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A STRUCTURAL VAR (SVAR) APPROACH TO COST CHANNEL OF MONETARY POLICY

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ABSTRACT

The study aims at investigating, whether or not the cost channel of monetary policy is effective in Pakistan. The cost channel is one of the theoretical justifications of *Price Puzzle*, a phenomenon that has been observed in a number of empirical studies. Using Structural Vector Autoregression (SVAR) and data from different industries of manufacturing sector of Pakistan over the period 2001:M07-2008:M04, we find strong evidence in favor of Price Puzzle in major industries. In industries like textile, food and beverages, pharmaceuticals, automobiles, and fertilizers, cost channel dominates the traditional demand channel. Same behavior is observed for aggregate price level in the overall manufacturing sector. The main reason for the result is the dependency of the above mentioned industries on short-term borrowing to finance their operational liquidity.

Key Words: Cost Channel, Price Puzzle, Working Capital, Monetary Policy, Marginal Cost, Structural Vector Autoregression (SVAR)

JEL Classification: C22, E31, E32

1. INTRODUCTION

Transmission of monetary policy instrument, to real output and prices, has been an area of research, though it remained controversial, for a long period of time. Traditional macroeconomic models are capable of exploring the transmission of changes in money supply to aggregate demand through different channels. Most of the studies of the latter half of 20th century have focused on demand side effects of monetary policy analyzing the role of interest rate, asset price, and credit channels in the transmission. Data, on the other hand, reveals another story. While estimating effects of changes in monetary policy instrument, some studies found hump-shaped response of prices to increase in interest rate, [see for instance, Shapiro (1981); Sims (1992); Christiano and Eichenbaum (1992); Bernanke and Gertler (1995); Bernanke and Mihov (1998), among others]. So, inflation responds positively to monetary tightening in short run, though, this effect reverse its direction in medium to long run. The theoretical justification of this contradictory result – known as *"Price Puzzle"* may be found in what is called *"Cost Channel of Monetary Policy"*.

Cost channel of monetary policy captures the effects of monetary shocks on the supply side of the economy. It is believed that most of the firms are dependent on short term borrowing to finance working capital (i.e., liquidity requirements for the upcoming operational expenses) in the production process. Positive shocks to nominal interest rate not only affect, through discouraging capital formation, long-run ability of the firm to produce but the effect on short-run capacity, through increasing cost financing working capital, is also significant. Monetary contraction, and hence an increase in interest rate,

has a direct impact on the marginal cost of firms relying on external loans and borrowing. This increased cost is passed on to consumers through mark-up pricing resulting in price puzzle[2].

In the last two decades, monetary economists have also focused on the supply side of monetary transmission to study cost channel not only for the aggregate economy but also at sectoral level as well. The sectoral analysis is helpful to identify industry specific responses to monetary policy shock, i.e., which industry is more sensitive to short-term financial requirements. It also provides useful information to monetary authorities by conducting optimal monetary policy.

Which channel of monetary transmission mechanism–traditional demand channel or cost channel – is effective in a particular economy, is an empirical question and matters a lot for practical policy making. For instance, in the presence of cost channel, monetary tightening in response to negative supply shock may exacerbate the problem at-least in the short run. Despite such importance of the issue, only limited number of studies is available in the area of monetary transmission mechanism in Pakistan. Studies including Gupta (2004), Ahmed *et al*. (2005), Alam and Waheed (2006), have analyzed traditional demand-side effects of monetary policy changes at aggregate and sectoral level of Pakistan's economy through nominal and real interest rate channel, credit channel, and asset price channel. However, to my knowledge, there is no study available in Pakistan

[2] For literature on empirics of price puzzle, see Farmer (1984); Blinder (1987); Farmer (1988); Fuerst (1992); Christiano and Eichenbaum (1992); Bernanke and Gertler (1995); Christiano *et al.* (1997); Barth III and Ramey (2001); Gaiotti and Secchi (2004); Chowdhury *et al.* (2006); Kaufmann and Scharler (2006); and Tillmann (2008).

that has captured the cost channel of transmission mechanism. This gap is a motivation for conducting research in the area.

The objective of this study is to investigate price puzzle, i.e., cost-channel of monetary transmission in Pakistan. The objective here is not only estimating effects of policy changes on aggregate real output and price level of the economy; rather cost channel is investigated in different industries of manufacturing sector. For this purpose we have used monthly data (2001:M7 to 2008:M4) of manufacturing production, prices, and money market rate. Structural Vector Autoregression (SVAR) has been used to find the dynamics, in response to policy changes, of output and inflation. SVAR, instead of using simple VAR, has the advantage of incorporating economic theory in the identification of structural shocks, (Sims (1986); Blanchard and Watson (1986); and Bernanke (1986)). The results confirm the existence of cost-channel not only at the aggregate level but price puzzle exists in industries like textile, food and beverages, pharmaceuticals, and fertilizers, showing reliance of these industries on credit for working capital.

Rest of the study proceeds as follow: The next section analyzed theoretical framework and methodology, which gives not only theoretical background of the problem under study but also explains, in detail, the econometric methodology of SVAR. The third section explains the construction of variables and sources of data used in the paper. Results of output and inflation dynamics are explained in section four. Finally, section five concludes the discussion and presents some policy implications.

2. THEORETICAL FRAMEWORK

We are using theoretical model which is based on a standard price equation presented in Bils and Chang (2000). The resulting price equation explicitly incorporates cost channel of monetary transmission, which reflects interest rate as one of its important determinants. It is assumed that labor, capital and material inputs are being used in the production process, and output prices are set over and above marginal cost as a mark-up in monopolistic competitive market. The role of working capital in the cost channel is modeled by incorporating material inputs into the production function, however, some fixed fraction of these inputs must be held by firms as inventories. The final assumption about the behavior of producer is that a fraction of material and labor inputs must be paid in advance before the firm receives its revenue. These assumptions clearly highlight the explicit role of credit and interest rate in the supply side of the economy. The role of material inputs and labor in the production function is to introduce cost channel of monetary policy in the model and must be paid in advance with a cost equal to borrowed money plus nominal interest payments at the rate prevailing in the economy.

Consider the following Cobb-Douglas production function,

$$Y_t = A_t M_t^{\alpha} N_t^{\beta} K_t^{\gamma} \tag{2.1}$$

In equation (2.1), Y_t is the total production of the firm, A_t is a production technology, M_t is assumed to be material inputs used by the producers in the production, N_t is the amount of labor, and K_t is the capital requirements for production.

Here, it is assumed that some fixed fraction of both labor (b_N) and material (b_M) inputs must be paid in advance which may be borrowed at an interest rate equal to R_t to incorporate cost channel in this model. This assumption is of particular importance in the literature on cost channel of monetary policy.

The prices of the production inputs like materials, labor, and capital are denoted by m, w, and c respectively, and the cost paid to finance working capital and expected wages as R_t, Total Cost of the production process is given by the following equation,

$$TC_t = m_t M_t (1 + b_M R_t) + w_t N_t (1 + b_N R_t) + c_t K_t \tag{2.2}$$

A profit maximizing producer maximizes the production in equation (3.1) subject to the constraint of the total cost in equation (3.2). The Lagrange problem becomes,

$$L = A_t M_t^{\alpha} N_t^{\beta} K_t^{\gamma} + \lambda [TC_t - m_t M_t (1 + b_M R_t) - w_t N_t (1 + b_N R_t) - c_t K_t] \tag{2.3}$$

After finding optimal first order conditions, we get indirect cost function of a typical firm.

$$TC_t = (\alpha + \beta + \gamma)[(\frac{v_t^{'}}{\alpha})^{\alpha} (\frac{w_t^{'}}{\beta})^{\beta} (\frac{c_t}{\gamma})^{\gamma}]^{\frac{1}{\alpha+\beta+\gamma}} (A_t^{-1})^{\frac{1}{\alpha+\beta+\gamma}} (y_t)^{\frac{1}{\alpha+\beta+\gamma}} \tag{2.4}$$

Through some manipulations, we can get the following dynamic version of marginal cost equation[3],

$$\dot{mc}_t = (1-\psi)\dot{w}_t + \psi \dot{m}_t - [\dot{y}_t - \psi \dot{M}_t - (1-\psi)\dot{N}_t)] + \underbrace{(1-\psi) b_N \Delta R_t + \psi B_M \Delta R_t}_{\substack{Cost\ Channel\ of \\ Monetary\ Policy}} \tag{2.5}$$

[3] The detailed derivation of equation (2.5) will be provided upon a reader's request.

In the monopolistic competition, producers have some power to charge prices above the marginal cost, as mark-up pricing. The price equation containing cost channel of monetary policy can be derived from equation (2.5), by equating the change in price to the change in mark-up plus the change in the marginal cost of the firm. It can be written as,

$$\dot{p}_t = (1-\psi)\dot{w}_t + \psi\dot{m}_t - [\dot{y}_t - \psi\dot{M}_t - (1-\psi)\dot{N}_t)] + \underbrace{(1-\psi)b_N\Delta R_t + \psi B_M\Delta R_t}_{\substack{\text{Cost Channel of} \\ \text{Monetary Policy}}} + \underbrace{\dot{\rho}_t}_{\substack{\text{Mark-up} \\ \text{Price}}} \qquad (2.6)$$

In the right hand side of equation (2.6), the term $\dot{\rho}_t$ is the time-varying mark-up charged by producers in the monopolistic competition market. Cost channel or "Price Puzzle" in the above equation is captured by the terms $(1-\psi)b_N\Delta R_t + \psi b_M\Delta R_t$. The term $(1-\psi)b_N\Delta R_t$ indicates the change in the short-term interest rate multiplied by the share of labor and capital input costs (value added) to the total cost ratio. If there is an exogenous change in the monetary policy, it will affect value addition to production by labor and capital inputs. The important one is labor from working capital point of view, which we have assumed to be paid in advance before producers receive their respective revenues. Another important form of working capital is the material inputs of the production process, which also captures the effects of contractionary monetary policy on the supply side activities of the economy. The term $\psi b_M\Delta R_t$ implies the change in the interest rate due to exogenous monetary policy multiplied by the ratio of material inputs costs to the total cost of production. An increase in rate of interest directly affects the contribution of material inputs as a working capital in the production process. These two

terms include in equation (2.6) with a positive sign, highlights the positive impact of interest rate shock on the price level of the economy.

The term $[\dot{y}_t - \psi \dot{M}_t - (1-\psi)\dot{N}_t)]$ reveals a measure of total factor productivity that shows the impact of an exogenous change in $\dot{A}_t$ on the level of short-run price of a specific industry of manufacturing sector of the economy. However, it also captures the impact of a user cost of capital on price, which leads to the changes in material inputs and labor inputs to capital stock of the economy. The remaining terms including $(1-\psi)\dot{w}_t + \psi \dot{m}_t$ exerts positive pressure on the price level of a change in labor inputs cost and material inputs cost to total cost ratio.

3. ECONOMETRIC METHODOLOGY

The most important problem of time series data is the existence of a unit root. To tests lag dependency of a series; we test the sequence with a statistical test known as Augmented Dickey- Fuller Test (ADF) (1979) as given in the following equation.

$$\Delta y_t = \alpha + \beta t + \delta y_{t-1} + \gamma_1 \Delta y_{t-1} + \ldots\ldots\ldots\ldots\ldots\ldots \gamma_p \Delta y_{t-p} + \varepsilon_t \qquad (3.1)$$

However, seasonality is also a key feature of many economic variables. It is not necessary that a stationary series is also seasonally stationary, and that the first difference of a seasonal unit root process may not be stationary. The nature of our data also reveals that it may have seasonal unit roots. We will also check seasonal unit roots in our desired variables with a test known as Hylleberg, Engle, Granger, and Yoo (HEGY) (1990) test.

The HEGY seasonal unit root test is presented by the following auxiliary regression,

$$Y13_t = \alpha_0 + \alpha_1 t + \sum_{j=1}^{12} \alpha_j D_{jt} + \sum_{j=1}^{12} \pi_j Yj_{t-1} + \varepsilon_t \qquad (3.2)$$

Where, $Y13_t = (1-L^{12})\, Y_t$, D_{jt} are seasonal dummies, Yj_{t-1} are variables obtained through proper filtering, and ε_t is a random variable which is i.i.d.

The results of a (HEGY) test confirm that there is no seasonal unit root in our data series[4]. However, some of the series are unit root process, which are made stationary with proper differencing.

3.1 Structural Vector Autoregression (SVAR)

The Cost-Channel of monetary transmission can be investigated through Structural Vector Autoregression (SVAR). The advantage of the SVAR is that it combines statistical techniques with economic theory to capture the impact of monetary policy. To analyze the supply side effects of monetary policy on real economic activities at aggregate level of the economy, SVAR comprises of the variables including Index of Manufacturing Production (AMP), Money Market Rate (MMR), Wholesale Price Index of the Manufacturing Sector (OVERALLWPI), and [industry specific WPI in case of individual Industry's analysis]; all the three variables are in logarithmic form except for MMR. Using these three variables, the Structural VAR model is constructed as follow,

[4] The results of HEGY test will be provided upon a reader's request.

$$amp_t = b_{10} + b_{12} mmr_t + b_{13}\Delta(overallwpi_t) + \beta_{1i}\sum_{P=1}^{4} mmr_{t-p} + \gamma_{1i}\sum_{p=1}^{4}\Delta(overallwpi_{t-p}) + \delta_{1i}\sum_{p=1}^{4} amp_{t-p} + \varepsilon_{1t}$$

$$mmr_t = b_{20} + b_{21} amp_t + b_{23}\Delta(overallwpi_t) + \beta_{2i}\sum_{P=1}^{4} mmr_{t-p} + \gamma_{2i}\sum_{p=1}^{4}\Delta(overallwpi_{t-p}) + \delta_{2i}\sum_{p=1}^{4} amp_{t-p} + \varepsilon_{2t} \qquad (3.3)$$

$$\Delta(overallwpi_t) = b_{30} + b_{31} amp_t + b_{32} mmr_t + \beta_{3i}\sum_{P=1}^{4} mmr_{t-p} + \gamma_{3i}\sum_{p=1}^{4}\Delta(overallwpi_{t-p}) + \delta_{3i}\sum_{p=1}^{4} amp_{t-p} + \varepsilon_{3t}$$

The system of equations (2.9) can be written as,

$$BX_t = B_0 + B_1\sum_{p=1}^{n} X_{t-p} + e_t \ , \qquad (3.4)$$

Equation (2.10) is a system of structural equations in matrix form. The system can be converted into reduced form as,

$$X_t = A_0 + A_1\sum_{p=1}^{n} X_{t-p} + u_t \ , \qquad (3.5)$$

In equation (2.11), u_t term links structural shocks to reduced form shocks in the follow manner,

$u_t = B^{-1}e_t$

Where e_t and u_t are Structural and Reduced form shocks respectively, and B is a matrix of parameters on contemporaneous variables in Structural VAR.

One of the important components of the VAR is its identification. To derive structural parameters from reduced form parameters, we need some restrictions to be imposed on the structural parameters. This exercise will not only give us structural parameters but also helps in the identification of the system. The matrix of the structural parameters with identifying restrictions can be written as,

$$B = \begin{bmatrix} * & 0 & 0 \\ * & * & * \\ * & 0 & * \end{bmatrix}$$

In matrix B, * denotes the contemporaneous response of the model variables to structural shocks. B matrix of the identifying assumptions reveals that aggregate manufacturing production is not affected contemporaneously by the structural shocks of interest rate and WPI, because production generally respond with a lag of four to five months to shock in the economy, Henzel *et al.* (2007). However, monetary instrument is contemporaneously sensitive to structural innovations in manufacturing sector production and its prices (This restriction is also consistent with Taylor (1993) rule). The final identifying assumption is that, manufacturing sector prices are only sensitive to shocks to its sector's production. The above identifying assumptions give the information that output and prices respond with a delay of about one quarter to surprise in monetary policy. These assumptions seem reasonable in the light of economic theory and empirical evidence for Pakistan's economy (see for instance Malik (2006); Khan and Schimmelpfennig (2006)). The same identifying assumptions have been applied on the structural parameters to estimate the impulse response functions of a positive interest rate shock on each individual industrial output level and prices of the large scale manufacturing sector of Pakistan's economy.

4. DATA AND VARIABLES

The given section presents the construction and data sources of variables that are used in the study. Period of analysis for the study is 2001:M7 to 2008:M4. The main reason for selecting this period is due to the limitation of data availability of Wholesale Price Index (WPI). Federal Bureau of Statistics (FBS) published this Index for the first time in 2001.

The fore most important variable of the study is the *Index of Manufacturing Industries* at the sectoral level. To my knowledge, an index of manufacturing industries at a sector-wise level is not available yet; however, *Index of Manufacturing Production* that is for the manufacturing sector at the aggregate level is published since 1950 at an annual and since 1977 at monthly basis by the International Financial Statistics (IFS). Due to this, one of the major problems that we have faced in this study is to construct a representative index for each industry of large scale manufacturing sector of Pakistan's economy.

To study cost channel of monetary policy transmission for the Pakistan's economy, the analysis requires data on manufacturing sector prices and quantities of different industries at a [5]monthly frequency. However, the data problems are very severe in a country like Pakistan. Due to problems like these, we have obtained monthly data of physical production of only thirteen major industries for the period 1984:M7-2008:M4. The thirteen major industries of large scale manufacturing sector are *Textile, Food Beverages and Tobacco, Petroleum Products, Fertilizers, Pharmaceuticals, Metal Industries, Chemicals, Electronics, Automobile, Leather Products, Paper and Board, Engineering Industries, Rubber Products.* As it is mentioned above, that we have only data of physical quantities of different industries products, which implies that different items have different units to measure. For example, some items are measured in tones, while others are in meters, liters, numbers, KGs, etc. In the absence of prices of specific items, it is convenient for us to construct a QUANTUM INDEX NUMBER[6], which is only based on quantities.

[5] Monthly frequency is important, as we have short data span in terms of years.
[6] The detailed of the Quantum Index Number is in Appendix-I.

The other important variables of the study are *Wholesale Price Index (WPI)* which is measured through Weighted Laspeyre's Index, *Manufacturing Production* which is calculated on monthly basis for the whole manufacturing sector of the economy, and Money *Market Rate*. Federal Bureau of Statistics (FBS) and International Financial Statistics (IFS) are the main sources of data for the above variables.

5. RESULTS AND DISCUSSION

STRUCTURAL VAR is used to study the cost channel of monetary transmission, first at aggregate level of manufacturing production and then at each individual industry of the Pakistan's large scale manufacturing sector.

5.1 SVAR Model for Aggregate Manufacturing Production

We start with a simple reduced form VAR Model like,

$$X_t = A_0 + A_1 \sum_{p=1}^{n} X_{t-p} + u_t \ , \qquad (5.1)$$

Where $\mathbf{X_t}$-is a vector of endogenous variables given as,

$\mathbf{X_t}$ = [Index of Manufacturing Production, Money Market Rate, Wholesale Price Index of the Manufacturing Sector], $\mathbf{A_0}$ is a vector of constants, $\mathbf{X_{t-p}}$ represents endogenous variables' lag values, and $\mathbf{u_t}$ is a vector of i.i.d error terms.

We have imposed standard identifying restrictions in the SVAR model given for instance in Henzel *et al.* (2007). The identifying assumptions are, manufacturing production does not contemporaneously respond to interest rate innovations; however, interest rate contemporaneously responds to shocks in manufacturing production and wholesale prices. Since, output and price level generally respond with a lag to a monetary policy shocks, these assumptions seen appropriate (see for instance Malik (2006); Khan and Schimmelpfennig (2006)).

5.1.1 Testing cost channel of monetary policy at aggregate level

Manufacturing sector of Pakistan is the second largest contributor (18.4% in FY 2008-2009) to the GDP. It receives 85% of private sector business credit. Such a heavily dependent sector on borrowing may be very sensitive to monetary policies. Therefore, it requires special attention of policy makers, especially of monetary authorities. It is generally expected that the tight monetary policy of SPB since 2003 (Economic Survey, 2008-2009) to control inflationary spiral has severe consequences for manufacturing sector. If price decreases along with output level, then traditional demand channel outweigh the supply side effects of monetary contraction, and if price rises with a decline in output, then the phenomenon of price puzzle exists. This channel is of particular importance for the firms, for which working capital is an important determinant of production in the short run. We estimated SVAR given in equation (5.1) to investigate the effects of monetary policy shock on output and inflation. Results are given in Figures 5.1 and onward.

FIGURE 5.1 RESPONSES OF AGGREGATE MANUFACTURING PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK

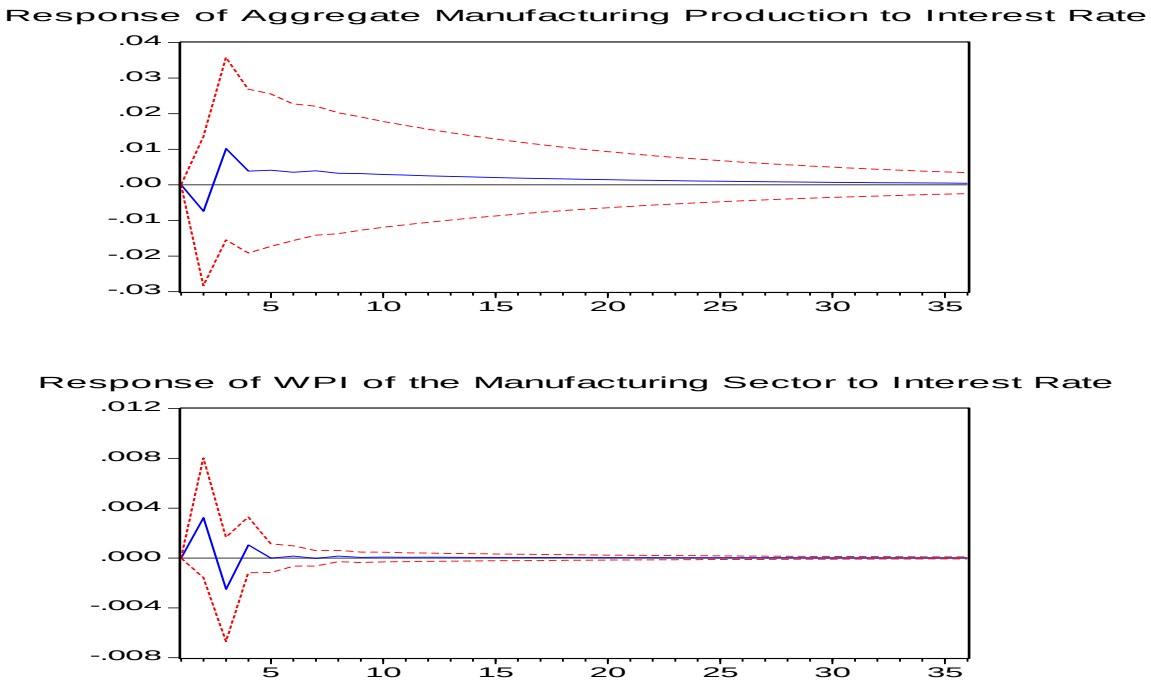


Figure 5.1 shows a decrease in output of overall manufacturing sector production in response to monetary contraction. However, only the decline in output is not signaling the significance of the cost channel of monetary policy. For the identification of cost channel, we have to study the response of prices to monetary tightening. The lower panel of figure 5.1 reveals the response of WPI inflation to a one-unit innovation in interest rate. It clearly identifies the existence of a "Price Puzzle", as price level increases after a monetary contraction. The presence of "Price Puzzle" is an evidence of the dependency of manufacturing sector on private sector loans, which absorbs 85% credit of private sector (Economic Survey, 2008-2009). This establishes that short-term financial requirement in the manufacturing sector is an important determinant of production.

In a country like Pakistan, there are stringent and hard conditions of borrowing in the financial market. Nevertheless, if producers want to take loans but due to restrictions and hard conditions either he/she is reluctant to borrow it or repay quickly the loans that he/she borrowed or borrow from an informal sector at high cost. It results in low liquidity in firms' balance sheet and high cost of borrowing, which leads to low demand for loan and low level of production. The literature that have studied that monetary contraction has strong supply side effects by affecting the aggregate supply of the economy included Blinder (1987), Christiano and Eichenbaum (1992), Bernanke and Gertler (1995), Barth III and Ramey (2001), Gaiotti and Secchi (2004), Chowdhury *et al.* (2006), Kaufmann and Scharler (2006), and Tillman (2008).

Manufacturing sector of Pakistan is also vulnerable to foreign and domestic shocks like world recession since 2000, oil prices, competition in international market, and low domestic demand due to high inflation in the last decade. However, our results confirm that monetary authorities' actions can be an important determinant of inflation in the manufacturing sector through cost channel, but, the effects of monetary actions on both output and prices not only transmit quickly but also are absorbed quickly. The negative response of output reaches its trough after two months of the monetary tightening and then recovers quickly to its normal level. The monetary contraction has immediate effect on inflation through supply side, but it converges to its normal level quickly. It means that cost channel of monetary transmission does not have permanent effects on inflation. It is note worthy that among the important determinants of manufacturing sector of

Pakistan; little importance in the past has been given to monetary policy actions. Nonetheless, monetary policy analysis illustrates that it has an important effects on real output and inflation through cost channel, implying that in the manufacturing sector, supply side channel dominates the traditional demand channel.

5.2 SVAR Model for Sectoral Analysis of the Manufacturing Sector

We have shown that manufacturing sector shows some sensitivity to monetary policy shocks, though "Price Puzzle" prevails for a very short period. In this section, we analyze which industry is more responsive to monetary policy innovations by investigating the output and price sensitivity. We start with a Reduced form VAR Model given as,

$$X_t = A_0 + A_1 \sum_{p=1}^{n} X_{t-p} + u_t \ , \qquad (5.2)$$

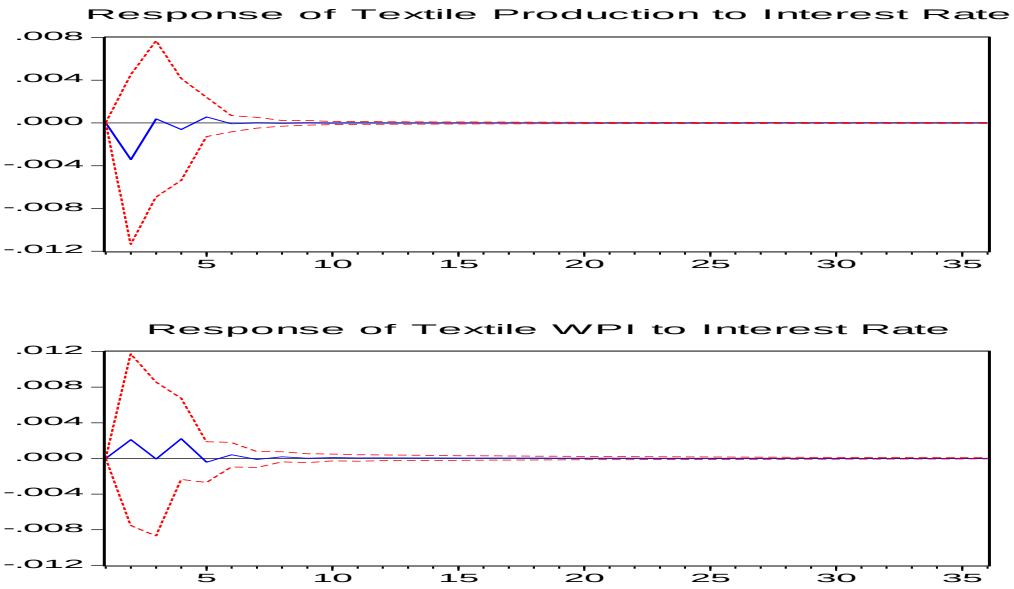
Where $\mathbf{X_t}$- is a vector of endogenous variables,

$\mathbf{X_t}$ = [Index of Manufacturing Production, Interest Rate, Index of Production of Industry 'j', Wholesale Price Index of Industry 'j'], $\mathbf{A_0}$ is a vector of constants, $\mathbf{X_{t-p}}$ represents endogenous variables' lag values, and $\mathbf{u_t}$ is a vector of i.i.d error terms. The same identifying assumptions are applied as assumed in section 3.

5.2.1 Response of textile industry to monetary policy shock

Results in Figure 5.2 indicate that output and prices in textile sector are responsive of short-term interest rate increase, because after a tight monetary policy, output declines along with a price increase. The output respond immediately to interest rate shock, reaches its trough in the second month but the effect dies out to zero with in four months, which indicates that monetary policy does have a significant impact on the production of textile sector. The rise in the WPI of textile sector in the second panel of figure 5.2 reveals the existence of "Price Puzzle." The cost channel's significance in the textile sector indicates that this sector depends heavily on short-term loans to fiancé their working capital. The producers of textile sector need a handsome amount of loan at the time of harvest to purchase raw materials for the whole year. They also demand loans to pay their daily wageworkers. The worldwide recession since 2000 badly affects the revenue of textile sector, this leads to the rising default risk of textile sector on their loans (Non Performing Loans) (Economic Survey, (2008-2009)). However, tight monetary policy since 2003 further hurt textile sector because textile sector was already in problems due to low demand and high competition in the international market. The dependency of textile sector on loans and working capital is also evident from the figures (Rs. 661,956.07 m in 2004-05, Rs. 666,730.46 m in 2005-06, Rs. 910,766.55 m in 2006-07, and Rs. 1,020,288.248 m in 2007-08 (SBP, 2009)). Due to these reasons, the output and prices of textile sector respond very quickly to interest rate's positive innovation. However, its dynamic nature equipped this sector to absorb shocks very quickly. The response of price to interest rate is positive and converges to the equilibrium level within a period of six months.

FIGURE 5.2 RESPONSES OF TEXTILE INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK

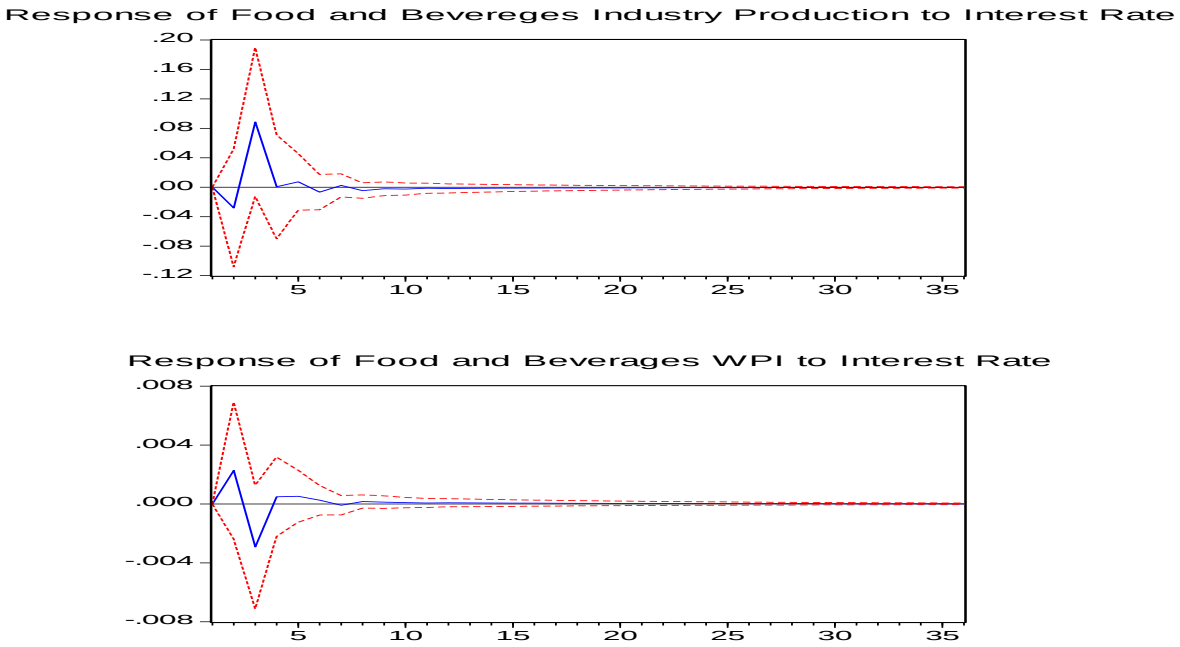


5.2.2 Response of food and beverages industry to monetary policy shock

The results in figure 5.3 explain the importance of supply side effects of monetary policy that outweigh the traditional demand channel of monetary shock. The first panel of figure 5.3 reveals that output responds very quickly to positive innovation to interest rate. The food items (sugar, cooking oil, vegetable ghee, cigarette, tea, beverages, salt, etc.) generally have an inelastic demand in the economy. The seasonal behavior of the raw materials increases the dependency of food and beverages industry on the availability of on-time short-term loans. As monetary authorities increase the interest rate, it increases the cost of working capital in the industry, where producers have inelastic demand for working capital. Therefore, they pass on the effect of increased cost of production to consumers. Output declines in response to a monetary shock, reaches its peak in the second month and then recovered. However, the recovery is not only quick, but also leads

to higher production than the normal. It may be due to the seasonal nature of the food products, which is clear from figure 5.3 that most of the time production remained high and in response, prices are low. It concludes that food and beverages industry is not so sensitive to monetary innovations, but still cost channel exists for a very short period.

FIGURE 5.3 RESPONSES OF FOOD AND BEVERAGES INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK

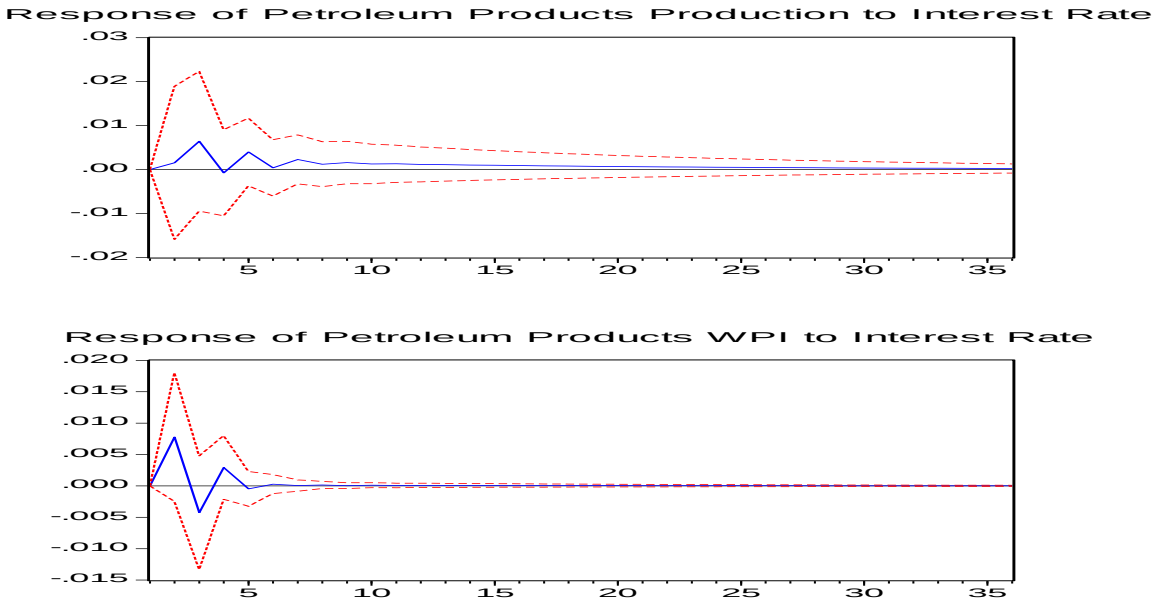


5.2.3 Response of petroleum products to monetary policy shock

The results of figure 5.4 confirm that positive innovation to interest rate is not influencing the production and prices of petroleum industry in the way the theory of "Price Puzzle" predicts. The main reason for this result is that in petroleum industry there are administered prices. Instead of market, determined prices are set by the government. These prices, in most of the times, reflect political reasons rather than economic factors. Another reason may be that petroleum industry is functioning with the help of heavy

machinery and equipment. It may not have reliance on short-term borrowing; rather it is more sensitive to long-term borrowing conditions and restrictions. Therefore, in the short-run output and prices are performing completely opposite to both demand and supply channel of monetary transmission. Production and prices both increases with an increase in the interest rate due to its high demand and low supply in Pakistan. Hence, producer will want to exploit opportunities like this; therefore, they increase production along with increase in prices. Another reason of the price increase is high prices of petroleum products in international market during the sample period; due to which domestic producer also have to adjust their prices.

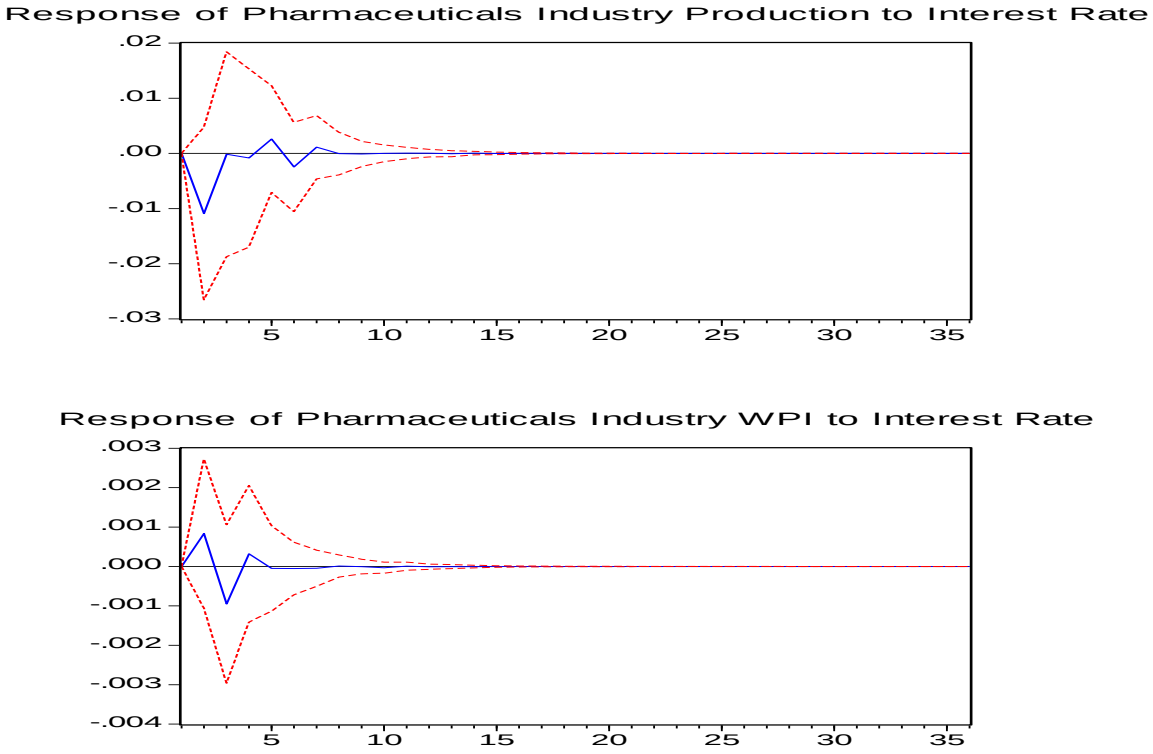
FIGURE 5.4 RESPONSES OF PETROLEUM PRODUCTS INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK



5.2.4 Response of pharmaceuticals products to monetary policy shock

Pharmaceuticals industry have inelastic demand in the market, producers even willing to borrow at a high cost to finance their working capital by transmitting high cost to consumers by increasing market prices of final products. However, very high cost of borrowing can also decline the output level of the industry, which is evident from figure 5.5. The decline in the production may be attributed to both high cost of working capital and cheaper availability of foreign products in the domestic economy. After a monetary tightening, output declines followed by price increase. Output immediately falls after interest rate shock, remains in the negative quadrant for about five months, and then converges to normal level. Similarly, price rises instantly with a monetary shock but the effect become zero in about five months.

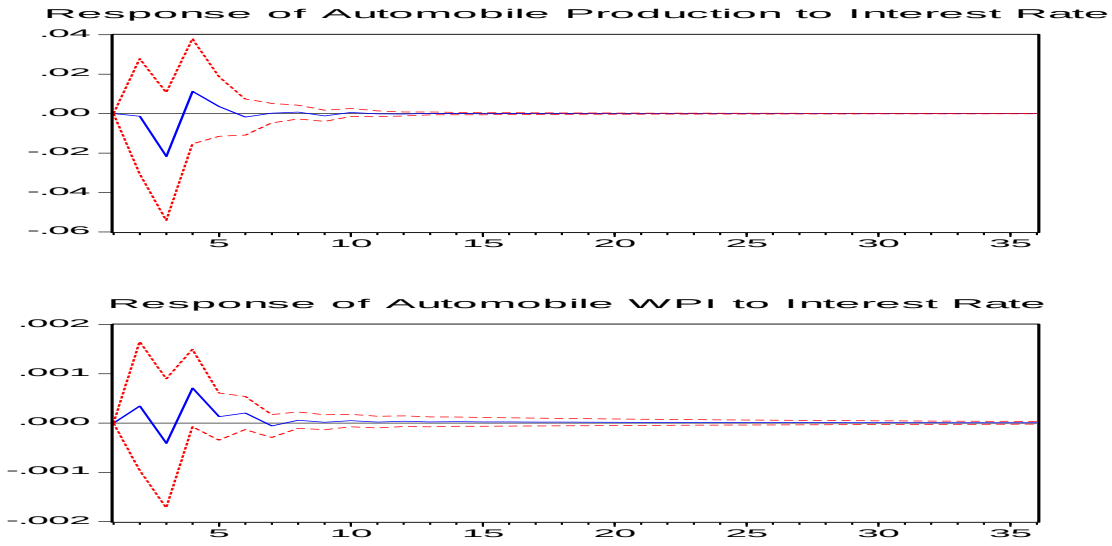
FIGURE 5.5 RESPONSES OF PHARMACEUTICALS PRODUCTS INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK



5.2.5 Response of automobile industry to monetary policy shock

Automobile industry may be considered the most sensitive industry to monetary shocks, as monetary authorities announced different policy programs to boost its domestic production. Schemes like car financing are the most important measure of monetary authorities to enhance domestic demand and production. If we look at the output and price responses of automobile industry in figure 5.6, it is clear that the industry has a significant dependence on the actions of monetary authorities. The domestic producers import major portion of raw materials of automotive industry. It requires time availability of short-term loans to finance these raw materials. However, high cost of borrowing since 2003 has limited their orders of imports in international market, which hurt badly our domestic automobile industry. The graphs reveal that cost channel is significantly operating in the respective industry as evident from declining output along-with rising prices[7].

FIGURE 5.6 RESPONSES OF AUTOMOBILE INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK



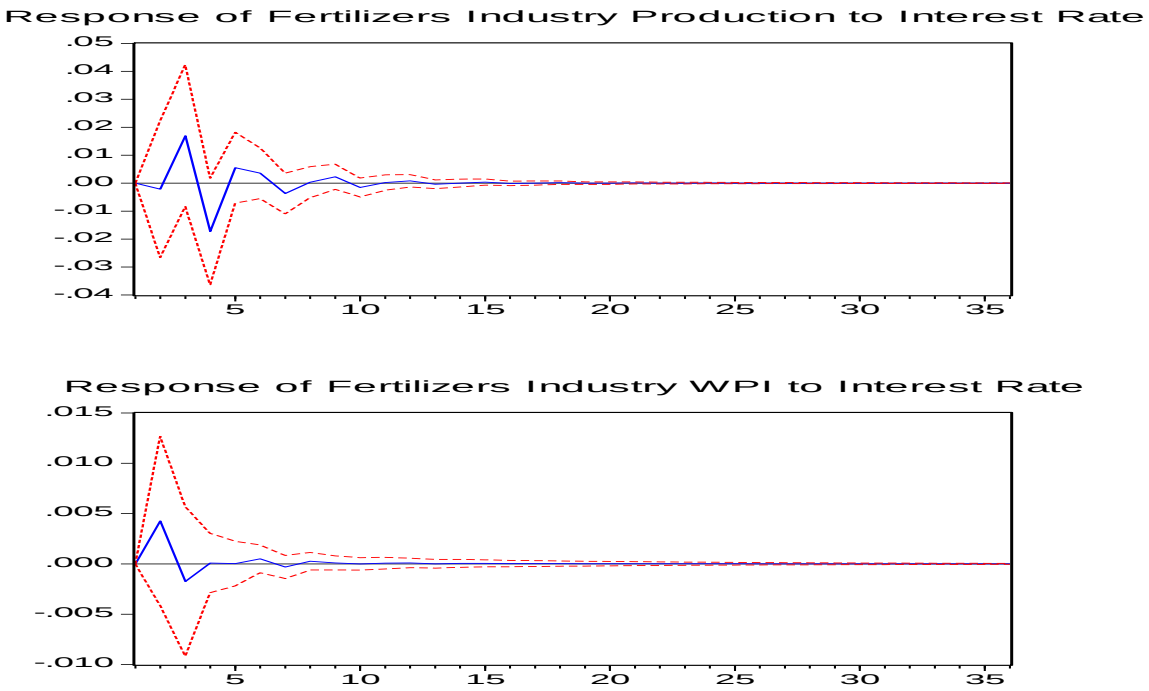
[7] It must be noted however that the results are surprising in the sense that automobile industry takes advance payment for delivery of new car.

5.2.6 Response of fertilizer industry to monetary policy shock

Availability of fertilizers is very important for the timely cultivation of crops. Farmers need loans to finance fertilizers for the production of their crops. However, producers also require credit to increase the production of fertilizers commodities. Therefore, it is expected that the industry will be confronted to both demand and supply channels of monetary authorities.

Figure 5.7 indicates that fertilizer industry has sensitivity to interest rate shock, i.e., cost channel works significantly. Price increases after one standard deviation shock to interest rate along with a decrease in output; however, price increase is more prominent and large as compared to output decrease. It implies that short-term financing has an important contribution in the production of fertilizer industry. We know that fertilizers demand is a seasonal phenomenon for which time constraint is very important. Producers have to borrow to provide fertilizers to farmers on time due to its inelastic seasonal demand in the economy. Because of inelastic demand of fertilizer products, producers have no fear to transfers high costs of production to consumers while not affecting their output too much. Shock to monetary policy decreases the output of a fertilizer industry, but that decrease is very marginal and recovers quickly. Too much increase of prices may be due to high demand of fertilizers in agriculture sectors as observed in the last decade.

FIGURE 5.7 RESPONSES OF FERTILIZERS INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK



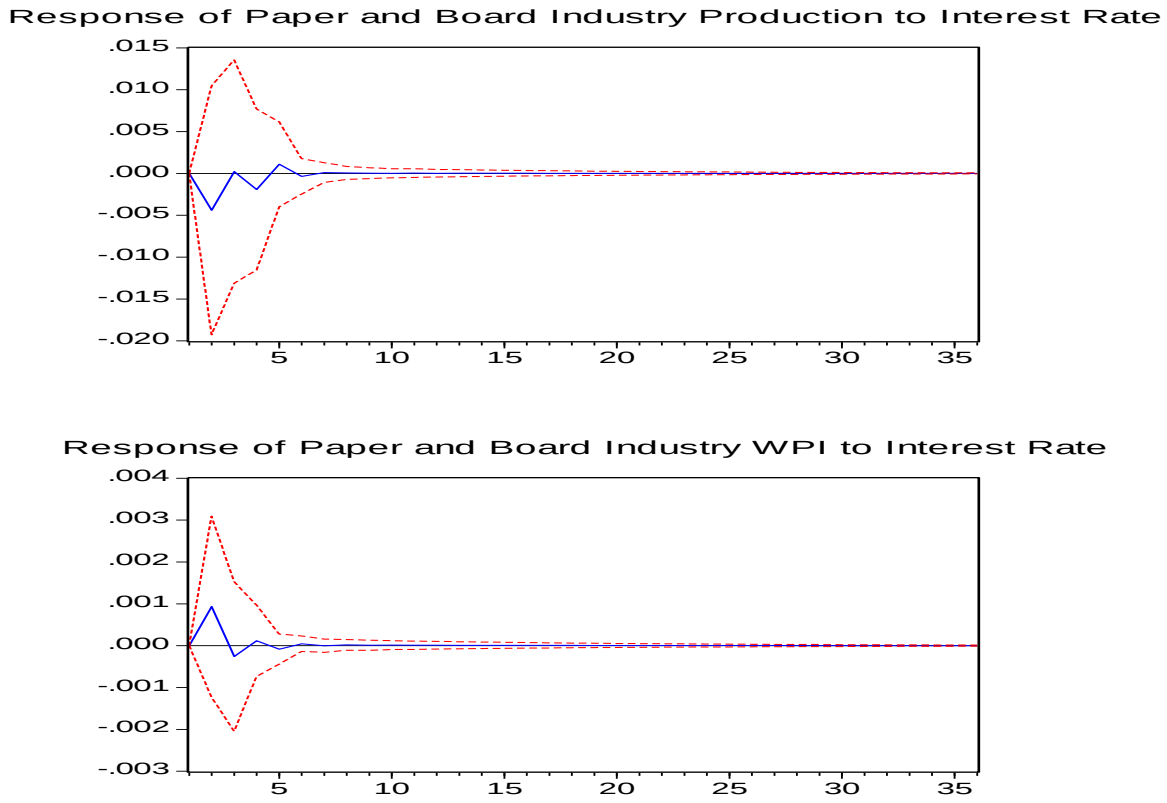
5.2.7 Response of paper and board industry to monetary policy shock

The industry of paper and board is heavily dependent on the availability of operating liquidity, because many small-scale industries even borrow from an informal market to purchase raw materials. The share of daily wageworkers is high in paper and board industry as compared to other industries of manufacturing sectors. The producers have to pay the wage bill and other expenses before they receive revenue.

The results in figure 5.8 clearly show the existence of cost channel of monetary policy. After a one-unit positive shock to interest rate, prices rise immediately along with a decline in output due to high cost of borrowing. Small-scale domination in the paper and board industry also limits its ability to borrow from financial market. Therefore,

producers rely on informal loans with a high cost of borrowing from the market. Producers respond to high cost by lowering its production and increase their prices. Output declines and converge to its normal production after six months of the shock. However, prices take less time compared to output to come back to its standard pace.

FIGURE 5.8 RESPONSES OF PAPER AND BOARD INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK

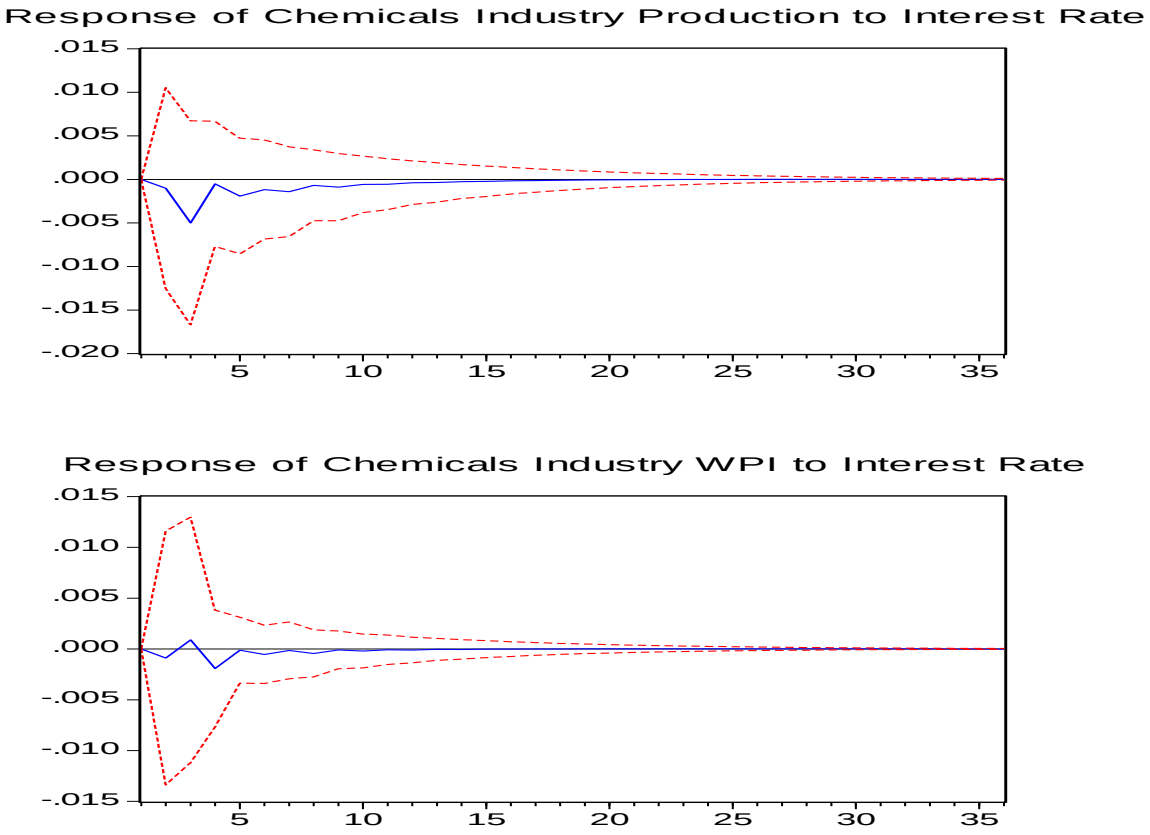


5.2.8 Response of chemical industry to monetary policy shock

The only industry of the manufacturing sector where traditional demand channels dominate the supply channel is the chemical industry. Chemicals industry output generally depend on the demand of other industries products. The demand of polishes and creams, paints and vanishes, etc., are related to the conditions of construction and other industries. The recession of the last decade leads to low level of construction in the

housing sector that also decreases the demand of chemical industry products. The operation of the demand channel is also evident from the figure 5.9 where output level falls along with prices after a shock to short-term interest rate.

FIGURE 5.9 RESPONSES OF CHEMICAL INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK



5.2.9 Responses of Remaining Manufacturing Industries to Monetary Policy Shock

In this section, the impulse responses of other industries to monetary tightening are presented. In these industries, either demand channel dominates the supply channel or responses are completely different from the demand and cost channels. The impulse response functions of these industries are presented in APPENDIX-II. The first one is the

metal industry, where a result opposite to both demand and cost side effects of monetary tightening exists. The graph highlights that both output and prices increases in response to one standard deviation shock to monetary policy. In electronic industry, output increases with a decrease in the price level. Result like this is very strange; however, the possible explanation may be the competition that Pakistan's electronic industry faced from Chinese industries. Because of cheaper availability of foreign goods and high level of domestic demand, producers have the opportunity to exploit this situation by increasing its production, which ultimately leads to low level of prices. It is happening to the leather, Rubber, and Tyres industries of the economy as well. Engineering industry also exhibits strange response after a monetary control, output increases next to price level. It may be due to the low working capital requirements, high demand, and less dependency on short-term financing requirements of the industry.

6. CONCLUSION AND POLICY IMPLICATIONS

This study made an empirical attempt to test the cost channel of monetary policy for Pakistan's economy. We have first estimated the model at the aggregate level of manufacturing production to test that whether "Price Puzzle" prevails in the large-scale manufacturing sector of Pakistan or not. Applying a Structural Vector Autoregression (SVAR) using data over the period 2001:M7 to 2008:M4 with standard identifying structural assumptions, the results confirm the existence of supply side effects of monetary transmission. It is evident from the figures that 85% private credit in fiscal year 2008-2009 is absorbed by this sector of the economy. Following a monetary contraction, aggregate output falls and aggregate price level raises, this reveals that "Price Puzzle"

exists in Pakistan's economy. The results further highlight that both output and prices respond very quickly to monetary contraction, but it's dynamic also becomes zero very rapidly to converge to the equilibrium level.

We also tested that which industry has more contribution in the cost channel by studying each industry response to monetary surprise. The industries where "Price Puzzle" exists are textile, food and beverages, pharmaceuticals products, automotive products, fertilizers, paper and board. The textile industry requires an outstanding amount of loan at the time of harvest to finance its raw materials for the whole year. It also relies on debt to finance its daily wageworkers and exports. Due to consumers' inelastic demand for food products, producers have the opportunity to finance their working capital at high cost by shifting easily the effect of increased cost of production to consumers. Same is happening to pharmaceuticals industry. Domestic producers of automobile industry import major portion of raw materials from international market. It requires time availability of short-term loans to finance these raw materials. However, high cost of borrowing since 2003 has decreased their ability of imports, which badly hurt domestic automobile industry. There is also high seasonal demand of fertilizer products; which allow producers of the industry to transfer easily high costs of production to consumers. So, fertilizer industry even buys at high rate to meet the local demands. Small-scale industry domination in the paper and board products also limits its ability to borrow from financial market that affects its production ability. Therefore, producers rely on informal loans at high rate of interest. Short-term financing is an essential component of production of the above

mentioned industries, with a high cost of borrowing; these industries will definitely reduce their demand for working capital and hence will decrease their production level.

Industries like petroleum products, chemicals products, metals products, electronic products, leather products, engineering, tyres-tubes, have either depicted responses to monetary contraction where traditional demand channel of monetary policy dominates the supply side effects, or strange response observed against the above two channels. Due to high domestic demand of petroleum products and its limited dependency on short-term loans, strict monetary policy does not have much influence on its production and price level. In the industry of chemicals, demand effects of monetary tightening dominated the cost side effects of monetary transmission, because the demand of chemicals products are depending on the health of construction industry, which is in recession since last decade. However, the remaining industries show strange results against demand and cost channels.

Several policy implications come into sight from our analysis. The "Price Puzzle" clearly exists in the overall large scale manufacturing sector of the economy. Monetary authorities must take into considerations the possibility of cost channel of monetary transmission in the manufacturing sector, when it is going to pursue a tight monetary policy. Some important industries of the manufacturing sector like textile, food and beverages, pharmaceuticals, fertilizer, paper and board showed dependency on short-term operating liquidity. The cost channel is more pronounced and dominant in these industries, and as we know that the share of these industries in the total production is very

high, due to which “Price Puzzle” has observed in the aggregate manufacturing sector of the economy. Monetary authorities should consider and take special care of these industries when pursuing its contractionary policy to control high level of inflation. Monetary policy makers should announced special incentive for the above-mentioned industries on loans when they perceive the respective policy. Otherwise, it would not possible for them to control inflation in the short run.

Production and prices of manufacturing sectors also depends on number of other exogenous shocks including oil price shocks, exchange rate shocks, expectations about inflation shocks, food prices shocks, domestic demand shocks, etc. We have not included any of these shocks in our estimation due to data and time constraint. However, future research should consider it, while studying the supply side effects of monetary policy.

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APPENDIX-I

QUANTUM OR QUANTITY INDEX NUMBER

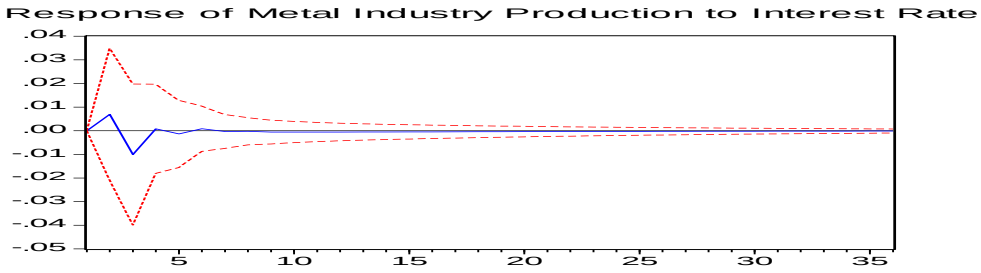
Quantum Index Number intends to measure the changes in the physical volume or quantity produced, consumed, or sold of certain goods and services with respect to time. The index is computed using the weighted arithmetic mean of quantity relatives $\left[\frac{q_n}{q_0}(w)*100\right]$, where "$q_n$"denotes the quantity of a product in the given period and "q_0"denotes the corresponding quantity in the base period (1999-2000=100 for this study), which measures the corresponding changes in quantity, with weights "w" being allotted to various items in proportion to value added in manufacturing industry. The final aggregate index is obtained by weighted relative quantity-index, as defined:

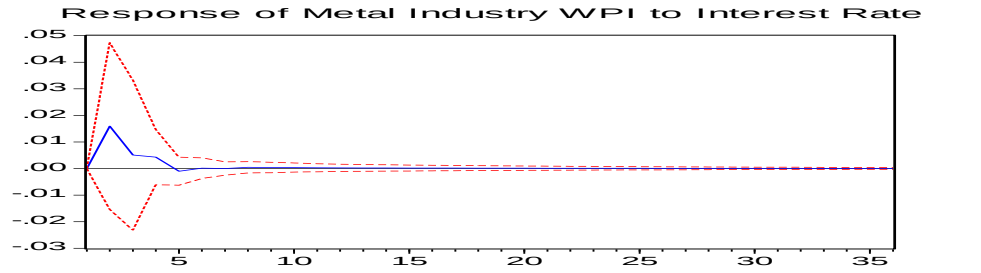
$$IMI = \frac{\sum(W_i Q_{it})}{\sum W_i}$$

Where "IMI" is the Index of Manufacturing Industries, "Q_{it}" is the Quantity or production relative of the ith item for the respective month in question, and W_i is the weight allotted to the ith item based on total output.

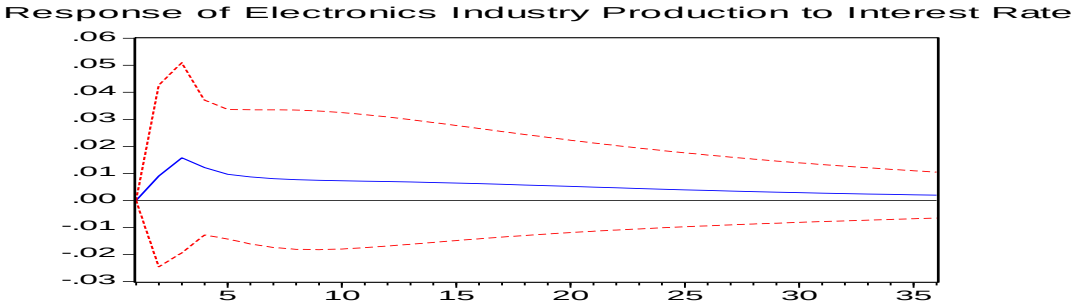
APPENDIX-II

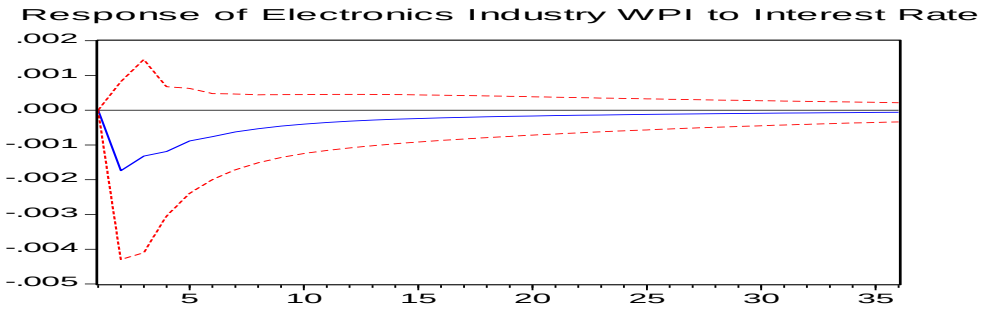
RESPONSSE OF METAL INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK WITH SVAR RESTRICTIONS



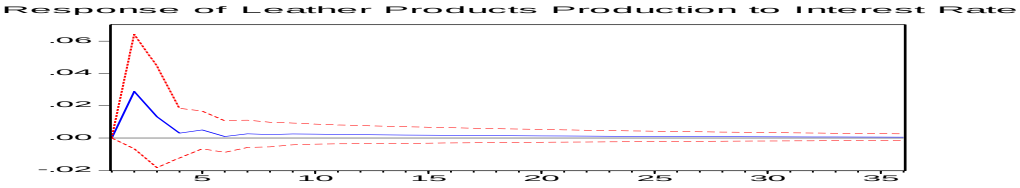


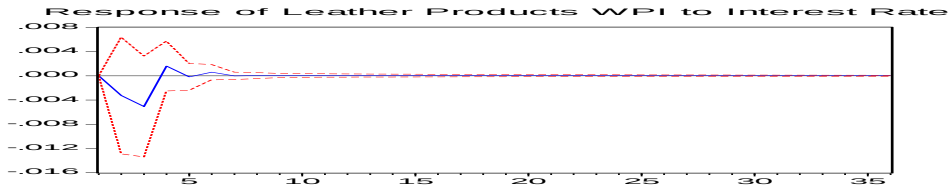
RESPONSES OF ELECTRONIC INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK



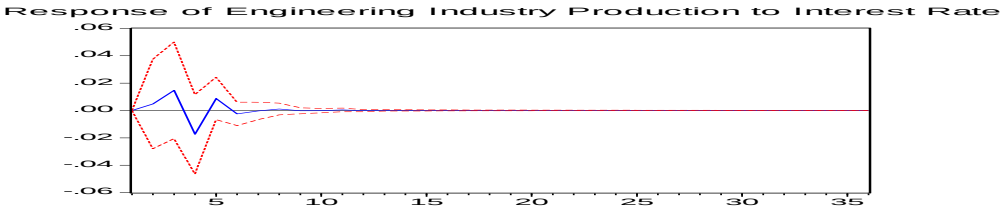


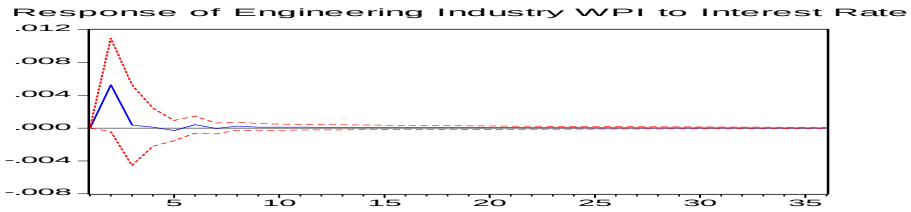
RESPONSES OF LEATHER PRODUCTS INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK





RESPONSES OF ENGINEERING INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK





RESPONSES OF RUBBER AND TYRES INDUSTRY PRODUCTION AND WHOLESALE PRICE INDEX TO INTEREST RATE SHOCK