food prices, (c) studies which support none of our hypotheses and argue that monetary policy is irrelevant as for as food prices are concerned. We explain studies of these three categories one by one and in detail.

2.1 Studies which support both hypotheses

Barnett *et. al, (*1983) examined the impact of money supply on nominal agricultural prices in case of USA. More specifically they checked that whether money supply take an active or passive role as for as price instability is concerned. They discussed that according to structuralist explanation money supply take a passive role as real shocks such as global crop failures, in some specific sectors of economy, raise prices of selected agricultural commodities and these higher prices are accommodated by increase in money supply so the prices of non-agricultural commodities need not decline. On the other hand monetarist argues that money supply take an active role they say that it is autonomous increase in money supply which lead the prices increase. Both these explanation agree on the point no inflation can occur without monetary expansion in the long run. They carried causality test by taking monthly data from January 1970 to December 1978 on US money supply, the food component of consumer price index and the nominal prices of No. 2 Kansas City hard red winter wheat. They found that US money supply plays an active role in bringing changes in the food component of consumer price index and Kansas City wheat price. They found no significant casual relationship to favor the argument that money supply plays a passive role.

Choe and Koo (1993) examined the impacts of money supply on food commodity prices and manufacturing commodity prices in case of USA. For long run relationship between these three variable Johanssen's maximum likelihood method has been adopted. Error correction mechanism (ECM) has been used to investigate short run dynamic relationship between variable. Quarterly time series data on these three variables from 3rd quarter of 1948 to 3rd quarter of 1991 was used. All data is seasonally adjusted. The results of Johanson cointegration confirmed that there exists long run relationship between these variable. ECM and impulse response function showed that food prices over shoot in the short run in case of monetary shock as they adjust at a faster rate than manufacturing goods prices.

Saghaian *et.al* (2002) examined the impact of monetary changes on agricultural prices, exchange rate and industrial prices in an open economy. More specifically they checked that given a monetary expansion whether or not agricultural prices over shoot their long run equilibrium level. This study made theoretical contribution by extending frankel (1986) model for open economy by incorporating exchange rate into the mathematical model. Authors employed maximum likelihood method of Johanson cointegration to check the long run relationship between four variables. To investigate the short run mechanism of impact of monetary changes on prices they employed vector error correction model. To check the relationship empirically authors used monthly time series data for these for variable from January 1975 to March 1999. Results of Johanson cointegration confirmed that there exist a long run relationship between two prices, exchange rate and money supply. Long run elasticity of agricultural and industrial prices with respect to money supply is 0.773% and 0.430%. It indicates that in case of monetary shock agricultural prices are being adjusted faster than industrial prices. This study rejected and long run neutrality of money as long run rate of increase in agricultural in industrial prices is not unit proportional to the rate of money supply.

Lai et. al (2005) made a theoretical contribution toward the literature of overshooting of agricultural prices. This study examined the robustness of the overshooting hypothesis of agricultural commodity prices by allowing various degrees of the asset substitutability between agricultural process and bonds. Author found that extent of asset substitutability between agricultural commodities and bonds is a crucial factor for undershooting or overshooting of agricultural commodities both in an open economy and in a closed economy.

Asfaha and Jooste (2007) explored the impacts of changes in monetary policy on relative agricultural commodity prices in case of South Africa. Share of agriculture in the GDP of South Africa is only 3 to 5 percent but it has enormous importance in the economy. To estimate long run relationship between agricultural commodity prices and monetary policy changes this study employed Johansen cointegration technique which used maximum likelihood method. To estimate short run relationship between variables the Vector Error Correction Model (VECM) has been employed. They use overshooting model of Saghaian et al. (2002) and incorporate four variables which are money supply (M_t), industrial production price index (P_{mt}), agricultural production prices index (P_{at}), exchange rate between the South African currency- Rand and US Dollar (EX_t). Monthly time series data from January 1995 to June 2005 for these four variables were used in this study. The Johansen cointegration analysis found that the rate of increase in agricultural and manufacturing prices is no unit proportional to the growth rate of money supply in South African economy and hence reject the long run monetary neutrality. The Vector Error Correction Model (VECM), on other hand, found that overshoot in short run.

Bakucs et. al (2007) focused on the time adjustment paths of the exchange rate and agricultural producer and industrial prices in response to unanticipated monetary shocks following model developed by Saghaian et al. (2002). It is indicated by results that agricultural prices adjust faster than industrial prices to innovations in the money supply, affecting relative prices in the short run, but strict long-run money neutrality does not hold. The impulse response analysis showed that an exogenous shock to the money supply has a significant and volatile effect on the three price variables. The extent of overshooting in agricultural prices is twice as large as for exchange rates or industrial prices. This indicates that in the case of monetary shocks the sectors associated with flexible changes bear the burden of adjustment vis-Ã -vis the sectors with sticky changes. The exchange rate pass-through on agricultural producer prices revealed by the forecast error variance analysis indicates the relatively greater importance of the exchange rate than the money supply in explaining the expected variation of the agricultural producer price. This is consistent with floating exchange rate policy, while agricultural trade policy for sensitive products has been more restricted until Slovenia joined the European Union.

2.2 Studies which support one hypothesis

Schuh (1974) became the first economists who check out the potential impact of Exchange rate (an important monetary policy variable) on agricultural prices. The main focus of this study was on missing the role of exchange rate in development of US agriculture and its trade development. This study claimed that exchange rate has much importance in influencing the rate of adoption of new technology. This study used an Invent possibility curve (IPC) and graphical approach to show that exchange rate exchange is an important variable which affects and control the distribution of benefits of technical change to US producers and consumers and ultimately between the world and US economy at large. If Schuh has correctly interpret the importance of exchange rate then following events should occur after US dollar will be depreciated; (1) the comparable or parity price relative ratio should rise; (2) value of land should be increased at a rapid rate than they increased previously; (3) ratio of expenditures of consumer which he spend on food should rise; and (4) there must be a shift in US agricultural product mix toward exportable products. This paper, indeed, open a new dimension of research for the agricultural and monetary economists.

Tweeten (1980) investigated how the inflation affects agricultural sector and farmers. More specifically he checked that how general inflation affects the prices paid by farmers and prices received by farmers. To check this he made two hypotheses. First of them is domestic demand function of farm commodity at farm level is homogeneous of degree zero in income and prices. Second hypothesis is based on the acceptance of first hypothesis that is if income and prices are homogenous of degree one than whether the ratio of prices received by farmers and paid by farmers are affected/changed by general inflation and whether or not general inflation has uneven impact on income and prices in the supply function versus demand function for farm output. To empirically estimate the results Tweeten use annual data starting from 1948 and ending at 1977. He divided this time period into two subcomponents of 15 year each to check the structural change between two time periods. He adopted ordinary least square (OLS) methodology to empirically estimate the results. He found that one cannot reject the hypothesis that at farm level, the economic functions which determine demand for output are homogenous of degree zero in prices and income. A pure general increase in overall inflation seems to increase the nominal prices receive by farmers but the real demand price does not change as the general price level also change in exact proportion. Now give that supply and demand functions are homogeneous of degree zero in income and all price the second of two hypotheses whether the ratio of prices received by farmers and paid by farmers are affected/changed by general inflation is rejected for the period of 1963 to 1977. In this period, prices paid by the farmers increase much more than the prices received by the farmers and leads to cost price squeeze as for as farm sector in concerned.

Bordo (1980) presented an explanation for the adjustment of pattern of commodity prices given a monetary innovation. Analysis is based on varying degree of price flexibility across various industries where contract length is the measure of price flexibility. The Contract length approach takes price flexibility into consideration hence, better than tradition approach. As a general rule, longer the contract length, the more inflexible (less responsive) would prices be to a monetary innovation. Uncertainty and transaction costs might be consider as two important factors that could explain the main reasons of fixed price and long term contracts. He estimates the regression equation by using quarterly data over the period of 1st quarter of 1957 to 4th quarter of 1971 for various components of US wholesale price index including industrial, farm, raw goods, manufactures, crude, intermediate, final, durable, nondurable and money supply. He found that crude product prices respond faster than to manufactured product prices to a monetary shock and within crude prices he found that agricultural product respond fast than industrial products.

Chamber (1981) developed some theoretical back ground by arguing that the decision by the Federal Reserve to tighten credit drives the interest rate up and this higher interest rate decreases the amount of commodity traded. He used graphical technique and elasticity form to support his point of view. The main reason of decrease in commodity trade is as a result of increase in interest rate farmers are more vulnerable to debt burden and hence invest less and produce less at each possible price. This less production lead to higher prices which resulted in lower amount of commodity traded. If the exchange rate in that particular country is flexible (not fixed) and it adjusted according to international money market, increase in interest may attract foreign investment and capital and hence improve payment position of country. A rise in interest resulted in decrease in domestic supply of agricultural product which in turn decreases the supply in the international market. To empirically check the relationships he used monthly time series data from January 1973 to June 1980 for money supply, interest rate, agricultural commodity export and agricultural commodity imports. The F-Statistics confirm that for the time period under study there exist a causal relationship between money supply and agricultural commodity export and agricultural commodity imports. The F-Statistics also confirm that there is little evidences for a causal relationship between interest rate and agricultural commodity export and agricultural commodity imports.

Chambers (1984) developed a short-run theoretical model for the interaction between the financial markets and agricultural sector to check the effects of monetary policy changes on the agricultural sector. Comparative static experiments of the model show that monetary policy is not neutral and agricultural commodities may adversely affected (cost price squeeze) by restrictive monetary policy. To test this relationship author used monthly time series data from May 1976 to May 1982 for four variables, which are: the agricultural trade balance (NET), farm income (FI), money supply (M1) and relative farm prices (RP). Author employed vector autoregressive (VAR) modeling to empirically test the relationship and found that money supply significant affect agricultural prices and relative agricultural prices in short run. Empirical results implied that a contractionary open market operation depresses the agricultural sector in the short run which leads to lower incomes, relative prices, and returns to factors particular to agriculture. These empirical results are in accordance with theoretical model predictions.

Bessler (1984) investigated the impact of monetary changes on agricultural prices, and industrial prices in case of Brazil. More specifically they checked that given a monetary expansion whether or not agricultural prices adjusted faster than industrial prices. To check the relationship empirically author employed vector autoregressive modeling. He used monthly time series data over the period of January 1964 to December 1981 for Brazilian money supply, Industrial prices and agricultural prices. The empirical results show that there exists strong one way granger type relationship from money supply to agricultural commodity prices. He also found that give a money supply shock agricultural prices do not adjust faster than industrial prices in Brazilian economy.

Frankel (1986) reviewed the literature which relates to the over shooting of agricultural commodity and draw the conclusion that monetary, fiscal and other macroeconomic policies are equally important for agricultural sector as price support and other sector-specific microeconomic policies. With the help of solid evidences he proved that the sticky-price of view of the world is more accurate and rationale than the frictionless one. He also concluded that not a single existing agricultural policy program is well planned to deal with macroeconomic instability.

Frankel (1986) theoretical verified the impact of monetary policy on agricultural commodity prices. He formalized this argument by applying the Dornbusch overshooting model. A rise (decline) in the nominal money supply is a rise (decline) in the real money supply in the short run. It lowers (raises) the real interest rate, which rises (depresses) real commodity prices. They undershoot (overshoot) their new equilibrium in order to produce an expectation of future appreciation enough to offset the lower (higher) interest rate. These effects vanish in the long run. Other important factor in overshooting of commodity prices is speed of adjustment as higher the speed of adjustment, the less will commodity price reacts. It is a slow speed of adjustment in manufacturing goods markets that adds to over-shooting in the commodity markets.

Taylor and Spriggs (1989) examined the impact of money supply on agricultural prices and industrial prices in case of Canada. More specifically authors checked the relative importance of macroeconomic variables (money supply, exchange rate) on agricultural price instability. For this purpose they used vector autoregressive (VAR) modeling, error decomposition and impulse response functions. The analysis was conducted by using quarterly data from 1st quarter of 1959 to 4th quarter of 1985 for five variables including) log-difference of agricultural prices, log-difference of money supply (M1), Canadian dollar exchange rate, US dollar exchange rate and log-difference of manufacturing price. They found that money supply and exchange rate have significant and sufficient contribution to agricultural prices instability in case of Canada. They also found that in case of monetary shocks agricultural commodity prices respond more quickly than to manufacturing prices in short run while manufacturing prices catch up in long run and money neutrality holds in the long run.

Orden and Fackler (1989) examined monetary impact on agricultural prices and industrial prices. They compare recursive and simultaneous VAR model and discussed some necessary identifying restrictions which needed to make structural interpretation of vector autoregressive model. They used three variable model of agricultural prices, money supply and industrial prices to demonstrate their point relating to effects of monetary changes on price dynamics. They empirically tested the model by using quarterly data from 1st quarter of 1975 to 1st quarter of 1988 on seven variables including price level, oil prices, money supply, exchange rate, interest rate, output and agricultural prices. For the period understudy, the results from recursive model did not fit the interpretations as the price level and agricultural prices fall when money supply increases. But when they employed simultaneous model, results become more plausible. Results of simultaneous model showed that in case of positive supply shock (excess supply) price level fall and in case of negative supply shock (least supply) price level rise but level of agricultural commodity prices rise more than overall price level and hence no cost price squeeze take place.

Robertson & Orden (1990) checked money neutrality hypothesis in case of New Zealand. More specifically they checked whether the changes in the level of money supply affect the level of agricultural and manufacturing (non agricultural) prices in the same way in the long run. They also checked whether or not agricultural prices overshoot in the short run. To check this relationship empirically authors used quarterly data from 1st quarter of 1963 to 1st quarter of 1987 for agricultural prices, manufacturing prices and money supply. They found that these three variables are cointegrated and has stationary proportional long run relationship over the period 1963:1 to 1987:1. Restricted vector error correction model showed that in the short run changes in money supply positively affect the agricultural prices. With the help of impulse response functions author showed that shock in agricultural prices did not affect manufacturing prices and money supply. While shock in manufacturing prices placed agricultural commodities prices in a cost price squeeze.

Peng *et.al* (2004) investigated the impact of money supply and interest rate (important monetary variables) on food prices in case of China. They used Johansson's' maximum likelihood method to estimate long run relationship between money supply, food prices and interest rate. Study also employed Granger causality test to check the direction of causality between variables. Study used annual data starting from 1980 to 2002 for the three time series. The Johansen cointegration analysis found that there exist long run relationship between food prices, money supply and interest rate, which indicate that in china food prices are being affected by monetary policy variables. Granger causality test indicated that root cause of huge food price variations in China is money supply and not interest rate.

Ejaz et. al (2007) examined the effect of money supply on general price indices and food component of Consumer Price Index (CPI). For analysis author employ ordinary least square (OLS) methodology and used annually time series data from 1975/76 to 2006/07. Author used CPI general, CPI Food, Whole sale Price Index (WPI) general, WPI good, Sensitive Price Index (SPI), and GDP deflator as measure of the inflation and as explanatory variables author used M1, M2 and M3 supply of money. Durbin-Watson criterion was used to make the series stationanry and to check the problem of autocorrelation AR(1) was used. The results for CPI general, CPI Food, Whole sale Price Index (WPI) general, WPI good, Sensitive Price Index (SPI), and GDP deflator showed that they have inverse relationship with supply of money M1 and M2. While results of OLS estimations shows that CPI general, CPI Food, Whole sale Price Index

(WPI) general, WPI good, Sensitive Price Index (SPI), and GDP deflator have positive relationship with money supply M3.

Hye (2009) investigated casual relationship between money supply and agricultural commodity prices in case of Pakistan. He employed Johanson cointegration to check the long run relationship between two variables. He also employed Toda and Yamamoto modified granger causality test. This study incorporated quarterly data from 1st quarter of 1971 to 4th quarter of 2007 for Broad money supply (M2) and agricultural prices index which was developed by the author himself. The results of Johanson cointegration analysis confirmed that there exist a long run relationship between money supply and agricultural prices in case of Pakistan. Long run elasticity of agricultural prices with respect to money supply was 0.79. The results of Toda and Yamamoto modified granger causality test showed that there exists unidirectional causality which was from money supply to agricultural prices and not reverse.

2.3 Studies which support none hypotheses

Lapp (1990) employed a model of the type pioneered by Lucas and Barro which assumeed market clearing equilibrium and imperfect information about aggregate prices. This model provided an econometric specification for testing for a causal relationship between money and the relative prices of agricultural commodities. He used quarterly data for the period 1951 to 1985. The relative prices of agricultural commodities were measured by the "Index of Prices Received by Farmers" deflated by (a) the consumer price index (CPI), and (b) the producer price index (PPI). The relative output of agricultural commodities was measured by real GDP for the farm sector relative to total real GDP. The MI definition of the money supply was used. Test results failed to verify that nominal money supply has important influence relative agricultural prices (prices received by farmers) to the other prices in the economy over the period 1951 to 1985.

2.4 Concluding Remarks

In a net-shell, the studies which totally support both hypotheses that monetary policy significantly affect food prices both in short run and long run are ;

Barnett, *et. al* (1983) empirically indicated unidirectional causality from money supply to agricultural prices and found non-neutrality of monetary policy in Brazilian data. Choe and Koo (1993) did not find a long run neutrality of money, however, a stable equilibrium relationship in which farm prices are proportional to nonfarm prices in the long run was found. Saghaian *et.al* (2002) empirically demonstrated that in long run money neutrality did not hold in determination of agricultural prices and the extent of the overshooting depends positively on the relative weight of fixed prices in the price index, interest response of money demand and the speed of adjustment. Asfaha and Jooste (2007) rejected the money neutrality hypothesis and also explained that in case monetary shock, agricultural sector would have to bear the burden of adjustment because of increase in farmers' financial vulnerability.

The studies which partially support that monetary policy affect prices in short run and there is long run monetary neutrality in food prices:

Schuh (1974) opened a new window of research in the field of agricultural economics by explaining the role of exchange rate in determining the US agricultural prices. Tweeten (1980) argued that an expansionary monetary policy decreases the farm/nonfarm price ratio (cost-price squeeze). Non-agricultural prices respond more quickly than agricultural prices to a monetary shock. Bordo (1980) found that to a monetary shock agricultural prices respond more quickly than industrial prices and manufacturing prices. Chambers (1981) expansionary monetary policy increases the price ratio (cost-price expansion). Agricultural prices respond more quickly to monetary shock than non-agricultural prices. Chambers (1984) found contractionary open market operation depressed the agricultural sector in the short run leading to lower relative prices, incomes, and returns to factors specific to agriculture. Frankel (1986) found that expansionary monetary policy favors agriculture in the short run, because of sticky industrial prices and flexible farm prices, but that the policy is neutral in the long run after complete price adjustments have occurred throughout the economy (fix-price/flex-price). Orden and Fackler (1989) used a three-variable vector autoregression (VAR) model and showed agricultural prices over-shoot long-run equilibrium levels. Taylor and Spriggs (1989) showed in case of Canada agricultural prices respond more quickly to monetary shocks in short run but that manufacturing prices catch up in later periods. Robertson and order (1990) showed that in case of New Zealand monetary shocks shift relative prices in favor of agriculture in the short run and permanently raise nominal prices. Peng et.al (2004) observed monetary variables impact on food prices in China and found food prices in China have a long-run equilibrium relationship with monetary variables. Hye (2009) found that in case of Pakistan, money supply significantly affects the agricultural prices and there is unidirectional causality from money supply to agricultural prices.

The studies which support none of our hypotheses and argue that monetary policy is irrelevant as for as food prices are concerned:

Lapp (1990) found that variations in the growth rate of the nominal money supply have not been an important influence on the average level of prices received by farmers relative to other prices in the economy over the period 1951-85.

3. Methodology

3.1 Introduction

This chapter discussed the theoretical framework and analytical model for empirical investigation of the relationship between money supply and food prices. We will explain the methodology we used in our study. We divided our methodology into two parts (a) the model and (b) econometric methodology. We will explain both of these in detail in the following subsection.

3.2 The Theory*

In order to develop the theoretical linkages of the model with the empirical equation(s), we follow and modify the Saghaian, *et. al* (2002) who clearly and very obviously explain the impact of monetary policy on food prices, in an open economy. Before directly going into details of mathematical equations of the model, we would like to share that Rudi Dornbusch in 1976 become the first economist to formally incorporate the overshooting phenomenon into a mathematical model. He explains the dynamics of overshooting of the exchange rate and reasons why it has a high variance. Then Frankel in 1986 using

*This part heavily rely on Saghaian, *et. al* (2002)

Dornbushch's (1976) work made a theoretical model for the overshooting of food prices, in case of monetary expansion, in a closed economy. Finally Saghaian, *et. al* (2002) extended Frankel's (1986) work for an open economy by incorporating exchange rate into the model. The model starts from this simple equation

$$i = i^* + s \qquad (1)$$

Where i and i^* represent domestic nominal interest rate and foreign nominal interest rate respectively while s is expected rate of exchange depreciation. Equation (1) represents the uncovered interest parity assumption and is implicitly a demonstration of perfect capital mobility. The equation emphasizes that domestic interest rate is kept equal to the exogenous world rate through arbitrage and the expected rate of change in domestic currency price of foreign exchange.

We are using this model for Pakistan, which is a small country as for as world trade is concerned. The small country assumption implies that the domestic nominal interest rate adjusted for expected depreciation equals the given foreign rate.

$$s = \dot{x} \qquad (2)$$

x represents the logarithm of the current exchange rate measured in units of Pakistani Rupee per unit of US Dollar. Equation (2) shows perfect foresight and represents assumption of rational expectations. The rational expectations assumption allows identification of the expected rate of change of the exchange rate with the actual rate of change. Equations (1) and (2) together represent the assumption that home and foreign currency bonds are perfect substitutes for each other. Thus, any difference between their nominal returns is offset exactly by an expected change in the exchange rate.

Money market equilibrium or the LM curve is represented by the following equation.

$$M - P = \aleph Q + \omega i \ , with\ \aleph, \omega > 0 \qquad (3)$$

Where M is the logarithm of the domestic nominal money supply, P is the logarithm of the domestic price level, Q is the logarithm of the domestic real output, taken to be fixed.

$$P = \gamma_1 P_m + \gamma_2 P_f + (1 - \gamma_1 - \gamma_2)(x + P^*), with\ 0 \leq \gamma_1 + \gamma_2 \leq 1 \qquad (4)$$

Where, P_m is the logarithm of the index of prices of manufactured commodities and P_f is the logarithm of the index of prices of food commodities. γ_1 and γ_2 are the share of domestic manufacturing goods and food goods respectively, while $(1 - \gamma_1 - \gamma_2)$ is the share of imports in the domestic consumer price index. Equation (4) is the definition of consumer price index we are using in our model. According to the equation, the consumer price index consists of fix-price manufactures sector "P_m" and flexible-price Food sector "P_f" and imports. Here, we use the assumption that domestic output is an imperfect substitute for imports.

$$A = \alpha_1(x + P^* - P_f) + \alpha_2(P_m - P_f) + \theta(i - \dot{P}) + \varphi y, with\ \alpha_1, \alpha_2, \theta, \varphi > 0 \qquad (5)$$

In equation (5) P^* is the logarithm of the foreign price level, A is the logarithm of the natural level of output in flex-price agriculture sectors, which is fixed, Equation (5) implies that the supply of the flex-price good is assumed to be fixed at A, its natural level, and that the supply of this good equals the demand for it; the demand for the flex-price good depends on the relative prices, real interest rate, and income (Obstfeld).

$$\dot{P}_m = \pi(Q^d - Q_m) + \mu \qquad (6)$$

Q^d is the logarithm of aggregate demand for manufactures, Q_m is the logarithm of potential domestic output in fix-price manufacture sectors, taken to be fixed, μ is the expected secular rate of inflation. Equation (6) indicates that, unlike the commodities, the level of manufacture prices is fixed according to its own past history. It can adjust in response to excess demand only gradually over time, in accordance with an expectations augmented Phillips curve (Frankel).

$$Q^d = \sigma_1(i + P^* - P_m) + \sigma_2(P_m - P_c) + \delta\big(i - \dot{P}\big) + \rho Q, with\ \sigma_1, \sigma_2, \delta, \rho > 0 \qquad (7)$$

Equation (7) is the aggregate demand for manufactures is a function of relative prices, real interest rate, and output.

The small country assumption, which is very realistic and an appropriate assumption in the case of Pakistan, simplifies the solution to the theoretical model and the specification of the empirical model as it permits determination of an arbitrary value for foreign price level P^* and foreign interest rate i^*. To simplify things, we can set $P^* = i^* = 0$. Also, we can assume the fixed levels of Q,Q_m and A to be equal to zero, without any loss of generality, otherwise, these variables will show up in the solutions as constants and their inclusion in the model does not change the overall results that we obtained in the end.

Now, we need to find the values of $\dot{x}$, $\dot{P}_m$ and $\dot{P}_f$. To find $\dot{x}$ from equations (1) and (2) we have

$$i = \dot{x} \qquad (8)$$

Also, from equations (3) and (4) we have

$$M - \left[\gamma_1 P_m + \gamma_2 P_f + (1-\gamma_1-\gamma_2)(x+P^*)\right] = \aleph Q + \omega i \quad (9)$$

Substituting equation (8) into equation (9) and using Q = 0, we obtain

$$M - \gamma_1 P_m - \gamma_2 P_f - (1-\gamma_1-\gamma_2)x = -\omega\dot{x} \quad (10)$$

At this step, stationary money supply is assumed which implies that $M = \bar{M}$, its long-run value. Also, in the long run, $i = \dot{x} = 0$ and interest rates are equalized (i.e. $i = i^*$). Thus, the long-run version of equation (10) can be written as:

$$\bar{M} - \gamma_1 \overline{P_m} - \gamma_2 \overline{P_f} - (1-\gamma_1-\gamma_2)\bar{x} = 0 \quad (11)$$

In the above equation, long-run values are indicated by placing bar (-) over the variables. Subtracting equation (11) from equation (10) and solving for $\dot{x}$, We get:

$$\dot{x} = \frac{1}{\omega}\left\{\gamma_1(P_m - \overline{P_m}) + \gamma_2(P_f - \overline{P_f}) + (1-\gamma_1-\gamma_2)(x-\bar{x})\right\} \quad (12)$$

We can observe from the equation that in the long run there will be zero excess demand in equation (6) (i.e. $Q^d = Q_m$), and $\dot{P}_m = 0$. Hence, in the long-run equilibrium, the relative price of the food and manufactured goods $(P_f - P_m)$ settles down to a given value $(\overline{P_f} - \overline{P_m})$, which is normalized at zero just for the sake of convenience (Frankel). Substituting equation (7) into equation (6), and using equation (12) along with the normalization$(\overline{P_f} - \overline{P_m} = 0)$, we obtain

$$(1-\pi\sigma\gamma_1)\dot{P}_m = \pi\left\{\left[\delta_1 - \frac{\sigma(\gamma_1+\gamma_2)(1-\gamma_1-\gamma_2)}{\omega}\right](x \quad \bar{x})\right.$$

$$-\left[\delta_1 + \delta_2 + \frac{\sigma\gamma_1(\gamma_1+\gamma_2)}{\omega}\right](P_m - \overline{P_m}) + \left[\delta_2 - \frac{\sigma\gamma_2(\gamma_1+\gamma_2)}{\omega}\right](P_f - \overline{P_f})$$

$$\left. + \ \sigma\gamma_2\dot{P}_f\right\} + \mu \qquad (13)$$

We note that equation (13) is in terms of both $\dot{P}_m$ *and* $\dot{P}_f$. Now again, by using equation (12) and normalization $(\overline{P_f} - \overline{P_m} = 0)$ in equation (5), this result into another equation in terms of both $\dot{P}_m$ *and* $\dot{P}_f$.

$$\dot{P}_f = \frac{1}{\theta\gamma_2}\left\{\left[-\alpha_1 + \theta(\gamma_1+\gamma_2)(1-\gamma_1-\gamma_2)\frac{1}{\omega}\right](x-\bar{x}) + \left[\alpha_1 + \alpha_2 + \frac{\theta(\gamma_1+\gamma_2)\gamma_2}{\omega}\right](P_f - \dot{P}_f)\right.$$

$$\left. + \left[-\alpha_2 + \frac{\theta(\gamma_1+\gamma_2)\gamma_1}{\omega}\right](P_m - \overline{P_m}) - \theta\gamma_1\dot{P}_m\right\} \qquad (14)$$

Substituting equation (14) into equation (13) and simplifying, we get:

$$\dot{P}_m = \pi\left\{\left[\sigma_1 - \frac{\delta}{\theta}\alpha_1\right](x-\bar{x}) - \left[\sigma_1 + \sigma_2 + \frac{\delta}{\theta}\alpha_2\right](P_m - \overline{P_m}) + \left[\frac{\delta}{\theta} \quad \sigma_2(\alpha_1+\alpha_2)\right](P_f - \overline{P_f})\right\}$$

$$+\mu \qquad (15)$$

By substituting equation (15) into equation (13), we get

$$\dot{P}_f = \frac{1}{\theta\gamma_2}\left\{\left[-\alpha_1 + \theta(\gamma_1+\gamma_2)\left(\frac{1}{\omega}\right)(1-\gamma_1-\gamma_2) - \theta\gamma_1\pi\,\sigma_1 + \gamma_1\pi\delta\alpha_1\right](x-\bar{x})\right.$$

$$+\left[(\alpha_1+\alpha_2) + \theta(\gamma_1+\gamma_2)\left(\frac{\gamma_2}{\omega}\right) - \theta\gamma_1\pi\,\sigma_2 - \gamma_1\pi\delta(\alpha_1+\alpha_2)\right](P_f - \overline{P_f})$$

$$\left. + \left[-\alpha_2 + \frac{\theta(\gamma_1+\gamma_2)\gamma_1}{\omega} + \theta\gamma_1\pi(\sigma_1 + \sigma_2) + \gamma_1\pi\delta\alpha_2\right](P_m - \overline{P_m}) - \theta\gamma_1\mu\right\} \qquad (16)$$

Hence, the dynamic system about its initial equilibrium is made up of equations (12), (15) and (16) and given in (17):

$$\begin{pmatrix} \dot{x}(t) \\ \dot{P}_m(t) \\ \dot{P}_f(t) \end{pmatrix} = \begin{pmatrix} (1-\gamma_1-\gamma_2)\frac{1}{\omega} & \frac{\gamma_1}{\omega} & \frac{\gamma_2}{\omega} \\ \pi(\sigma_1 - \frac{\delta}{\theta}\alpha_1) & \pi\left[-(\sigma_1 + \sigma_2) - \frac{\delta\alpha_2}{\theta}\right] & \pi\left[\sigma_2 + \frac{\delta}{\theta}(\alpha_1+\alpha_2)\right] \\ \emptyset_1 & \emptyset_2 & \emptyset_3 \end{pmatrix}$$

$$\begin{pmatrix} x - \bar{x} \\ P_m - \overline{P_m} \\ P_f - \overline{P_f} \end{pmatrix} + \begin{pmatrix} 0 \\ \mu \\ -\frac{\gamma_1\mu}{\gamma_2} \end{pmatrix} \qquad (17)$$

Where

$$\emptyset_1 = \frac{1}{\theta\gamma_2}\left[-\alpha_1 + \theta(\gamma_1+\gamma_2)\left(\frac{1}{\omega}\right)(1-\gamma_1-\gamma_2) - \theta\gamma_1\pi\,\sigma_1 + \gamma_1\pi\delta\alpha_1\right]$$

$$\emptyset_2 = \frac{1}{\theta\gamma_2}\left[-\alpha_2 + \frac{\theta(\gamma_1+\gamma_2)\gamma_1}{\omega} + \theta\gamma_1\pi(\sigma_1 + \sigma_2) + \gamma_1\pi\delta\alpha_2\right]$$

$$\emptyset_3 = \frac{1}{\theta\gamma_2}\left[(\alpha_1+\alpha_2) + \theta(\gamma_1+\gamma_2)\left(\frac{\gamma_2}{\omega}\right) - \theta\gamma_2\pi\,\sigma_2 - \gamma_1\pi\delta(\alpha_1+\alpha_2)\right]$$

The characteristic roots for (17) are the solutions, β_1, β_2 and $\beta_3$to the characteristic polynomial $det\ (\beta - \omega I) = 0$, where β is the matrix in the system equation $dX/dt = \beta X$ of (17). One of these roots is negative and two are positive, hence, the system yields a "saddle-point" stability solution (Saghaian), to focus on the stability of the system we ignored the positive roots.

Suppose $-\beta, (\beta > 0)$, is the negative characteristic root. As in Frankel, the solutions for the expected future paths of two prices and the exchange rate in level form, as t goes from zero to ∞ are

$$\begin{pmatrix} x(t) - \bar{x}(t) = exp(-\beta t)\,[x(0) - \bar{x}(0)] \\ P_m(t) - \overline{P_m}(t) = exp(-\beta t)\,[P_m(0) - \overline{P_m}(0)] \\ P_f(t) - \overline{P_f}(t) = exp(-\beta t)\,[P_f(0) - \overline{P_f}(0)] \end{pmatrix} \quad (18)$$

In rate-of-change form, these equations are

$$\begin{pmatrix} \dot{x} = -\beta(x - \overline{x}) \\ \dot{P}_m = -\beta(P_m - \overline{P_m}\quad) + \mu \\ \dot{P}_f = -\beta\left(P_f - \overline{P_f}\right) - \frac{\gamma_1}{\gamma_2}\mu \end{pmatrix} \quad (19)$$

3.1.2 The Theoretical Results

The interest rate is reduces by monetary expansion and this phenomenon leads to the expectation of a currency depreciation in the long run. Attractiveness of domestic assets is reduced by these factors and this phenomenon leads to a capital outflow, and cause the spot exchange rate to depreciate. The immediate effect of a monetary expansion is to induce depreciation in the spot rate in short run and it exceeds the long-run depreciation. Since, only under these circumstances there will be the public anticipation to an exchange rate appreciation and thus be rewarded for the reduced return on domestic assets. In the model, food prices will increase more than proportionately to the change in the money supply and hence they overshoot their long-run equilibrium value. For food commodities to be held willingly, they must be adequately overvalued such that there is an expectation of future price decreases fair enough to offset the lower interest rate. If we Combine equations (12) and (19), we get

$$x = \frac{1}{\omega}\{\gamma_1(P_m - \overline{P_m}) + \gamma_2(P_f - \overline{P_f}) + (1 - \gamma_1 - \gamma_2)(x - \bar{x})\} = -\beta(x - \bar{x})$$

$$x = \bar{x} - \frac{\{\gamma_1(P_m - \overline{P_m}) + \gamma_2(P_f - \overline{P_f})\}}{\omega\beta + (1 - \gamma_1 - \gamma_2)} \qquad (20)$$

Equation (20) shows a relationship between the exchange rate and the food and manufacturing goods price levels. It states that deviation of the spot exchange rate from its long run equilibrium value is proportional to the amount, food and manufacturing goods prices deviate from their long run equilibrium values. Differentiating equation (20) with respect to money supply, M, and noting that $d\bar{x} = dM = d\overline{P_f} = d\overline{P_m}$, (i.e., money neutrality in the long run) and $dP_m/dM = 0$, (i.e., stickiness of manufactured prices in the short run), we get a proper expression for the impact of a monetary expansion

$$\frac{dx}{dM} = 1 + \frac{\gamma_1}{\omega\beta + (1 - \gamma_1 - \gamma_2)} - \frac{\gamma_2}{\omega\beta + (1 - \gamma_1 - \gamma_2)}\left[\frac{dP_f}{dM} - 1\right] \qquad (21)$$

To fully focus on overshooting of the exchange rate, for the moment, we can ignore the possibility of overshooting of the commodity prices and assume money neutrality for commodities. That is, $dP_f/dM = 1$, then $dx/dM = 1 + (\gamma_1/[\omega\beta + (1 - \gamma_1 - \gamma_2)]$, here the coefficient of exchange rate is greater than one (unity) , which shows that the exchange rate overshoots its long-run equilibrium value in reaction to a monetary change. Also note that in this case, if $\gamma_1 = 0$, (i.e., in the absence of fix price manufacturing sector, or the manufactured goods prices adjust instantaneously), then exchange rate will not overshoot. The extent of the overshooting depends positively on the relative weight of sticky prices in the price index, while it is a decreasing function of the relative weight of flexible prices. It also depends on the speed of adjustment β or the expectation coefficient and the interest response of money demand. A high interest response of money demand, ω, dampens the overshooting because it implies that a given monetary expansion will only induce a small changes in the interest rate. A small change in the interest rate in turn requires only a small expectation of currency appreciation to offset it and hence result in only a small depreciation of the spot exchange rate (in excess of the long-run rate) to generate that expectation given the expectation coefficient and the long-run rate. The coefficient of expectation β has exactly same interpretation.

Now, suppose that $[(dP_f/dM) - 1] > 0$, which implies that the flexible price sector is also overshooting. Then equation (21) implies that, in case of a money supply shock, the exchange rate may still overshoot its long run equilibrium value, but definitely not as much as before in the above case. In the case that food prices undershoot (i.e., $[(dP_f/dM) - 1] < 0$), from equation (21), the exchange rate will overshoot the most and take all the burden of the shock. Now, to concentrate on the overshooting of food prices (flexible-price sector), equation (20) can be solved for P_f, to get

$$P_f = \overline{P_f} - \frac{\gamma_1}{\gamma_2}(P_m - \overline{P_m}) - \frac{\omega\beta + (1 - \gamma_1 - \gamma_2)}{\gamma_2}(x - \bar{x}) \qquad (22)$$

Differentiating equation (22) with respect to a change in money supply, m, and considering stickiness of manufactured prices in short run and the monetary neutrality in the long run, that is, $d\bar{x} = dM = d\overline{P_f} = d\overline{P_m} = 0$ and $dP_m/dM = 0$, we obtain

$$\frac{dP_f}{dM} = 1 + \frac{\gamma_1}{\gamma_2} - \frac{\omega\beta + (1-\gamma_1-\gamma_2)}{\gamma_2}\left[\frac{dx}{dM} - 1\right] \qquad (23)$$

Now, to concentrate on overshooting of food prices , for the time being ,we ignore the overshooting of exchange rate; i.e., if $[(dx/dM) - 1] = 0$, then $\left(dP_f/dM\right) = 1 + (\gamma_1/\gamma_2)$, which shows that coefficient of food prices is greater than one and hence food prices overshoots. The extent of overshooting of the prices of food is a decreasing function of γ_2, the relative weight of the flex-price sector and it also depends positively on γ_1, the relative weight of the manufacturing sector. A higher (γ_1/γ_2) implies a higher degree of overshooting of food prices. However, the commodity prices do not overshoot, if manufactured prices adjust instantaneously.

In the case$[(dx/dM) - 1] > 0$ (the overshooting of exchange rate), from equation (23) with positive monetary shocks, food prices might still overshoot their long run value but definitely not as much as before. Also, as in the case of the exchange rate, the extent of overshooting depends positively on the relative weight of sticky prices, and a large β or a high interest response of money demand, dampens the overshooting of food prices. In this case, there is also the possibility that food prices undershoot their long run equilibrium level. Overshooting also affected by the expectation coefficient, β and the interest response of money demand, ω. A relatively large manufacture sector (i.e., a sector with sticky prices) along with low-interest response of money demand and expectation coefficient will lead to over shooting of food prices. In the case of exchange rate undershooting, food prices have to overshoot the most.

3.3 The Model

Based on the theory discusses in section 3.2, the long run Model and the dynamic model we will estimate can be represented by the following equation;

3.3.1 The long run model

$$P_{ft} = \beta_1 M_{2t} + \beta_2 x_t + \beta_3 P_{mt} + \beta_4 \text{trend} + \varepsilon_t$$

Where

P_f = Log of Food Prices

M_2 = Log of Money Supply

β_1 = Coefficient of Money Supply

x = Log of nominal exchange rate between US Dollar and Pakistani Rupee

β_2 = Coefficient of exchange rate

P_m = Log of manufacturing goods prices

β_3 = Coefficient of manufacturing goods prices

Trend = Trend component

β_4= Coefficient of Trend component

ε = Error Term

It might be interesting to note that we focus on only two monetary variables i.e exchange rate and money supply in case of Pakistan like before us Saghaian et.al (2002) in case of USA and Asfaha & Jooste (2007) in case of South Africa used to explain overshooting of food prices.

3.3.2 The Dynamic Model

To check dynamic relationship between money supply and food prices we develop the error correction mechanism.

$$\Delta P_{ft} = \sum_{i=1}^{12} \alpha_i \, \Delta P_{ct-i} + \sum_{i=1}^{12} \beta_i \Delta M_{t-i} + \sum_{i=1}^{12} \gamma_i \, \Delta x_{t-i} + \delta_i ECM_{t-i} + \sum_{i=1}^{11} \gamma_i S_i + \varepsilon_t$$

We start our procedure by estimating following general equation, which includes 12 lags of 1st difference of food prices, manufacturing goods price, exchange rate and eleven monthly seasonal dummies and Error Correction Mechanism (ECM).

3.4 Econometric Methodology

The impact of monetary policy on food prices is estimated by using three steps methodology (Ahmad and Qayyum, 2008 and Qayyum, 2002, 2005). These steps include A) test of stationarity, B) test of cointegration and estimating long run relationship, C) Dynamic relationship. A brief description of the econometric methodology we use in our study is given on next page.

3.4.1 Testing of Unit Roots

We employ Dickey and Fuller (1979) for unit root test. Unit root tests are of special importance as for as time series analysis is concerned. The classical OLS is based on the assumption that both endogenous and exogenous variables are stationary. However a time series data often shows nonstationarity. Hence, there is a need to check and verify whether or not the time series data for the variables for which we are using OLS is stationary, and if they are not, then further transformation techniques need to be applied to make the variable stationary. Stationary time series has three basic properties. It has a finite mean, finite variance and has a finite (auto) covariance (Enders, 2004). The unit roots tests help detect the stationarity and non-stationarity of time series data used for the study. An augmented Dickey-Fuller (1979) test (ADF) is a test for unit root in a time series. It is an augmented version of the Dickey-Fuller test and it includes extra lagged terms of dependent variable in order to eliminate autocorrelation (Asteriou and Hall, 2007).

The test procedure for the ADF test is applied to the model is:

$$\Delta Y_t = \alpha_0 + \beta t + \alpha_1 Y_{t-1} + \sum_{i=1}^{11} \gamma_i S_i + \delta_1 \Delta Y_{t-1} + \delta_2 \Delta Y_{t-2} + \cdots + \delta_p \Delta Y_{t-p} + \varepsilon_t$$

Where α_0 is constant, β is the coefficient of the time trend and P is the lag order of the autoregressive process. Here three different options are possible, first is imposing the constraints $\alpha_0 = 0$ and $\beta = 0$ corresponds to modeling a random walk, second is using the constraint $\beta = 0$ corresponds to modeling a random walk with drift and third possibility is of using no constraint at all and this model correspond to random walk with drift and time trend.

The ADF test for stationarity is test on the coefficient of the lagged dependent variable ΔY_{t-1} from one of the three models discussed above. This test does not however have a conventional *t*-distribution and so we must use special critical values which were originally calculated by Dickey and Fuller (1991). Mackinnon (1991) tabulated appropriate critical values for each of the three above possible model.

In all cases the test concerns that weather α_1=0. The ADF test statistics is the t-statistics for the lagged dependent variable ΔY_{t-1}. If the ADF statistical values are smaller in absolute terms than the critical value then we reject the null hypothesis of a unit root and conclude that Y_t is a stationary process (Asteriou and Hall, 2007).

If the variable is stationary at level, the variable is said to be integrated of order zero, I(0). If the variable is non stationary at level, the first difference of the variable can be used for testing a unit root. In this case, the variable is said to be integrated of order one. Similarly, one can test for the higher order of integration of the variables.

3.4.2 Cointegration Analysis

We use Johansen, S. (1991) for cointegration analysis. Cointegration implies that there always exists a linear combination of these variables that is stationary and there is a corresponding error correction representation. Generally, Johansen the cointegration analysis is based on the model as follows, Step No.1 $Z_t = M_1 Z_{t-1} + M_2 Z_{t-2} + \cdots + M_q Z_{t-q} + U_t$

$Z_t, Z_{t-1}, \ldots, Z_{t-q}$ are vectors and $M_1, M_2, \ldots, M_q$ are matrices

Z_t is an n-vector of I(1) variables

Step No.2 $\Delta Z_t = N_1 Z_{t-1} + \sum_{j=2}^{q} N_j \Delta Z_{t-j+1} + U_t$

$N_1 = -(I - \sum_{i=1}^{q} M_i)$

$N_j = -(\sum_{i=1}^{q} M_i)$ For j=2, 3, …, q

Step No.3 Since $\Delta Z_t, \ldots, \Delta Z_{t-q+1}$ are I(0) but Z_{t-1} is I(1)

In consistent to this equation N_j should not have full rank. Suppose its rank be $\gamma < n$.

If $N_1 = \alpha\beta'$, α and β' are both matrices. α is n x m and β' is m x n matrix.

Now;

$\beta' Z_{t-1}$ are γ cointegrated variables

β' is a matrix which contained coefficient of cointegrating vectors.

α is matrix of speed of adjustment parameters or error correction terms or it may called as how much time is required to come back at steady state.

Step No.4 Regression ΔZ_t on $\sum_{j=2}^{q} N_j \Delta Z_{t-j+1}$ estimate residuals and name it as E_D.

Again regress Z_{t-1} on $\sum_{j=2}^{q} N_j \Delta Z_{t-j+1}$ estimate residuals and name it as E_L.

By doing so, our regression can be written like this $E_D = -\alpha\beta' E_L + U_t$

Step No.5 Define a Matrix $\begin{bmatrix} S_{00} & S_{01} \\ S_{10} & S_{11} \end{bmatrix}$

Where

S_{11} = Sum of square of E_D

S_{00} = Sum of square of E_L

S_{01} = Sum of Product of E_D and E_L

All these matrices are of order n x n

One thing which very important to note here is that we cannot estimate vector autoregressive (VAR) model with ordinary least square (OLS) due to presence of cross equation restriction, So we have to use maximum likelihood method.

Step No.6 we can obtain maximum likelihood function by solving for the problem of eingen values

$$\left| S_{10} S_{00}^{-1} S_{01} - \lambda S_{11} \right| = 0$$

3.4.3 Error Correction model (ECM)

If Johanson technique shows that our variables have long run relationship then we estimate the Vector Error Correction (VEC) model. VECM is more appropriate than a Vector Auto Regressive (VAR) model to characterize the multivariate relationships among the four macroeconomic series, because the VEC model will not only allow estimates the dynamic relationship, but it also preserves the long-run relationships among the variables. A VEC is a VAR in first-difference form that unambiguously builds in cointegration to capture the information contained in each series' long-run stochastic trend. In Vector Error Correction Model (VECM), lag length have to be selected. For this purpose, we will start with over specified model by using an order high enough to be reasonably confident that the optimal order would not exceed it. Then we will use general to specific methodology to chose right lag length. We estimate the ECM by ordinary least square (OLS) method, more specifically we estamte following equation by OLS.

$$\Delta P_{ft} = \sum_{i=1}^{12} \alpha_i \, \Delta P_{ct-i} + \sum_{i=1}^{12} \beta_i \Delta M_{t-i} + \sum_{i=1}^{12} \gamma_i \, \Delta x_{t-i} + \delta_i ECM_{t-i} + \sum_{i=1}^{11} \gamma_i S_i + \varepsilon_t$$

3.3.4 Diagnostic test for VECM

Diagnostic tests to be used are as follows:

(a) LM Test

The Breusch–Godfrey (1988) serial correlation LM test is a test for autocorrelation in the errors in a regression model. The null hypothesis is that there is no serial correlation of any order up to *p*. To check the problem of autocorrelation in our model we apply LM test at 1st and 12th lag.

(b) LM ARCH Test:

We use Engle (1982) Lagrange multiplier (LM) test to check autoregressive conditional heteroskedasticity (ARCH) in the residuals in our model. We apply LM ARCH test at 1st and 12th lag.

(c) Normality Test

This test displays a histogram and descriptive statistics of the residuals, including the Jarque-Bera (1990) statistic for testing normality.

3.3.5 Stability of the Model

To check the stability of the model we will apply cusum test and cusum square test.

(a) The CUSUM Test

The CUSUM test (Brown, Durbin, and Evans, 1975) is based on the cumulative sum of the recursive residuals. The test discover parameter instability if the cumulative sum goes outside the area between the two critical lines.

(b) CUSUM Square Test

The CUSUM (Brown, Durbin, and Evans, 1975) of squares test provides information about parameter or variance instability.

3.5 Data

We use monthly time series data from July 1991 to December 2010 in this study. We use four variables for the analysis. We define these variables in the following paragraphs and provide a brief description about sources of data.

3.5.1 Money Supply:

The M_2 monetary aggregate includes the narrowly defined official money measure M_1 such as currency, travelers' checks, demand deposits, other checkable deposits and other time deposits. Data on a money supply is taken from statistical bulletin, published by State Bank of Pakistan (SBP) and shown graphically on table 4.1.

3.5.2 Exchange Rate

The exchange rate is measured as number of Pakistani rupee per unit of US dollar. Data on exchange rate is taken from online data base of International Financial Statistics (IFS) and shown graphically on table 4.2.

3.5.3 Food Prices

Food price is a component of Wholesale Price Index (WPI) which is our main measure of price changes at wholesale level. Data on food prices is taken from the Pakistan Bureau of Statistics (PBS) and shown graphically on table 4.3. We convert the data to same base year and 2000/01 is taken as base year. Food price index consists of "Wheat, Wheat flour, Maida, Suji, Rice, Barley, Maize, Jowar, Bajra, Gram (whole), Gram (split), Masoor, Mash, Moong, Potatoes, Onions, Tomatoes, Vegetables, Fresh Fruits, Dry Fruits, Fresh Milk, Milk Food, Vegetable Ghee, Mustard & Rapeseed Oil, Cottonseed Oil, Cakes Oil, , Gur, Sugar Refined, Chicken, Eggs Fish, Meat, Spices, Condiments, Salt, Tea and Beverages" (PBS, 2009/10).

3.5.4 Manufactured Prices

Manufactured goods price is a component of Wholesale Price Index (WPI) which is our main measure of price changes at wholesale level. Data on Manufacturing goods prices is taken from the Pakistan Bureau of Statistics (PBS) and shown graphically on table 4.4. We convert the data to same base year and 2000/01 is taken as base year. Manufactured price index consists of "Leather, Cotton yarn, Blended Yarn, Nylon Yarn, Cotton Textiles, Hosiery, Silk & Rayon Textiles, Woolen Textiles, Jute manufactures, Readymade garments, Utensils, Chemicals, Dyeing materials, Soap, Cosmetics, Drugs &medicines, Fertilizers, Machinery, Transport, Tyres, Tubes, Audio-Visual Instruments, Other electric goods, Cigarettes, Glass products, Paper, Matches Plastic Products and Footwear" (PBS, 2009/10)

3.6 Concluding Remarks

In this chapter we have discussed the theoretical model and its back ground in detail. We also comprehensively discussed the econometric methodology we are going to use in our study. Finally, we provided a brief description about the variable used in this study and their frequency, time span and sources of data.

4. Impact of Monetary Policy on Food Prices in Pakistan

4.1 Introduction

In the previous chapter we explain theoretical and econometric methodology in detail and provide brief description of data. In this chapter we, in first step, check the statistical properties of the variables understudy, correlation between variables and trend and pattern of the data. Then, in second step, we check the stationarity of the data and report results of cointegration analysis and dynamic model, interpret our results and give reasoning if there is some dramatic deviation.

4.2 Statistical Properties and Trend in Data

Before applying formal test of stationarity, we check the statistical properties of our data. In Table 4.1 we reported descriptive statistics of food prices, manufacturing goods prices, money supply and exchange rate.

Table 4.1 Descriptive States

	M_2	P_f	P_m	x
Mean	2153416	115.7355	101.3345	51.72259
Std Dev	1579283	56.54957	29.81103	17.29973
Min	403858	43.61306	51.28424	24.561
Max	6295663	290.52	200.05	85.8537

In Table 4.2 we reported the correlation between the variables we used in this study.

Table 4.2 Correlation between Variables

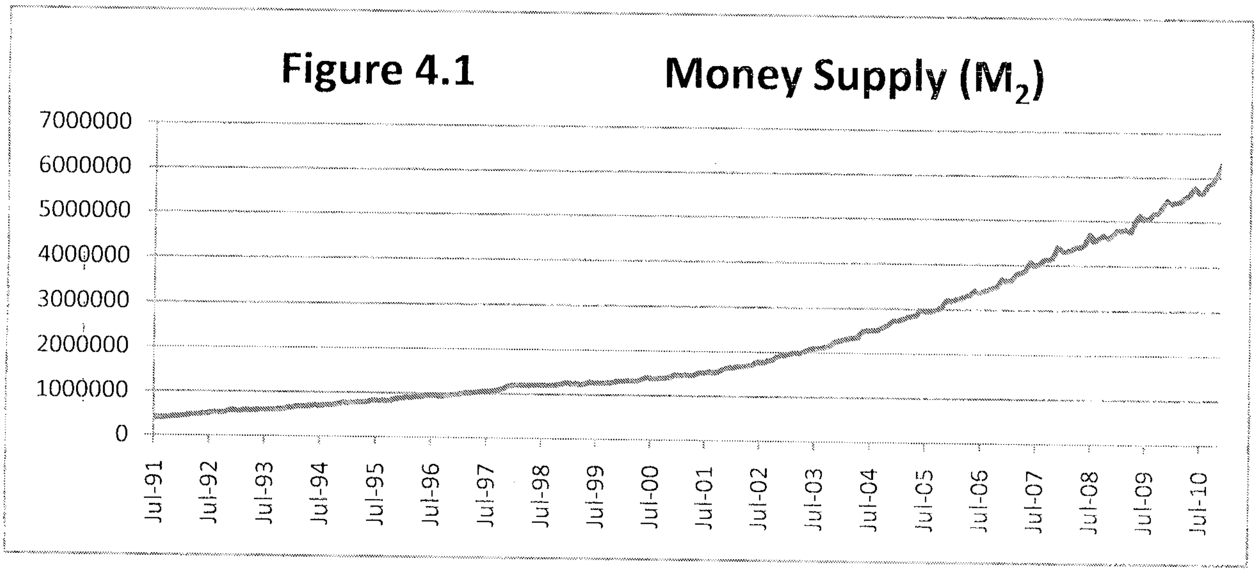
	P_f	M_2	x	P_m
P_f	1.000000	-	-	-
P_m	0.978273	1.000000	-	-
x	0.944919	0.941203	1.000000	-
P_m	0.979565	0.961089	0.964317	1.000000

Table shows that there exists high degree correlation between all variable. Highest correlation exists between food prices and manufacturing goods prices which is almost 98 percent. Lowest correlation exists between exchange rate and money supply which is almost 94 percent, still very high. It indicates that all variables have a tendency to move in a similarly direction over the period of time.

Now, we present the trend and variation in the time series data of each variable and then comment on pattern of each variable.

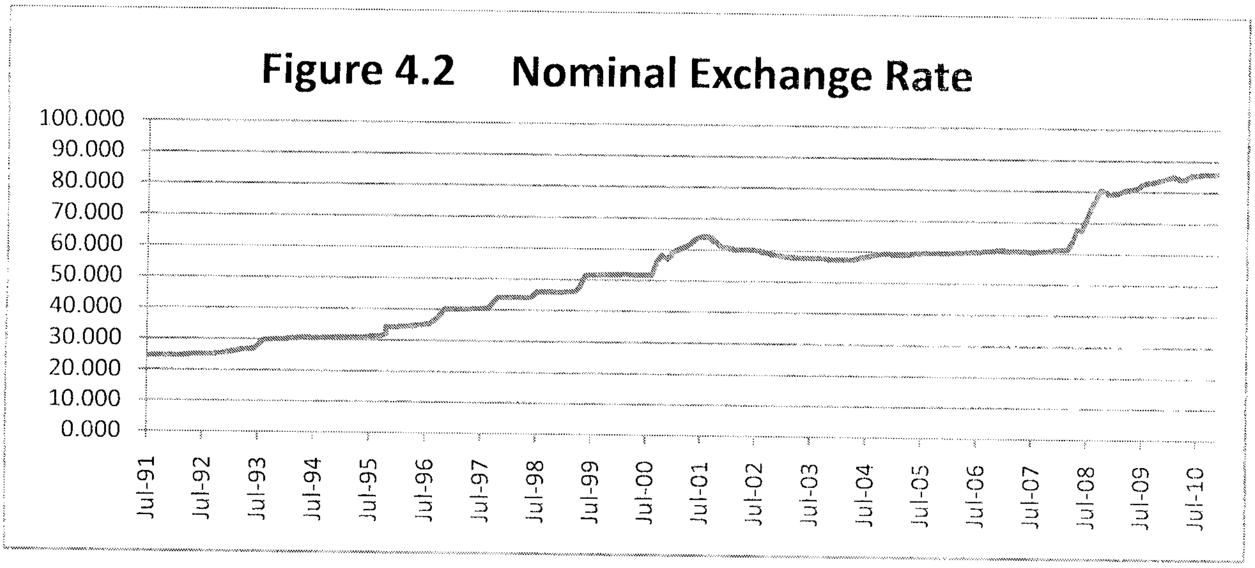
4.2.1 Money Supply

We start with the money supply, monthly time series data on money supply presented in the figure 4.1. Data for money supply as shown in the figure grew over time. There is no dramatic variation in the data which needs special explanation but we can guess by observing the graph that the amount of money supply (M_2) grew over time and the data has a linear upward trend. If we divide our graph into two parts (a) from July 1991 to July 2000 and (b) from July 2000 to December 2010 we realize that variations in the money supply data are much more over the last decade because rate of growth of money supply in last decade is much higher than the previous one.



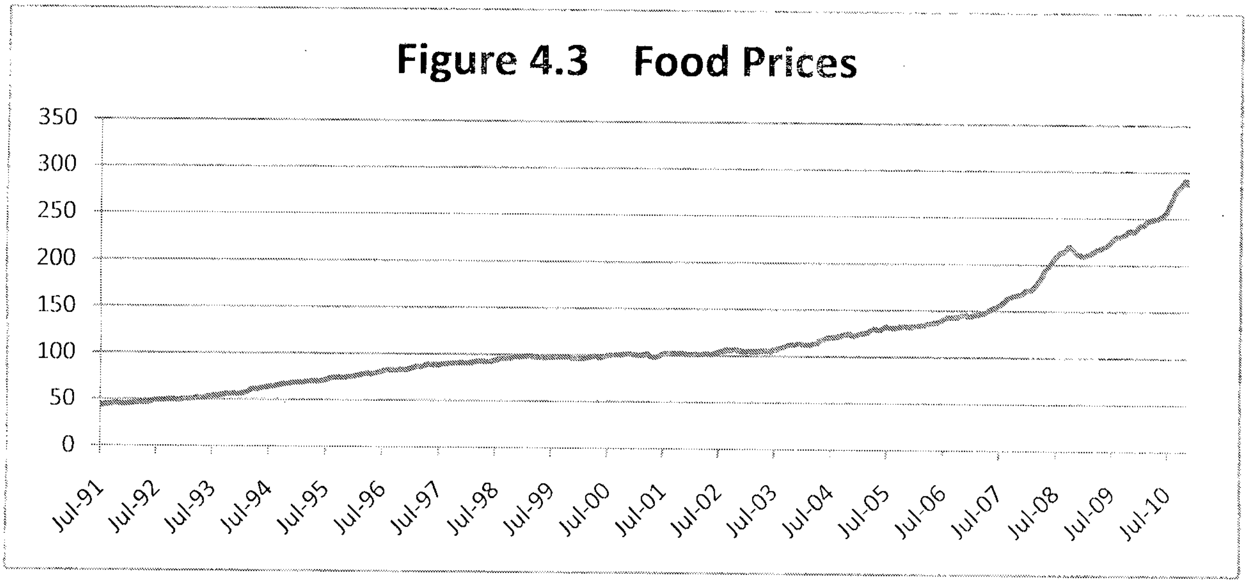
4.2.2 Exchange Rate

In the figure 4.2, we present the monthly time series data on exchange rate. The nominal exchange rate data as depicted in the figure shows that the Pakistani rupee depreciated against the US dollar from July 1991 to August 2001, during this period large current-account surplus of Pakistan pushed the value of the rupee up versus the dollar(Wikipedia; economy of Pakistan). During the mid-2000s, Pakistan has experienced a period of fabulous growth, averaging 7% annual GDP growth between 2003 and 2007 and it is interesting to see that between 2001 and 2007, the exchange rate remained almost the same. It again start depreciating with the beginning of global financial crises along with rise oil prices, political instability, the lawyer's movement, out flow of foreign exchange reserves, and decline in the Foreign Direct Investment (FDI) the rupee totally collapsed and fell from 60-1 USD to over 80-1 USD in a few months in 2008.



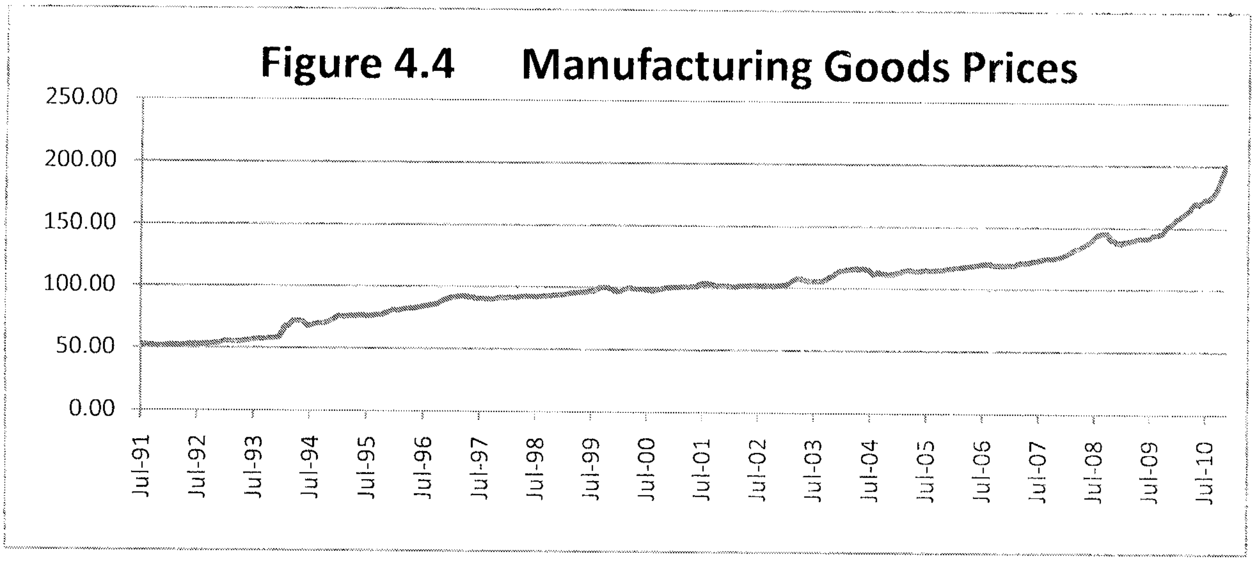
4.2.3 Food Prices

In the figure 4.3, we present the monthly time series data on food. If we look at the figure of food prices in case of Pakistan we come to know that food prices grew over time and showed a liner trend but there is some vivid variation in food prices as well during April 2008 to September 2008. One possible reason for this huge variation is the triple convergence of floods, Ramadan, and global wheat crisis which caused this price hike and left a much larger proportion of Pakistanis unable to secure basic food items at affordable prices.



4.2.4 Manufacturing Goods Prices

Monthly time series data on manufacturing goods prices is presented in the figure 4.4. The reasons of variation in manufactured goods' prices are almost same as for those of food prices. Generally, manufacturing prices increased with the increase in their raw material.



4.3 Testing Stationarity of the Data

We have monthly data for four series; food prices, manufacturing goods prices, money supply and exchange rate. We apply augmented Dickey-Fuller (ADF) test on these series. First of all we apply ADF test on level of each series, if a series turned out to be non stationary we applied ADF test on 1^{st} difference of that particular series.

We start ADF test with estimating following simple equation by ordinary least square (OLS) method;

$$\Delta Y_t = \alpha_0 + \beta t + \alpha_1 Y_{t-1} + \sum_{i=1}^{11} \gamma_i S_i + \delta_1 \Delta Y_{t-1} + \delta_2 \Delta Y_{t-2} + \cdots + \delta_p \Delta Y_{t-p} + \varepsilon_t$$

This equation includes 1^{st} difference of a particular series as dependent variable and constant, trend, 1^{st} lag, seasonal monthly dummies and error term as independent variables. For ADF to be properly applicable, the error term must be the white noise or i.i.d. To confirm whether or not the error term is white noise, we apply the Breusch–Godfrey serial correlation LM test for serial correlation. We found that in case of all variables LM test indicates that the error term is not white noise. So, to make error term white noise, we include suitable lags of dependent variable. In case of food prices, manufacturing goods prices and exchange rate error term become white noise after including 12 lags but in case money supply error term become stationary after including 24 lags. We adopted general to specific approach and drop all those lags whose t-values are insignificant. Then we apply the Wald test at the constant component, trend component and monthly seasonally dummies one by one and drop them only if results of the Wald test indicate to do so. Results of ADF test at level and frist difference are reported in the table 4.3.

Table 4.3 Results of ADF test at level and first difference

Variable	Constant	Trend	Seasonal Dummies	τ-test Stat	Critical Value	Lag Length	Result
Food Prices "P_f"	Yes	Yes	Yes	-0.073719	-3.43	12	Non-Stationary
Manufacture Prices "P_m"	Yes	Yes	No	-1.850728	-3.43	12	Non-Stationary
Money Supply "M_2"	Yes	Yes	Yes	-1.219555	-3.43	24	Non-Stationary
Exchange Rate "x"	Yes	No	No	-1.211008	-2.88	3	Non-Stationary
ΔP_f	Yes	No	Yes	-7.465022	-2.88	12	Stationary
ΔP_m	Yes	No	No	-7.373749	-2.88	11	Stationary
ΔM_2	Yes	No	Yes	-11.16897	-2.88	24	Stationary
Δx	Yes	No	No	-6.457420	-2.88	3	Stationary

Critical values are taken from Mackinon (1991)

Results of ADF test are exactly in accordance with our expectations. The ADF tests show that the null hypothesis of a unit root is accepted for all variables in levels. All the series are non-stationary at level and become stationary after taking first difference and hence all series are integrated of order one i.e I(1).

If all the series found to be integrated of order one i.e I(1), as in our case, then we can apply cointegration analysis. The most common test for estimating long run relationship between variables is Johansen maximum likelihood method (Johansen, 1991). We will use it in our study.

4.4 Cointegration Analysis

We use Johanson cointegration technique for estimation of long run relationship between our variable. Johanson cointegration is applicable only when each series are of same order. The results of ADF test confirm that Johanson technique is applicable in our case. To test for cointegration, the johansen Likelohood Ratio test based on trace and maximum eigenvalue statistics is applied. We start our analysis with an over-specified model and by adopting general to specific methodology we choose 6 lags as six lags enable us to obtain results of long run relationship which are free from serial correlation of residuals.

We do not include the constant term in our regression analysis as Qayyum (2005) suggested "if the variables included in the system show growth then constant term should not be placed into cointegrating space". In our case money supply, food prices and manufacture prices all have definite growth over time. The exchange rate was relatively stable during March 2001 to March 2008, other than this the exchange rate also exhibited the same growth rate as other variables. We included linear trend component due to the fact that all variables have a linear trend and grow over time. Results of both λ_{trace} and λ_{max} are reported in the table 4.4 and table 4.5. respectively;

Table 4.4 Trace Test for Cointegration

Null Hypothesis	Alternative Hypothesis	Eigenvalue	Trace Statistic	0.05 Critical Value
r = 0	R $\geq$ 1	0.136517	66.92791	63.87610
r = 1	R $\geq$ 2	0.085140	33.60870	42.91525
r = 2	R $\geq$ 3	0.040518	13.40939	25.87211
r = 3	R $\geq$ 4	0.017555	4.020277	12.51798

Trace test indicates 1 cointegrating equation at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 4.5 Maximum Eigenvalue Test for Cointegration

Null Hypothesis	Alternative Hypothesis	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value
r = 0	R = 1	0.136517	33.31921	32.11832
r = 1	R = 2	0.085140	20.19931	25.82321
r = 2	R = 3	0.040518	9.389110	19.38704
r = 3	R = 4	0.017555	4.020277	12.51798

Trace test indicates 1 cointegrating equation at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Results of both λ_{trace} and λ_{max} shows that there exist one long run cointegrating vector between food prices, money supply, manufacturing goods prices and exchange rate in case of Pakistan. This long run relationship is reported in following equation.

$$P_f = 1.0605\, P_m + 3.811507x + 5.109987\mathrm{M}_2 - 0.064069\mathrm{trend}$$

Standard Error:	0.75146	0.79931	1.12849	0.01368
T-Statistics:	1.41126	-4.76848	-4.52814	4.68231

We can note from the results of cointegration that in the case of Pakistan manufacturing prices and food prices do not have significant long run relationship, so we dropped manufacture prices "P_m" from our equation.

We estimate new equation which include only money supply, exchange rate and food prices and does not include manufacturing goods prices. Results of λ_{trace} and λ_{max} for this new equation are reported in table 4.6 and table 4.7 respectively.

Table 4.6 Trace Test for Cointegration

Null Hypothesis	Alternative Hypothesis	Eigenvalue	Trace Statistic	0.05 Critical Value
r = 0	R $\geq$ 1	0.130393	49.59487	42.91525
r = 1	R $\geq$ 2	0.060344	17.87986	25.87211
r = 2	R $\geq$ 3	0.016389	3.751125	12.51798

Trace test indicates 1 cointegrating equation at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 4.7 Maximum Eigenvalue Test for Cointegration

Null Hypothesis	Alternative Hypothesis	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value
r = 0	R = 1	0.130393	31.71501	25.82321
r = 1	R = 2	0.060344	14.12874	19.38704
r = 2	R = 3	0.016389	3.751125	12.51798

Max-eigenvalue test indicates 1 cointegrating equation at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Results of both λ_{trace} and λ_{max} shows that there exist one long run cointegrating vector between food prices, money supply, manufacturing goods prices and exchange rate in case of Pakistan. This long run relationship is reported in following equation.

$$P_f = 3.172250\text{M}_2 + 2.489837x \quad - \quad 0.040793\text{trend}$$

Standard Error:	0.60691	0.36124	0.00786
T-Statistics:	-5.22690	-6.89252	5.19111

Results show that in the long run food prices and money supply has statistically highly significant relationship. One percent increase in money supply almost brings 3.17 percent increase in food prices in case of Pakistan. Exchange rate also affects food prices in the long run but not as much as money supply. Relationship between exchange rate and food prices is highly significant as well. Food prices also affected by trend component in the long run and this relationship are also statistically highly significant.

Our study found significant long run relationship between food prices and money supply, this relationship has important policy implication that loose monetary policy could be used to boost up the agricultural prices which leads to an increase in farmer's income or to use tight monetary policy in order to control agricultural prices for easing urban consumers. Due to the linkages between money supply and food prices in the long run, we recommended that agricultural policy makers and monetary authorities should work closely in designing and implementing monetary policy in the country, otherwise, monetary policies meant to stabilize the economy might have less desirable impacts on farmers and consumers.

4.5 Dynamic Relationship:

To check dynamic relationship between money supply and food prices we develop the error correction mechanism. We start our procedure by estimating following general equation, which includes 12 lags of of 1st difference of food prices, manufacturing goods price, exchange rate and eleven monthly seasonal dummies and Error Correction Mechanism (ECM).

$$\Delta P_{ft} = \sum_{i=1}^{k} \alpha_i \, \Delta P_{ct-i} + \sum_{i=1}^{k} \beta_i \Delta M_{t-i} + \sum_{i=1}^{k} \gamma_i \, \Delta x_{t-i} + \delta_i ECM_{t-i} + \sum_{i=1}^{11} \gamma_i S_i + \varepsilon_t$$

4.6 Diagnostic test for Dynamic Relationship

We conducted different diagnostic test for to check the the problem of serial correlation, conditional heteroskedasticity and normality of results. We reported all these results below.

4.6.1 LM Test

The Breusch–Godfrey serial correlation LM test is a test for autocorrelation in the errors in a regression model. It makes use of the residuals from the model being considered in a regression analysis, and a test statistic is derived from these. The null hypothesis is that there is no serial correlation of any order up to *p*.

To check the problem of autocorrelation in our model we apply LM test at 1st and 12th lag. Probability values are reported in parenthesis and test is conducted at 5% level of significant.

χ^2_1= 0.031106 (0.860173), χ^2_{12}=0.457116 (0.937280)

Both results show that the problem of autocorrelation neither exists at 1st lag nor at 12th lag.

4.6.2 LM ARCH Test:

We use Lagrange multiplier (LM) test for autoregressive conditional heteroskedasticity (ARCH) in the residuals in our model. We apply LM ARCH test at 1st and 12th lag.

Probability values are reported in parenthesis and test is conducted at 5% level of significant.

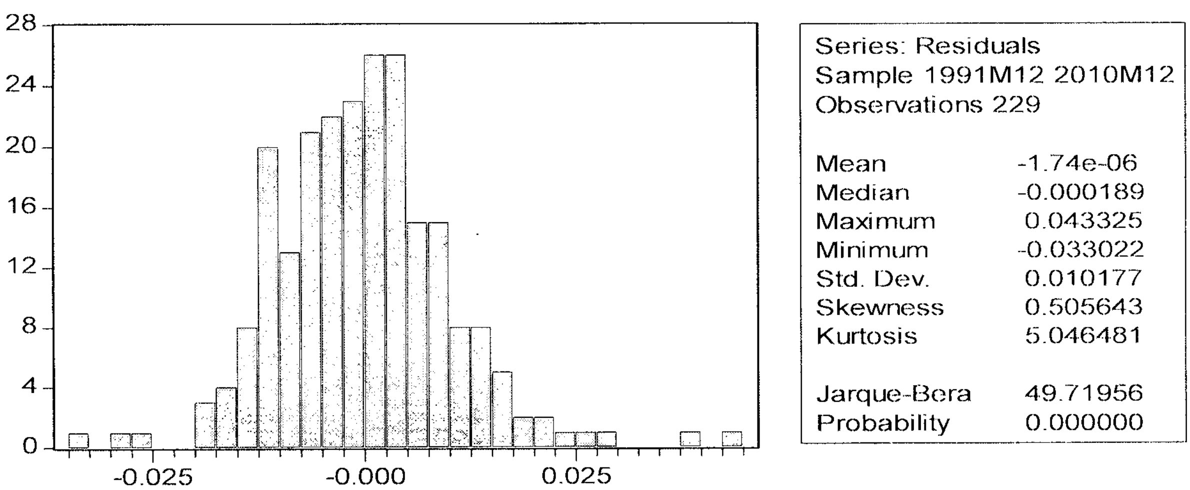
χ^2_1= 0.518216 (0.472347), χ^2_{12}=0.457116 (0.937280)

Both results show that the problem of hetroscedasticity neither exists at 1st lag nor at 12th lag.

4.6.3 Normality Test

This test displays a histogram and descriptive statistics of the residuals, including the Jarque-Bera statistic for testing normality. If the residuals are normally distributed, the Histogram should be bell-shaped and the Jarque-Bera statistic should not be significant;.

Figure 4.5: Normality Test



We can note by looking at the historghram that it is almost bell shaped and probability of Jarque-Bera test is 0.00, which indicate it is significant. So, we concluded that results of dynamic model are not normal.

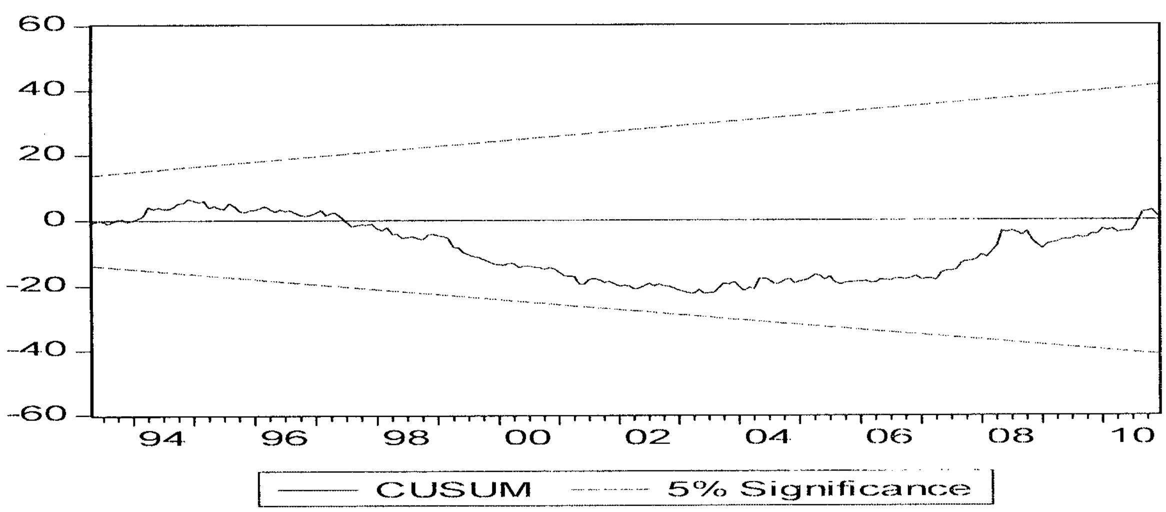
4.7 Stability of the Model

To check the stability of the model we apply cusum test and cusum square test. Both of these tests are reported in the table below.

4.7.1 The CUSUM Test

The CUSUM test (Brown, Durbin, and Evans, 1975) is based on the cumulative sum of the recursive residuals. In this test we plot the cumulative sum together with the 5% critical lines. The test discover parameter instability if the cumulative sum goes outside the area between the two critical lines.

Figure 4.6 Cusum Test

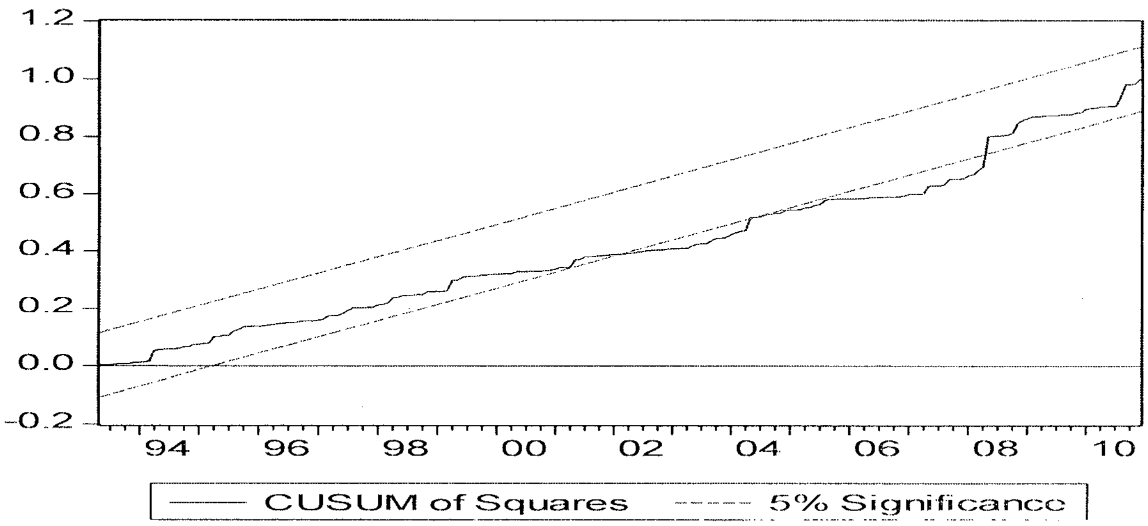


The test clearly indicates the parameter stability in the equation during the sample period.

4.7.2 The CUSUM Square Test

The CUSUM (Brown, Durbin, and Evans, 1975) of squares test provides a plot of series against time and the pair of 5 percent critical lines. As with the CUSUM test, movement outside the critical lines is suggestive of variance instability.

Figure 4.7 Cusum Square Test



The cumulative sum of squares is not entirely within the 5% significance lines, suggesting that the residual variance show instability from 2001 to 2008.

4.8 Reasons of Instability of Dynamic Model

After doing almost everything that we can do to bring the results of Cusum square test into stable region, we shift our focus to find some potent reason of this instability of the results. We found that artificial stability of exchange rate th

4.8.1 Stability of Exchage rate and Instability of Residuals of Cusum Square Test

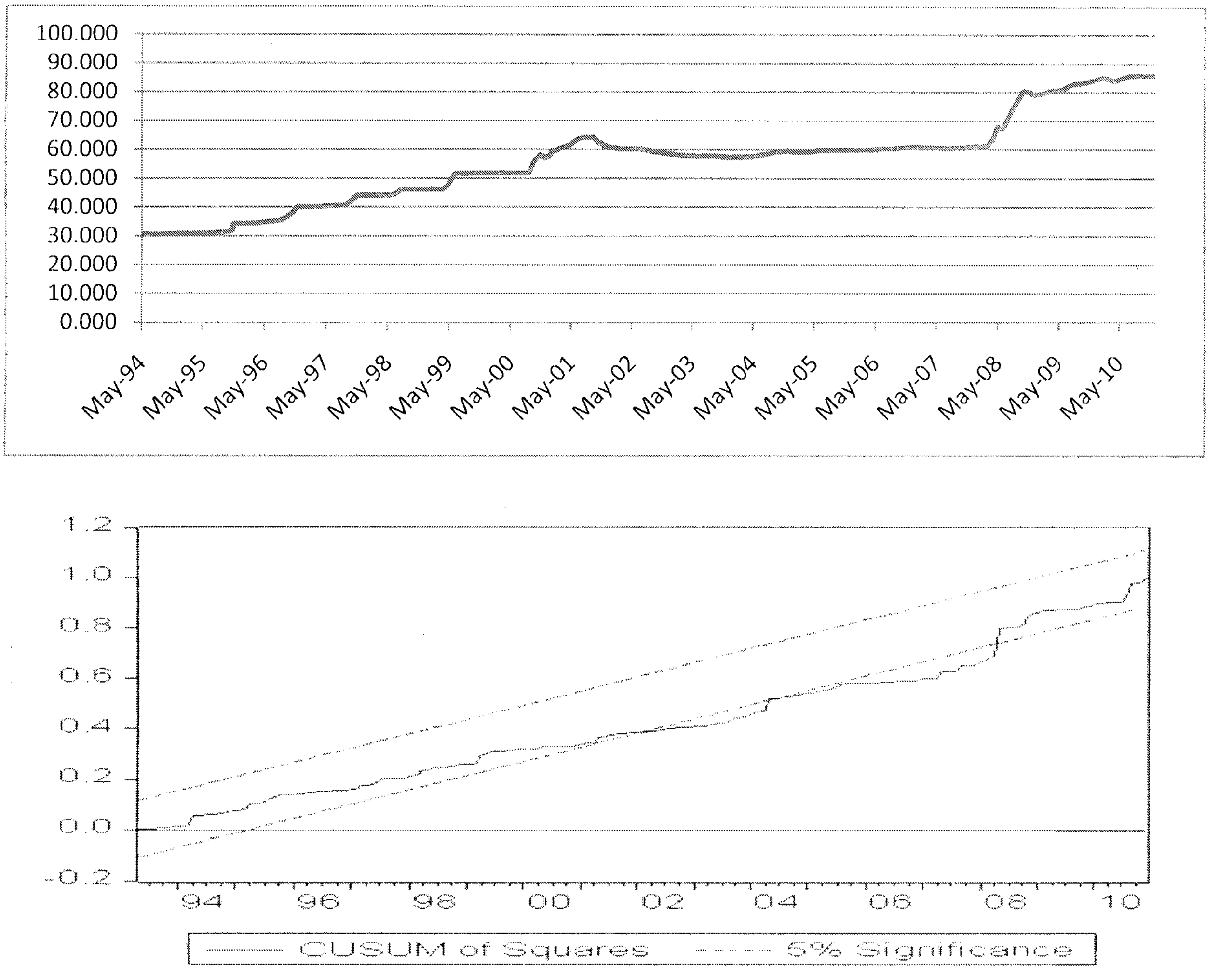
We find interesting facts by closely looking at graph of the exchange rate and the residual of Cusum square test (shown in the next page).

We come to know that from November/December 2001 to April/may 2008 exchange rate is almost stable and exactly during this period residual show instability. Exchange rate start depreciating in July-August 2008 and during exactly same period residual becomes stable. So we can draw inference that stability of exchange has something to do with instability of residual and it might be the main reason that our results are not within stable region of 5% significant band. We have to know whether this stability in exchangre rate is without any intervention from State Bank of Pakistan (SBP) or SBP had internened during this period to keep exchange rate constant.

4.8.2 Sterilization of Exchange Rate

Pakistan has experienced huge surge in capital inflows during 2001 to 2007 particularly in the form of unprecedent rise in remittances. These inflows had increaces demand for Pakistani Rupee and should had induced appreciation in it but the graph of exchage shows that exchange rate is quite stable during this period. This shows Government/Monetary autorities must have taken some action to keep exchange rate

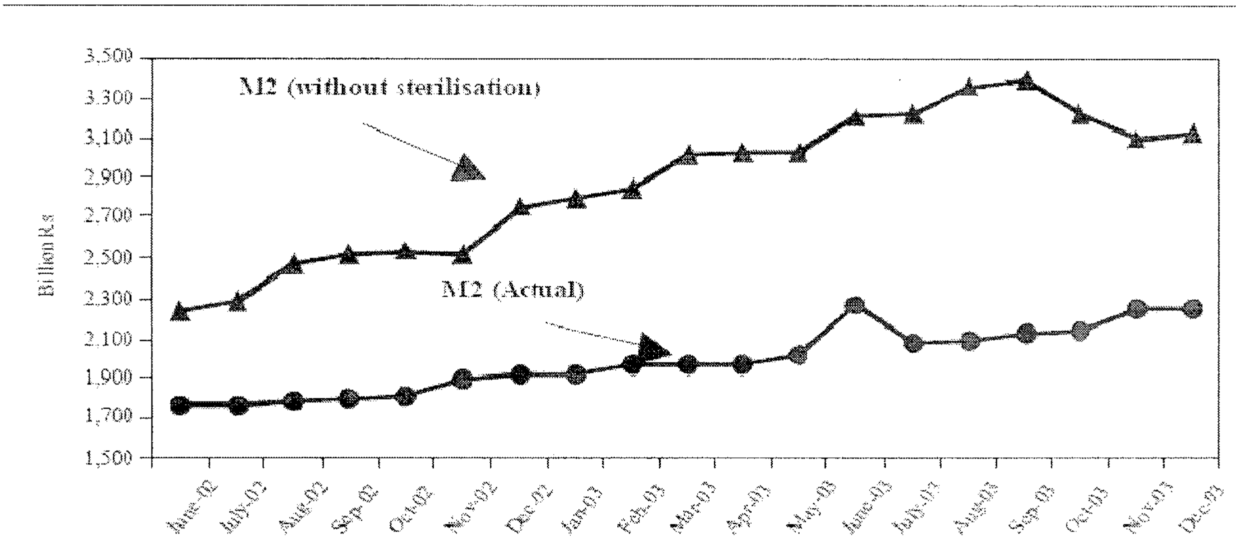
Figure 4.8 Exchange Rate and Residual of CUSUM Square Test



in control. The main instruments available to deal with the possible effects of large capital inflows include trade and exchange liberalisation including easing controls on capital outflows, fiscal tightening and sterilised intervention. The State Bank of Pakistan (SBP) used sterilization policy to keep heavy foreign capital inflows in check during to 2001 to 2007.

According to Jan et.al (2005) "through its effective sterilization policy, SBP had successfully managed to offset the expansionary effects of foreign capital inflows particularly on reserve money (RM), money supply (M2) and exchange rate". Jan et. al (2005) further empirically measured that the sterilization coefficient for Pakistan during July 2000 to December 2003 was (–) 0.87 which, indicates that 87 percent increase in net foreign assets of SBP, was effectively sterilized. Jan et.al (2005) also found that the level of money supply M_2 was also severely affected by sterilization policy as shown in the graph.

Figure 4.9 Effect of Sterilization on Money Supply



Jan et.al (2005) study ends in December 2003 but from stability of exchange beyond December 2003 we can draw inference that sterilization from SBP has been continued beyond this period.

Clearly, in the absense of sterilization the level of money supply and exchange rate would have been much different than the present level and results of residuals of the Cusum square test, in our model might also become within stable region.

4.8.3 Flawd Food Price Policies in Pakistan

Apart from distorted data on money supply (M_2) and exchange rate during sterilization period, if we look at prices pattern of various major crops in Pakistan. We come to know that food price policy in Pakistan don't know follow any economics theory and prices are mostly set according to political or other reason. In the table 7.1, we present support price for various major crops in Pakistan.

We first argue with reference to wheat only which is widely used all over the Pakistan in both rural and urban areas and then we talk about food component of wholesale price index (WPI).

Wholesale Price Index (WPI) for "food" in July 2008 was 206.37 and in December 2010 it was 286.07. There is huge shift in overall food prices, hence in food inflation, both retail level and consumer level but the wheat support prices has not increased by a single penny. Similarly huge shift in wheat support price from 425 in 2006-07 to 950 in 2008-09 also not justifiable on economic grounds.

Table 4.8 Support Price of Major Crops in Pakistan

Year	Wheat	Sugarcane (Punjab)	Rice {Basmati 385}	Seed Cotton {(Phutti) B-557, F-149, Niab-78}
1990-91	112	15.25	143.50	-
1991-92	124	16.75	155.00	245
1992-93	130	17.50	175.00	280
1993-94	160	18.00	185.00	300
1994-95	160	20.50	210.90	315
1995-96	173	21.50	222.00	400
1996-97	240	24.00	255.30	400
1997-98	240	35.00	310.00	500
1998-99	240	35.00	330.00	500
1999-00	300	35.00	350.00	825
2000-01	300	35.00	385.00	725
2001-02	300	42.00	385.00	725
2002-03	300	42.00	385.00	780
2003-04	350	42.00	400.00	800
2004-05	400	42.00	415.00	850
2005-06	415	45.00	460.00	925
2006-07	425	60.00	-	975
2007-08	625	60.00	-	1025
2008-09	950	80.00	1250.00	-
2009-10	950	100.00	1000.00	1465
2010-11*	950	-	-	-
2011-12*	1142 (Suggested)	-	-	-

Source: Pakistan Economic Survey 2009-10

***Source: The Dawn newspaper**

Food price policy in Pakistan is flawed; mostly support prices are announced after plough time and purely on political basis not on genuine economic or purchasing power basis, so how these prices when used in an economics or econometric model can follow the economic theory. This is one of many reasons that the results of our dynamic model are not stable. The Government of Pakistan and relevant departments need to collaborate with each other and should follow some certain mechanism when they announced support price of major crops in Pakistan particularly of wheat.

4.9 Final equation of dynamic Model

We adopt general to specific methodology and drop all those lags which are statistically insignificant. Final equation with all significant lags and its results are reported below;

$$\Delta P_{ft} = \sum_{i=1}^{3} \alpha_i \, \Delta P_{ct-i} + \gamma_1 \Delta x_{t-1} + \gamma_4 \Delta x_{t-4} + \delta_1 ECM_{t-1} + \sum_{i=1}^{11} \gamma_i S_i + \varepsilon_t$$

Results of this equation are reported in the table 4.8

Table 4.9 Results of Dynamic Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ΔP_{ct-1}	0.145191	0.067510	2.150642	0.0326
ΔP_{ct-2}	0.141863	0.067732	2.094486	0.0374
ΔP_{ct-3}	0.161868	0.067839	2.386067	0.0179
Δx_{t-1}	0.087169	0.050744	1.717827*	0.0873
Δx_{t-4}	-0.087959	0.050998	-1.724732*	0.0860
ECM(-1)	-0.000165	4.57E-05	-3.618950	0.0004
S_1	0.015962	0.003491	4.572024	0.0000
S_2	0.014440	0.003543	4.075841	0.0001
S_3	0.016915	0.003531	4.791086	0.0000
S_4	0.020948	0.003423	6.120501	0.0000
S_5	0.004713	0.003471	1.357838	0.1760
S_6	0.015100	0.003477	4.342535	0.0000
S_7	0.023242	0.003511	6.620065	0.0000
S_8	0.018809	0.003566	5.274236	0.0000
S_9	0.011058	0.003484	3.173509	0.0017
S_{10}	0.010618	0.003473	3.057541	0.0025
S_{11}	0.011127	0.003426	3.247724	0.0014

* Indicates significant at 10 % level of significance

We report only the final results and we started our procedure by including 6-lags each series. But all lags of money supply are statistically insignificant and eventually dropped out which indicate that in case of Pakistan money supply does not affect food prices in short run. Impact of 1st and 4th lag of exchange is significant only at 10% level of significance. Almost all seasonal dummies are significant except s5 which indicate the month of May. Food prices affected by their own lag values in short run and this relationship is statistically significant. Sign of coefficient of speed of adjustment is negative which indicate that in case of monetary shock or exchange rate, food prices adjust to regain equilibrium but speed of adjustment is too slow. One possible reason of this low speed of adjustment is that seasonal variations are dominant in food prices over variation due to monetary or exchange rate shock.

4.10 Concluding Remarks

In this chapter, we found that all variables are integrated of order one and hence cointegration analysis is applicable on our data. We found significant long run relation ship between food prices and money supply. While in short run we did not find any significant relationship between these two variables. Results of dynamic model did not satisfy all diagonistic test. But we provide plausible reasons and concluded that there is nothing wrong in our theoretical model and econometric specification. Data on food prices, money supply and exchange rate in Pakistan is distorted and manipulated. So our results are of dynamic model are not stable.

5. Summary, Conclusion and Policy Recommendations

In this chapter we conclude our results in one paragraph and give some policy recommendations which are based on our results.

5.1 Summary and conclusion:

In our study, we have checked out the potential impact of monetary policy on food prices in case of Pakistan by using monthly data from July 1991 to December 2010. For this we first analyzed the time series properties of the data. Tests for stationarity failed to reject the unit root at levels of the individual series for food prices, manufacturing prices, exchange rate and money supply. However these series are found stationary at their 1^{st} difference. After confirming stationarity, we established long run relationship between our series by employing Johanson cointegration procedure. We also estimate error correction mechanism (ECM).

First objective of the study is to check out impact of monetary policy on agricultural prices in long run. The results of Johanson cointegration have confirmed that statistically significantly relationship between money supply and food prices in the long run. Second objective of the study is to check out impact of monetary policy on agricultural prices in short run. The result of dynamic model has failed to confirm that money supply affect food prices in short run in case of Pakistan. We found monthly seasonal dummies are main responsible for short run variation in the food prices. The Cusum square test of dynamic model is not stable. One of the possible reason of this instability might be the sterilization effect during 2001 to 2007 and flawed food price policies prevailing in Pakistan.

5.2 Policy Implications

Our study found significant long run relationship between food prices and money supply, this relationship has important policy implication that loose monetary policy could be used to boost up the agricultural prices which leads to an increase in farmer's income or to use tight monetary policy in order to control agricultural prices for easing urban consumers. We have found that agricultural support prices which are indicator of agricultural price policy are not follow any certain rules and economic mechanism in Pakistan. For example Wholesale Price Index (WPI) for "food" in July 2008 was 206.37 and in December 2010 it was 286.07. There is huge shift in overall food prices, hence in food inflation, both at retail level and consumer level but the wheat support prices has not increased by a single penny. Similarly huge shift in wheat support price from 425 in 2006-07 to 950 in 2008-09 also not justifiable on economic grounds. It is difficult to get desire result of monetary policy if there is no coordination between different policy making departments like monetary authorities and agricultural price policy makers. Hence, Due to the linkages between money supply and food prices in the long run, we recommended that agricultural policy makers and monetary authorities should work closely in designing and implementing monetary policy in the country, otherwise, monetary policies meant to stabilize the economy might have less desirable impacts on farmers and consumers.

These impacts of monetary policy on food prices add to price and income instability, and influence financial viability of farmers tremendously. Farmers can reduce risk by using various techniques such as purchasing crop insurance, hedging and diversifying crops. However, those commodity market techniques cannot reduce income and price risks completely. Temporal monetary impacts warrant great care and attention toward macro-policy decision making to diminish or smooth out the variability and fluctuations in agricultural prices.

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