Effectiveness of the Exchange Rate Channel in Monetary Policy Transmission in Pakistan

FAYYAZ HUSSAIN and MEHAK EJAZ

The exchange rate is one of the most important channels of monetary policy transmission to the real economy. However, the effectiveness of this channel depends on the extent of exchange rate flexibility, degree of international capital mobility, and inflation expectations. Like other emerging economies, Pakistan is typically characterised by weak fiscal and monetary institutions, currency substitution, liability dollarisation, and vulnerability to sudden stops of capital flows. These features compel emerging economies to follow managed exchange rate regimes by restricting the mobility of capital flow. All these factors weaken the effectiveness of the exchange rate channel of monetary policy transmission. This study estimates the effectiveness of the exchange rate channel in monetary policy transmission in Pakistan and explores the impact of exchange rate regimes on the channel's strength. The study benefitted from the widely used structural VARs methodology and found that the exchange rate channel is less effective in transmitting monetary policy shocks to the real economy. In recent years, however, greater flexibility in the exchange rate has improved the effectiveness of this channel.

1. INTRODUCTION

Monetary policy is one of the important aggregate demand management tools to smooth business cycle fluctuations in the economy. One of the essential channels of monetary policy transmission to the real economy is the exchange rate (Mishkin, 1995). Monetary policy shock affects exchange rate, which, in turn, impacts aggregate demand through different channels such as trade, financial, and fiscal channels.

Monetary policy transmission is relatively weak in developing countries relative to developed countries (Mishra and Montiel, 2013). One of the reasons for less effective monetary policy in these economies is the typical characteristics that make them suffer from fear of floating and, therefore, fixation or stabilisation of exchange rates. These characteristics include but are not limited to weak fiscal and monetary institutions, currency substitution, liability dollarisation, and vulnerability to sudden stops of capital flows (Calvo and Mishkin, 2003). The fixation/stabilisation of the exchange rate weakens the working of the exchange rate channel of monetary policy transmission (Kami, 1997).

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Being a small open economy, Pakistan is also vulnerable to sudden stops of capital flows, foreign liabilities of the government far exceed her foreign assets, and monetary and fiscal institutions have yet to develop fully. In this backdrop, the exchange rate is allowed only limited flexibility that might have weakened the effectiveness of monetary policy transmission in Pakistan through a weak exchange rate channel.

In recent years, however, many emerging economies that moved to using interest rates as operational targets under inflation targeting regimes are allowing greater flexibility in the exchange rate (Brandao-Marques, et al. 2020). Allowing greater flexibility in exchange rate bodes well for gaining monetary autonomy and enhancing the effectiveness of monetary policy transmission (Li and Tsai, 2013). Since Pakistan also intends to switch to flexible inflation targeting regime, the State Bank of Pakistan has announced adopting a market-based flexible exchange rate regime from May 2019.[1]

Moreover, SBP has further liberalised foreign exchange controls related to trade and investment policies from February 2021. SBP has revised its foreign exchange manual to facilitate start-ups, fintechs, and exports.[2] To facilitate business where foreign exchange approvals are required, SBP has launched an online portal to provide such approvals. In collaboration with commercial banks, SBP has also successfully launched Roshan Digital Account (RDA) for non-resident Pakistanis from 10th September 2020.[3] These accounts provide innovative banking solutions for non-resident Pakistanis to invest in real estate, stock exchange, Naya Pakistan certificate, and pay utility bills. These measures are likely to integrate Pakistan with the global financial system. Global financial integration strengthens the exchange rate channel of monetary policy transmission (Gudmundsson, 2008; Meier, 2013).

Against this backdrop, the objective of this study is twofold. First, to assess the effectiveness of the exchange rate channel in monetary policy transmission in Pakistan, and second how this effect changes with the episodes of greater flexibility in the exchange rate. This study is different from the previous studies in the following respects. First, this study considers exchange rate regimes while estimating the effectiveness of the exchange rate channel of monetary policy transmission. Second, international economic environment is taken into account by controlling for global economic growth, global interest rates, and world food prices. Third, we also controlled for public sector borrowings from the banking system to acknowledge the impact of fiscal dominance on monetary policy.

The results show weak transmission of monetary policy shock through the exchange rate channel. Working of the exchange rate channel is, however, better during the episodes of greater exchange rate flexibility. The study also finds that the exchange rate channel is more effective in impacting inflation than domestic economic activity. This reflects the impact of pass-through of exchange rate changes to domestic prices through imported items in the consumer basket and inflation expectations. In particular, one standard deviation appreciation in exchange rate reduces inflation by about 30 basis points.

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[1]Pakistan Request for an Extended Arrangement Under the Extended Fund Facility-Press Release; Staff Report; and Statement by the Executive Director for Pakistan: https://www.imf.org/en/Publications/CR/Issues/2019/07/08/Pakistan-Request-for-an-Extended-Arrangement-Under-the-Extended-Fund-Facility-Press-Release-47092

[2]FE Circular No. 01 of 2021 at https://www.sbp.org.pk/epd/2021/FEC1.htm. Background note is placed at https://www.sbp.org.pk/press/2021/Pr1-10-Feb-21.pdf

[3]https://www.sbp.org.pk/press/2021/Pr-10-Feb-21.pdf

The rest of the study is organised as follows. Section 2 discusses the theoretical background, section three reviews the literature followed by a section on exchange rate history in Pakistan. Section five elaborates methodology, and section six describes data. Section seven discusses the results, and the last section concludes the study.

2. THEORETICAL BACKGROUND

The exchange rate channel of monetary policy works through the interest rate parity condition. Specifically, when the central bank lowers policy rates, the return on domestic assets falls relative to foreign assets. This makes foreign assets more attractive, in turn, putting pressure on local currency (Kamin, 1997). This exchange rate depreciation makes domestic goods cheaper than foreign goods, thereby leading to expenditure switching and a rise in net exports and the overall level of aggregate demand (Mishkin, 1995).

However, a part of this trade channel of the exchange rate may be offset by adverse balance sheet effects in the presence of large debt in foreign currency. A depreciating exchange rate may weaken borrowers (whose foreign liabilities exceed foreign assets) net worth, limiting their ability to borrow and contracting economic activity (Krugmen, 1999, Céspedes, Chang & Velasco, 2004; Avdjiev, Bruno, Koch & Shin, 2019).

Two things are essential for the exchange rate channel of monetary policy transmission to work. First is the degree of reaction of the exchange rate to monetary innovations, and second is the extent of responsiveness of economic activity and prices to movements in the exchange rate. The response of the exchange rate to changes in interest rates would be higher provided there is greater substitutivity between domestic and foreign assets (Kamin, 1997). For instance, despite the policy rate in Pakistan remaining around 20 percent in FY-1997, far above the interest rate on the foreign bonds of the same tenor, Pak Rupee witnessed depreciation. This counter-intuitive response of the exchange rate to policy-induced increase in interest rate shows weak substitutivity between domestic and foreign bonds, probably on account of the low level of foreign exchange reserves and the consequently higher risk premium. Lastly, even if international capital flows are sensitive to shocks to policy rates, fixation or heavy management of exchange rate weakens the effectiveness of monetary policy transmission through this channel (Kamin, 1997).

The second important link for the exchange rate channel's effectiveness is the exchange rate's impact on economic activity and prices. The impact of the exchange rate on economic activity depends on the elasticities of exports and imports to exchange rate movement. If the absolute sum of price elasticity of exports and imports is higher than one (Marshall Lerner Condition), then exchange rate depreciation (appreciation) will increase (decrease) net exports and, thereby level of aggregate demand (Robinson, 1937). Along with the exchange rate sensitivity, the effect of the exchange rate on domestic economic activity also depends on the degree of openness of an economy. The exchange rate channel is expected to be more effective in the case of a more open economy (Brandao-Marques, 2020). The effectiveness of the exchange rate channel in the transmission of monetary policy depends on the nature of exchange rate regimes followed and the degree of openness of the economy. For instance, Bryant, Hooper, & Mann (2010), Taylor (1993), and Smets (1995) found that smaller and more open economies tend to see more significant effects through this channel.

Along with aggregate demand, the exchange rate also directly impacts domestic costs through increased prices of imported consumer goods. This is also called the exchange rate pass-through to domestic prices. Exchange rate pass-through is likely to be higher if the consumption basket contains a large number of imported goods. In case prices of imported items are administered by the government, the exchange rate pass-through on domestic prices will be weaker.

The exchange rate pass-through is typically higher in a high inflation environment (Taylor, 2000). In high inflation countries, exchange rate movement is considered an essential signal of future price movement, and wages & prices may change even before the movement in import costs through the cost structure (Kamin, 1997).

The strength of the exchange rate channel of monetary transmission is expected to be negatively impacted if foreign liabilities of government, financial and non-financial firms exceed their foreign assets (Krugman, 1999). For example, with a large share of external liability (external debt), exchange rate depreciation would increase the government's foreign liabilities, reducing the government's net worth. Exchange rate depreciation will also increase the external debt servicing costs of the government. As a result, the sovereign risk premium will increase. These will constrain the government's ability to raise external funds by issuing bonds in the international market. As a result, aggregate demand and prices will be negatively affected. Same holds true for firms and the financial sector whose foreign liabilities are greater than their foreign assets.

To sum up, for the effectiveness of the exchange rate channel of monetary policy transmission, in the first step, interest rate changes must impact the exchange rate. If domestic assets are imperfect substitutes of foreign assets, the central bank intervenes in the foreign exchange market to manage the exchange rate, and capital are less mobile across the border, then the exchange rate will be less responsive to changes in interest rate. In the second step, changes in the exchange rate must affect aggregate demand through net exports. However, higher external debts of the business and the government will adversely impact the strength of the monetary policy exchange rate channel. Apart from the indirect impact on aggregate demand, prices are also affected directly by the increase in prices of imported goods in the CPI basket. This direct exchange rate pass-through is swifter in a high inflation environment (Taylor, 2000).

3. LITERATURE REVIEW

Mishra, et al. (2013) survey empirical literature on the effectiveness of monetary policy transmission in developing countries. They find that monetary policy transmission is relatively weak in developing countries relative to developed countries. One of the reasons for less effective monetary policy in these economies is the acute stabilisation of the exchange rate that weakens the working of the exchange rate channel of monetary policy transmission.

In the case of Pakistan, there are very few studies on the monetary policy transmission channels in general and the exchange rate channel in particular. These studies do not have a consensus on the effectiveness of the exchange rate channel of monetary policy in Pakistan. Most noticeable amongst those is Agha, et al. (2005). Using monthly data from July 1996 to March 2004, they find that Pakistan's exchange rate channel is not robust. Their findings suggest that the credit channel is

the most dominant monetary transmission in Pakistan. However, using monthly data from January 1964 to December 2007, Hussain (2009) shows that the exchange rate channel also plays a vital role in monetary policy transmission in Pakistan. In a relatively more recent paper, Nizamani, et al. (2015) find the exchange rate channel as the least important for monetary policy transmission in Pakistan. They use quarterly data from Q1-1996 to Q4-2012.

Apart from the overall exchange rate channel, literature on its components is also rare. For instance, for the exchange rate channel to work, changes in the policy rate should impact the exchange rate. The relationship between exchange and interest rates is investigated by testing the interest rate parity condition. If interest rate parity holds, then changes in policy rate do affect the exchange rate. For Pakistan, we can find only two studies that tested the interest rate parity condition. First is by Singh and Banerjee (2006). Their results show that real interest rate parity does not hold for emerging economies, including Pakistan. The second study by Omar, et al. (2013) tests interest parity conditions for Pakistan only. Using monthly data from January 2001 to December 2008, they show that the interest parity condition holds for Pakistan.

The second important step in the exchange rate channel of monetary policy transmission is the responsiveness of net exports to changes in the exchange rate. The effectiveness of exchange rate depreciation in improving net exports depends on the Marshall Lerner condition. In Pakistan, there is no final agreement on whether the Marshall Lerner condition holds or not. Shazad, et al. (2017) test Marshal Lerner condition for seven south Asian countries. Their estimates indicate that the Marshall Lerner condition does not hold for these economies as the absolute sum of the price elasticity of imports and exports is less than one. Iqbal, et al. (2015) test Marshall Lerner condition in bilateral trade between Pakistan and its ten trading partners. Their results indicate that the Marshall Lerner condition holds with six of the trading partners, and there is no evidence of the condition for the remaining partner.

Apart from the indirect impact of aggregate demand, the exchange rate also directly impacts prices through an increase in prices of imported goods. Here are some studies that estimated the impact of exchange movements on inflation. McCarthy (2000) find that exchange rates have a modest effect on domestic price inflation, while import prices have a more substantial effect. Ehsan and Hakura (2006), using a panel of 71 countries from 1979–2000, show strong evidence of a positive and significant association between the pass-through and the average inflation rate across countries and periods. Michele, et al. (2007) examine the degree of Exchange Rate Pass-Through (ERPT) to prices in 12 emerging markets in Asia, Latin America, and Central and Eastern Europe. Their results show that exchange rate pass-through into both import and consumer prices is always higher in "emerging" than in "developed" countries.

Regarding literature on Pakistan, Hyder and Shah (2005) main findings are: (1) the exchange rate movements have only a moderate effect on domestic prices, i.e., exchange rate pass-through is low, (2) the exchange rate pass-through is more substantial in wholesale price index (WPI) relative to consumers price index (CPI) and (3) the impact of pass-through on domestic prices spreads over 12 months. In another study on Pakistan, Ahmad and Ali (1999) emphasise that the empirical work in Pakistan provides

unwavering proof that the domestic price level responds significantly but gradually to exchange rate devaluation. All these studies show low to moderate pass-through of exchange rate changes on domestic prices. This probably reflects a relatively lower share of imported items in the CPI basket. Further, the government determines the prices of a considerable number of imported CPI items. In short, existing literature shows that exchange rate channel of monetary policy transmission is weak.

4. HISTORY OF EXCHANGE RATE IN PAKISTAN

Pakistan came into existence on 14th August, 1947. At that time, the exchange rates of the International Monetary Fund (IMF) members were fixed under the Bretton Woods system. Under this system, every member country was required to fix its exchange rate to Gold, and IMF filled temporary imbalances in the balance of payments. As per the best global practices, Pakistan also followed fixed exchange rate regimes in the first decades. By March 1973 Bretton Woods system was broken, and member countries were free to float the exchange rate. After the breakdown of the Bretton Wood system, most of the economies moved from fixed exchange rates to floating exchange rate regimes. The regime shift resulted in significant fluctuation in the exchange rate in these countries. With much volatility in the exchange rates of trading partners and global oil prices, Pakistan had to make a big adjustment in the exchange rate. However, Pakistan continued with the fixed exchange rate regime till 1982.

**Fig. 1. History of Exchange Rate Regimes for Pakistan**
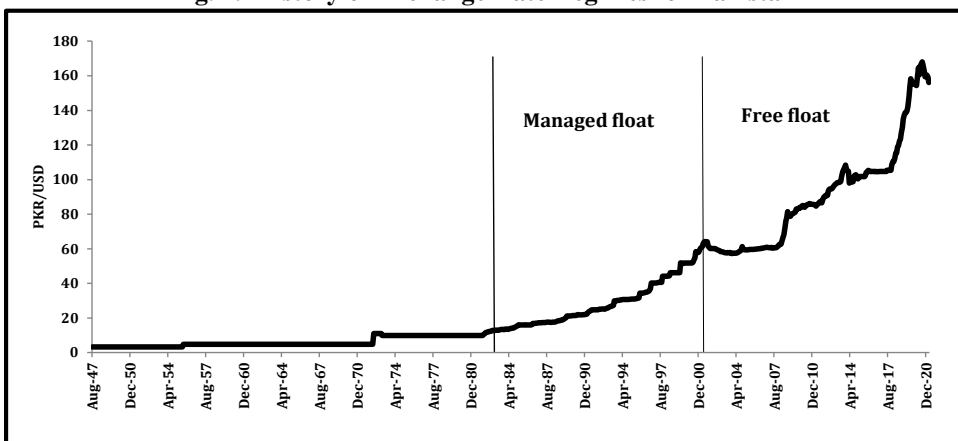
With the difficulties in managing the balance of payments position, Pakistan approached the International Monetary Fund and signed the Extended Fund Facility (EFF) programme in 1981. As per IMF advice under Article IV consultation, Pakistan was asked to adjust its exchange rate significantly. Pakistan had two options, either to make a onetime adjustment or gradual adjustment on a daily basis. Pakistan opted for the second option and shifted to managed float in January 1982. Under this regime, the exchange rate was set on a day-to-day basis, keeping in view (i) exchange rate movements of Pakistan's fourteen major trading partners, (ii) exchange rate movement of 32 major export destinations of Pakistan, and (iii) exchange rate movement of export

competing countries. Pakistan followed managed float till mid-2000. After the nuclear blasts in May 1998, Pakistan switched to a dual exchange rate regime for a short time. In July 2000, Pakistan switched to a free float exchange rate regime and is officially following this regime till now. In this regime, the State Bank of Pakistan intervenes in the foreign exchange market from time to time to smooth unnecessary volatility and quell speculative attacks on the exchange rate. For instance, with the substantial capital inflows after 9/11, the State Bank of Pakistan purchased foreign exchange from the interbank market to avoid abrupt appreciation in the exchange rate. Likewise, in case of a temporary shortage of foreign exchange in the interbank market, the State Bank of Pakistan sells foreign exchange in the market.

In this background, market forces had a relatively limited role in exchange rate determination till 2000. This implies monetary policy shocks or changes in policy rate might have had a limited influence on the exchange rate at least before 2000. A simple plot (Figure 2) of the policy rate in Pakistan and the United States shows that monetary policy did not explain much of the movement in the exchange rate before 2000. For instance, in the 1990s, the policy rate increased to around 20 percent. This should have appreciated the exchange rate. Conversely, the exchange rate depreciated from about 22 rupees per dollar to 40 rupees per dollar in the same period.

Fig. 2. Exchange Rate and Policy Rates
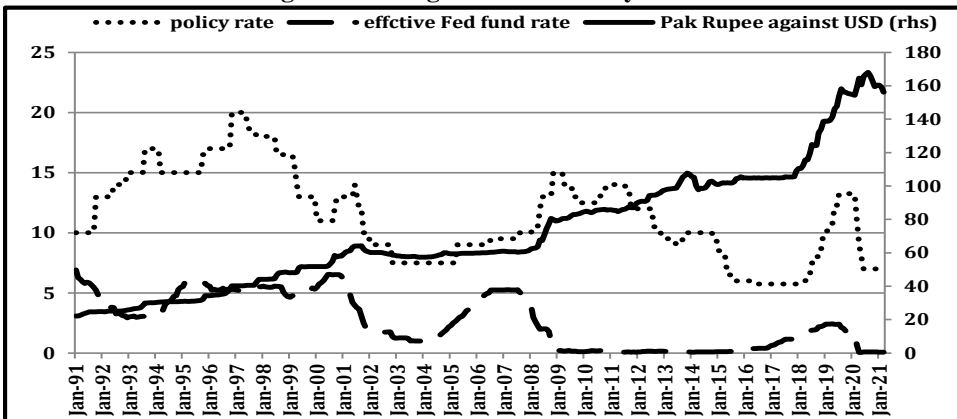
However, after the adoption of the free-floating of the exchange rate in 2000, market forces role has increased in the determination of the exchange rate. This becomes even clearer when we look at the rolling correlation between the interest rate differential between the policy rate of Pakistan and the world proxied by the federal fund rate of the United States. The correlation coefficient between the interest differential on the two currencies and the exchange rate was positive before 2000 (Figure 3). This was counter-intuitive. As per the prediction of interest rate parity condition, the interest rate differential between the local and foreign currencies should be negatively associated with the exchange rate movements. From 2000 onward, this prediction appears correct. However, this association weakened in the post-2008 period, which probably reflects an increased risk premium on the local currency due to the balance of payments crises. The correlation coefficient again turns negative after 2016.

Fig. 3. Rolling Correlation between Exchange Rate and Interest Rate Spread

Fig. 4. Defacto Exchange Rate Regime

Hard peg = 1
Crawling Peg = 2
Managed Float= 3
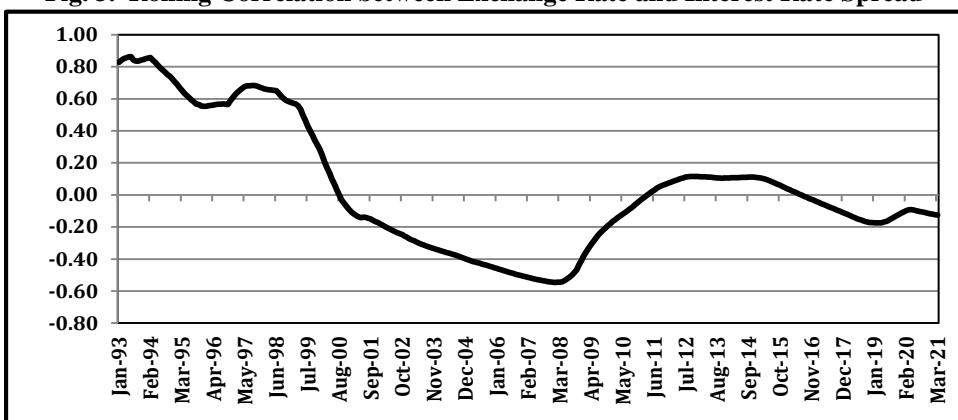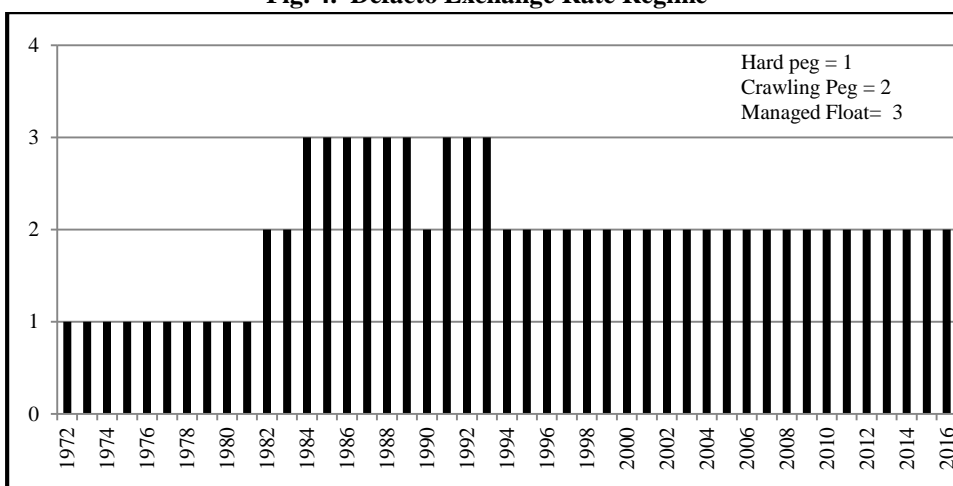
Apart from the flexible exchange rate, the introduction of FE-25 foreign currency deposits from 1999 onward might also have contributed to the increased sensitivity of exchange rate changes to interest rate differential. With the increase in the policy rate, the interest rate on local currency deposits increases relative to foreign currency deposits. This increases demand for local currency relative to foreign currency, which leads to an appreciation of the local currency. However, expectations of exchange rate depreciation may weaken this link. Specifically, the expected exchange rate depreciation makes foreign currency attractive, which may offset the impact of increased interest rate on local currency deposits. Another possibility for interest rate parity to work is lending against foreign currency deposits. An increase in policy rate increase borrowing costs in local currency; as a result, importers and exporters may increase demand for borrowing in foreign currency against FE-25 deposits. This borrowing against FE-25 deposits will increase the supply of foreign currency in the interbank market, leading to appreciation of the local currency. Other than interest rates, borrowing costs in foreign currency also

include expected exchange rate movements. Expectations of exchange rate depreciation increase borrowing costs in foreign currency that may discourage borrowing in foreign currency and hence limited impact on exchange rate.

Though the State Bank of Pakistan officially follows a free float exchange rate and intervenes in the foreign exchange market only to curb disorderly market conditions, many independent analysts argue that it is not pure free float. For instance, EIlzetzki, et al. (2017) classification of the de facto exchange rate regime suggests that from 1993 onward, Pakistan is following a crawling peg. Despite the fact that Pakistan is officially following free float, it is still categorised in a crawling peg. This excessive stabilisation of the exchange rate may weaken the working of the exchange rate channel of monetary policy transmission in Pakistan.

To address these concerns, the State Bank of Pakistan has announced market-based flexible exchange rate regime from May 2019. Allowing exchange rate flexibility is not only important for keeping the external balances at a sustainable level but would also help SBP gain more independence under inflation targeting regime. Li and Tsai (2013) show that allowing flexibility in exchange rates increases the autonomy of monetary authority.

Other factors that are important for the effectiveness of the exchange rate channels are the openness of the economy. Trade openness, as measured by the ratio of exports plus imports to gross domestic products, fluctuated between 30 to 40 percent. This ratio peaked at 39.9 percent in 1991, and it had again come down to 27.6 percent in 2015. This gradual decline in the openness of the economy might have adversely affected the working of the exchange rate channel of monetary policy transmission in Pakistan.

5. METHODOLOGY

Mishra, et al. (2011), in their survey of literature on the transmission of monetary policy in developing countries, showed that Vector Autoregressive (VAR) has become customary to investigate the effect of monetary policy. Following standard practice in the literature, this study also uses VAR to estimate the impact of the exchange rate channel on monetary policy transmission. This approach has various advantages over other model-based approaches. First, residual in the VAR are pure unanticipated innovations, so they can potentially separate the impact of unanticipated monetary policy shock on the aggregate demand. Second, this takes into account the simultaneity bias between monetary policy variables and real variables like economic activity and inflation, and third, with no serial correlation among the residual of VARs, there is no need to include all the potential determinants of aggregate demand other than the indicators that influence monetary policy decision making of the central bank. This study will use four endogenous variables that include gross domestic product proxied by large-scale manufacturing, consumer price index, policy rate proxied by call rate, and exchange rate. The exogenous variables include global food prices, global gross domestic product proxied by the United States Industrial Production Index, international interest rates proxied by federal fund rate, and fiscal dominance captured by the government borrowing from the banking system. The study uses monthly data on these variables from 1995 to 2020.

The Benchmark *VAR(P)* representation looks as follows:

$$\sum_{i=0}^{p}\phi_i Y_{t-i} = \delta X_t + \epsilon_t \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \quad (1)$$

Where Y_t is the vector of endogenous domestic variables, X_t is the vector of exogenous variables. ϕ and δ are the lag polynomial and ϵ_t represents the vector of structural innovations.

To analyse the dynamic impact of monetary policy shocks on the channeling variable exchange rate and goal variables i.e., output and prices, we discuss the impulse responses. We estimate structural impulse responses by using the Cholesky decomposition of the variance-covariance matrix of the reduced form Vector Autoregressive models.

Following Bernanke and Blinder (1992) identification scheme, monetary policy variables appear last in the Cholesky ordering, assuming that the endogenous macro variables could be observed contemporaneously by the policy-makers. We have used the following specific restrictions. First, any shock to the exchange rate has no contemporaneous impact on all the other variables, but other variables do affect it in the same period. Second, with the transmission lag in monetary policy, nominal policy shocks have no contemporaneous impact on output and prices, but it instantly impacts the exchange rate. Third, consumer prices have zero contemporaneous impact on output, but it immediately impacts policy and exchange rates. Fourth, real shock contemporaneously affects all the variables in the system, but other variables do not impact it. The restriction structure looks as follows.

$$\begin{bmatrix} U^Y t \\ U^P t \\ U^R t \\ U^{ER} t \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^Y \\ \varepsilon_t^p \\ \varepsilon_t^R \\ \varepsilon_t^{er} \end{bmatrix}$$

To estimate the impulse responses, we have used monthly data for Pakistan from January 1991 to December 2020.

6. DATA

Data on consumer price index and large-scale manufacturing is collected from Pakistan Bureau of Statistics (PBS), exchange rate, interest rates and public sector borrowing from the banking system are collected from the State Bank of Pakistan and world food prices, the United States Industrial Production iIndex, United States interest rates are collected from International Financial Statistics of International Monetary Fund.

As we are using data on a monthly basis, essential variables such as large-scale manufacturing and prices depict much seasonality. For instance, large-scale manufacturing usually gains momentum when the sugar crushing season starts. Likewise, consumer prices show variation due to seasonal demand for goods and services in winter and summer. To study the underlying trend of the data, we have seasonally adjusted all the variables except interest rates (discount rate and federal fund rate). To further smooth the data, we have taken a log of all the series except the discount rate and federal fund rate.

6.1. Correlation Analysis

Table A1 in Annexure 1 shows the correlation coefficient of the variables used in the model. Looking at the correlations will give some sense of association between the

monetary policy instrument and other variables relevant for exchange rate transmission. Correlation between some of the important variables is as follow: Policy rate and the federal fund rate are positively associated. This indicates that while policy rate setting, monetary authority in Pakistan also considers world interest rates. Second, the policy and nominal effective exchange rates are also positively associated. This also makes intuitive sense, an increase in policy rate is usually associated with exchange rate appreciation through interest rate parity conditions. The correlation coefficient between the policy rate and large-scale manufacturing is negative. This reflects the contractionary impact of monetary policy tightening on growth. Lastly, the correlation coefficient between the policy rate and inflation is also negative. This indicates that monetary policy tightening is associated decline in prices.

Likewise, consumer prices are positively associated with supply-side factors such as world food prices and global oil prices. On the demand side, prices are positively associated with public sector borrowing and negatively associated with exchange rate appreciation.

6.2. Augmented Dicky Fuller Test

We have applied the Augmented Dicky Fuller Test to test the stationarity of the data. First, we tested the stationarity of the data in levels. As in absolute terms, test statistics of the ADF test are low than its critical value at a five percent level of significance for all the series; we fail to reject the null hypothesis of a unit root. Thus, all the series have unit-roots. Then we applied the ADF test to the first difference of these variables. Now, in absolute terms, the test statistics of the ADF test of all the variables are greater than critical values that imply we reject unit root in these series. As all the series are first difference stationary, these series are integrated of order one. Thus, we have transformed the data accordingly.

Table 1

Summary Statistics

	Observations	Mean	Median	Maximum	Minimum	Std. Dev.	Order of Integration
World food price index	143	0.001	−0.002	0.123	−0.176	0.035	I(1)
US Industrial production index	143	0.000	0.001	0.014	−0.042	0.007	I(1)
Federal fund rate	143	−0.020	0.000	0.250	−1.250	0.184	I(1)
Global oil prices	143	−0.001	0.011	0.242	−0.333	0.091	I(1)
Consumer price index	143	0.002	0.003	0.125	−0.126	0.034	I(1)
Large scale manufacturing index	143	0.007	0.006	0.030	−0.009	0.007	I(1)
Policy rate (call rate)	143	0.023	0.000	3.950	−6.420	0.949	I(1)
Neer	143	−0.006	−0.004	0.039	−0.056	0.015	I(1)
Public sector borrowing from banking system	143	0.018	0.015	0.159	−0.051	0.025	I(1)

Note: All the variables are in log difference form except interest rates that are in simple difference form.

Different lag criteria were giving different optimal lag lengths. Schwarz information criterion chose an optimal lag length of one month, while Akaike information criterion criteria chose a lag length of 12 months. Since one month is too short, we opted for seven months lag.

7. EMPIRICAL RESULTS

The impulse response function shows that one standard deviation unanticipated positive shock to policy rate leads to an appreciation of nominal effective exchange rate. Transmission of this shock is almost complete within twenty months. However, the magnitude of the response of the exchange rate to monetary policy shock appears small and statistically insignificant (Figure 5 c).

Contractionary monetary policy shock hurts growth. Transmission of monetary policy shock on LSM growth takes time to materialise. After showing some oscillations during the first twelve months, monetary policy shock has a permanent contractionary impact on growth from thirteen months onward. The impact becomes statistically significant in almost seventeen to eighteen months (Figure 5 a).

Fig. 5a. Cumulative Impulse Response of Growth to One Standard Deviation Shock to Policy Rate
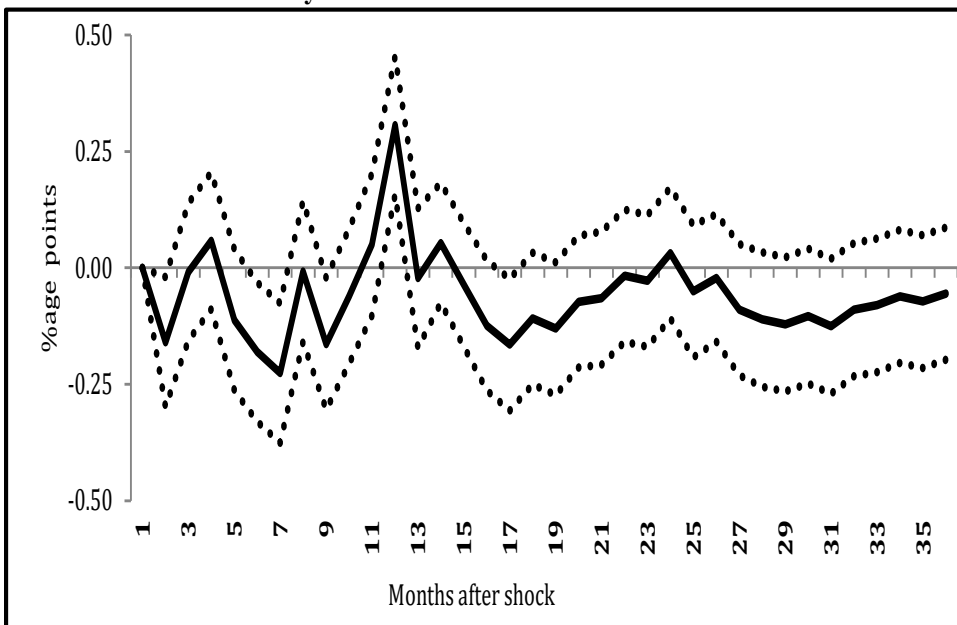
The transmission lag of monetary policy is even more substantial in case of inflation. The impact becomes statistically significant from four months after the monetary policy shock. Monetary shock (normalised to 100 basis points increase in call rate) decreases inflation by around 15 basis points (Figure 5b). The transmission of monetary policy shock to consumer prices is also complete in 24 months.

Fig. 5b. Cumulative Impulse Response of Inflation to One Standard Deviation Shock to Policy Rate
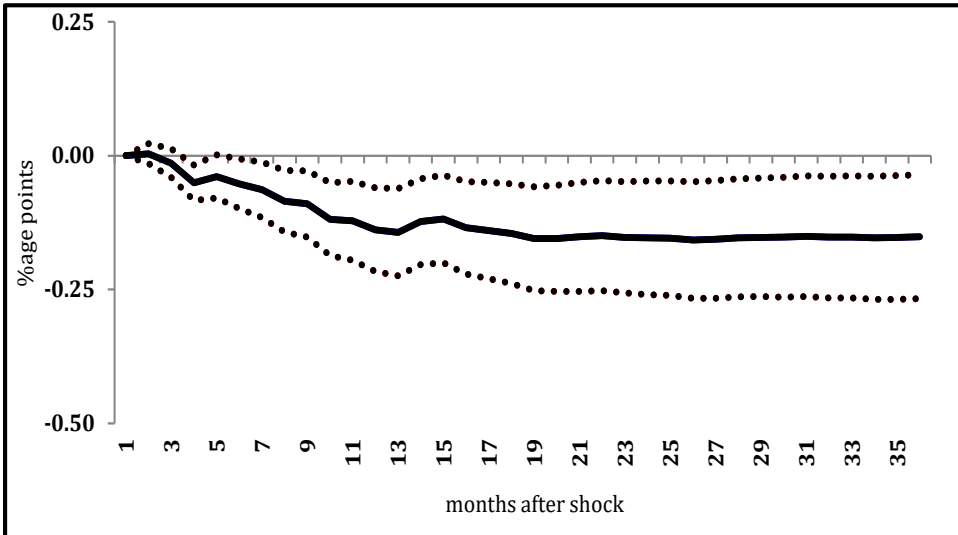
Appreciation in a nominal effective exchange rate (increase in NEER means appreciation) leads to a price fall (Figure 5e). The impact of exchange rate appreciation takes some time to affect the prices. This reflects the downward rigidity in prices. Transmission of exchange rate changes on prices almost stabilised toward the end of the second year. Specifically, one standard deviation positive shock to the exchange rate, reduces inflation by around 30 basis points.

Fig. 5c. Cumulative Impulse Response of NEER to One Standard Deviation Shock to Policy Rate

Hussain and Ejaz
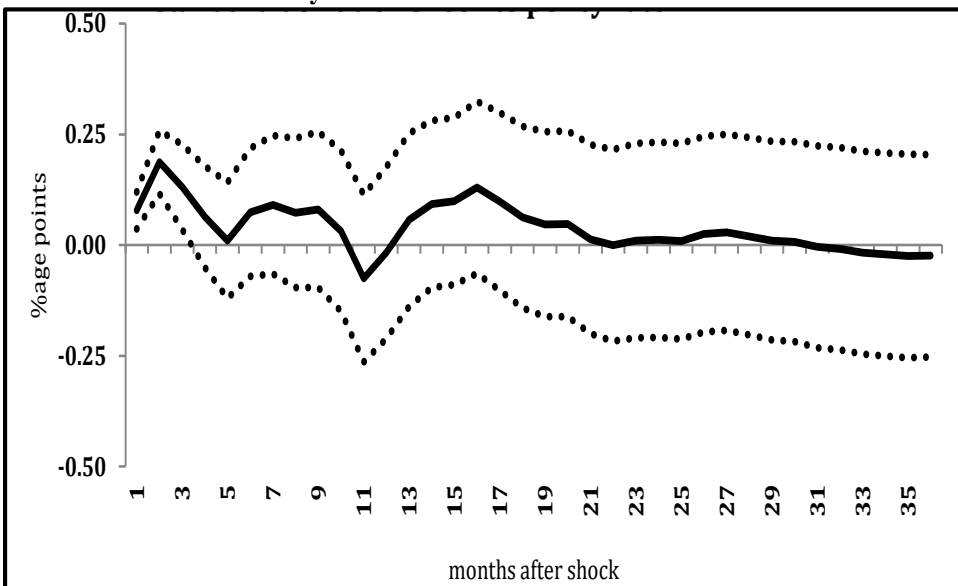
**Fig. 5d. Cumulative Impulse Response of Growth to One Standard Deviation
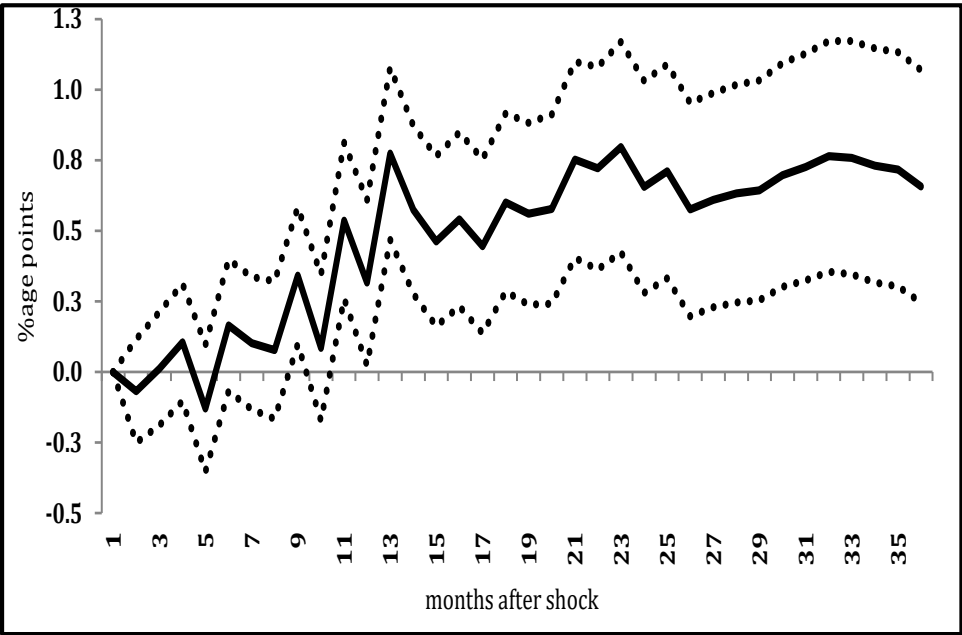   Shock to NEER**

**Fig. 5e. Cumulative Impulse Response of Inflation to One Standard Deviation
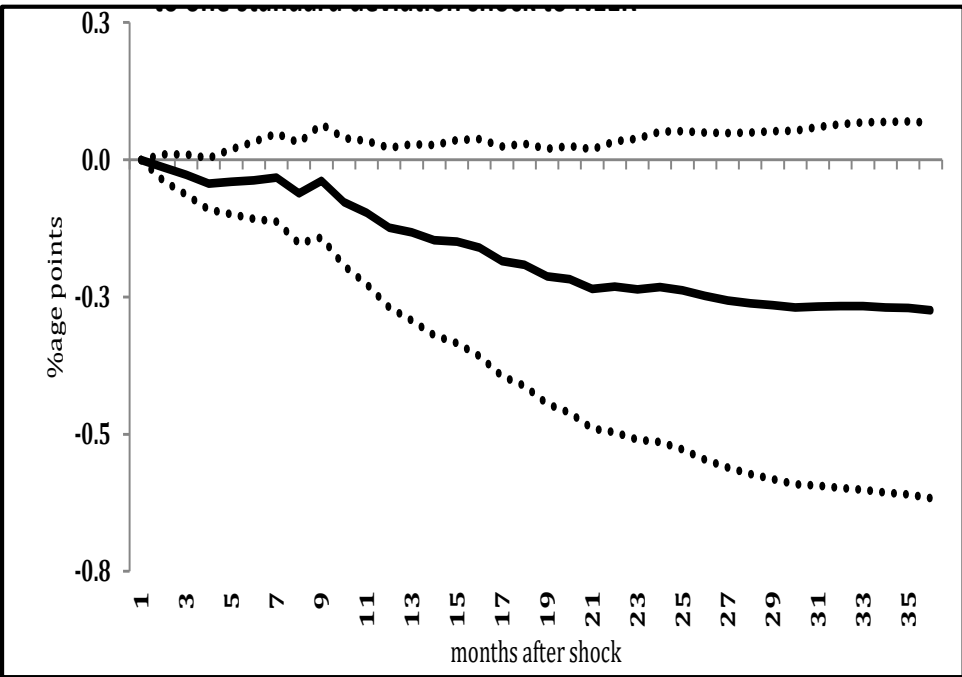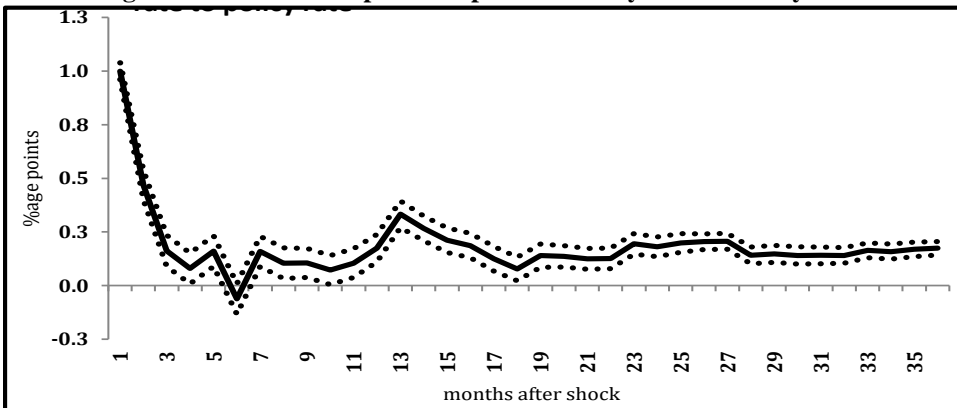   Shock to NEER**

Fig. 5f. Cumulative Impulse Response of Policy Rate to Policy Rate

The impact of exchange rate appreciation on LSM growth appears counter-intuitive. Exchange rate appreciation has a positive impact on LSM growth (Figure 5d). The probable reason for this increase in LSM growth may be explained by the dependence of Pakistan's economy on imports. Specifically, the Pakistan industry is dependent on the import of raw material such as oil, gas, chemicals etc., and machinery to grow. With the appreciation in the exchange rate, these imports become cheaper. The consequent reduction in costs of production of the businesses may explain this increase in LSM production.

7.1. Strength of the Exchange Rate Channel

We have attempted to test the strength of the exchange rate channel in the following way. We ran two regressions, one with the exchange rate channel working and the other with the exchange rate channel shut down. Specifically, in the first case, we have allowed the exchange rate to respond to policy shock and other variables in the system. In the second case, we treated the exchange rate and its potential lags as exogenous variables, i.e., the exchange rate was not allowed to respond to changes in the policy rate and other variables in the system. Then we compared the impulse responses of the two cases.
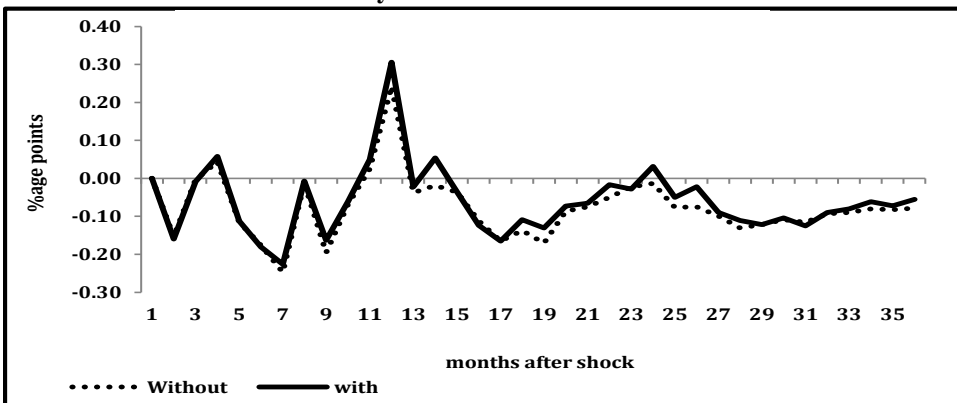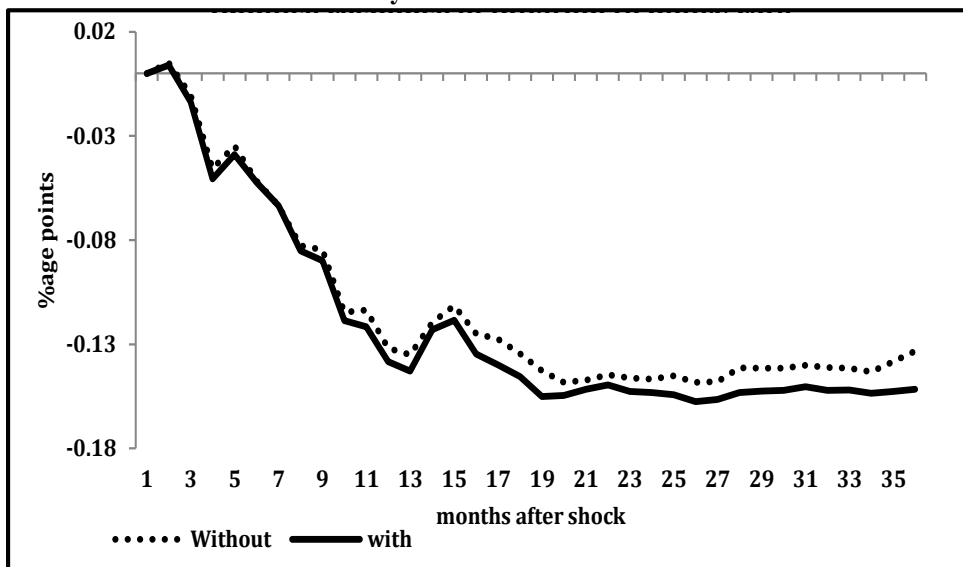
Fig. 6a. Relative Strength of Exchange Rate Channel: Impulse Response of Growth to Policy Rate

**Fig. 6b. Relative Strength of Exchange Rate Channel: Impulse Response
of Inflation to Policy Rate**

The exchange rate channel does not appear effective for large-scale manufacturing growth. The transmission of monetary shocks on LSM growth is similar with and without the exchange rate channel. However, the exchange rate channel appears relatively effective when we analyse the impact of monetary policy shock on inflation. Though the exchange rate has little impact on aggregate demand, as is shown in LSM growth, a stronger impact on prices probably reflects the impact of exchange rate pass-through on import prices. As mentioned earlier, one standard deviation appreciation in exchange rate is estimated to decreases inflation by 30 basis points.

7.2. Strength of the Exchange Rate Channel under Different Exchange Rate Regimes

As discussed earlier, the exchange rate channel is more potent under a flexible exchange rate regime. To test this hypothesis for Pakistan, we have categorised the exchange regime for Pakistan into managed versus flexible. First, we followed the de-jure exchange rate classification, where Pakistan followed the managed exchange rate till 2000 and shifted to a flexible exchange rate after that. Second, we followed the de-facto exchange rate classification done by Ilzetzki, Reinhart, & Rogoff (2017).

We have used dummy variables to capture the exchange rate regime.

$$Dumerregime = 1, if\ exchange\ rate\ flexible$$

$$Dumerregime = 0, if\ exchange\ rate\ is\ fixed\ or\ managed$$

To investigate the impact of the exchange rate regime on the effectiveness of the exchange rate channel, we interacted the exchange rate regime dummy with the exchange rate. Structural VAR estimates the regression. Finally, impulse responses of growth and inflation to exchange rate are compared with the exchange rate interacted with the regime dummy.

Figure 7 shows the comparison of impulse responses for growth. The impulse response of growth to monetary policy shock under a flexible exchange rate regime (both de jure and de facto) is not much different from the original impulse response.

However, this is not true for inflation. Here the exchange rate channel of monetary policy transmission has become stronger under a flexible exchange rate regime. This is true for both de jure and de facto classification of exchange rate regimes.

7.3. Variance Decomposition

Variance decomposition of LSM growth shows that initially, a large part of the variation is explained by its lags. However, after ten months, most of the variations in growth are explained by interest rate and exchange rate shocks. More CPI inflation also explains a considerable part of the variation in LSM growth.

Fig. 7a. Impulse Response of Growth to Policy Rate under Flexible Exchange Rate Regime
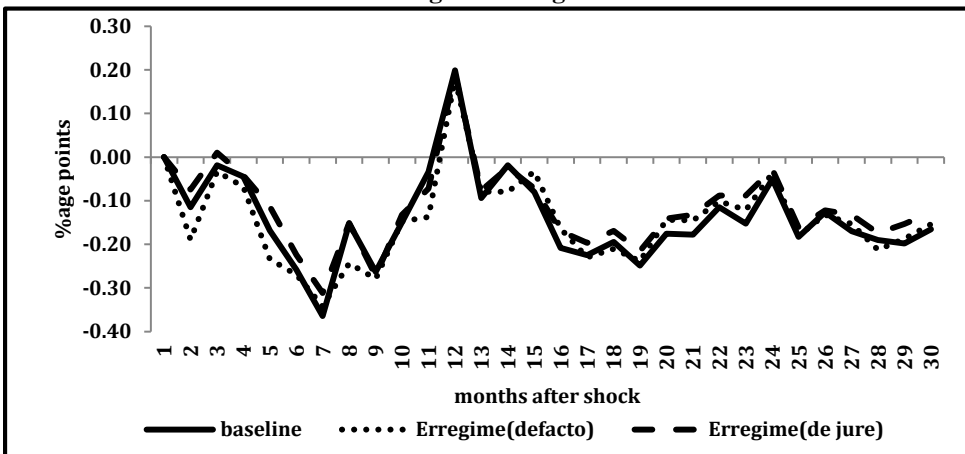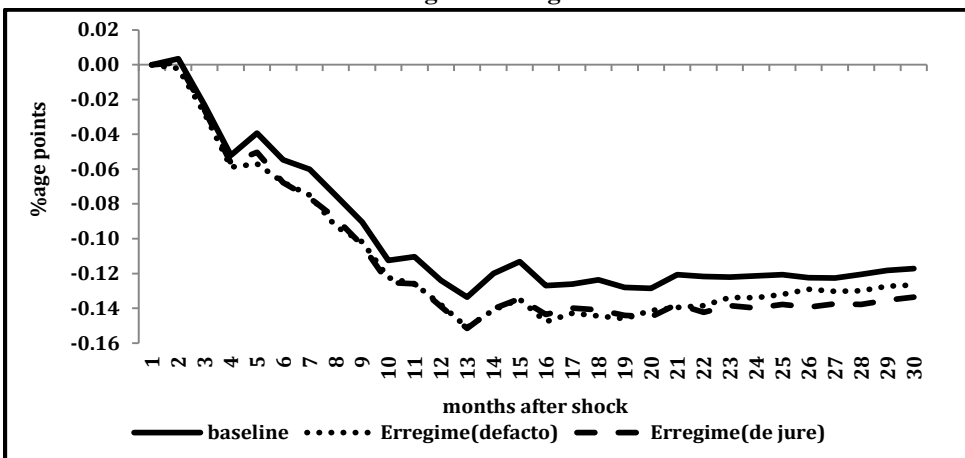

Fig. 7b. Impulse Response of Inflation to Policy Rate under Flexible Exchange Rate Regime

Variance decomposition of CPI inflation shows that adaptive expectations explain around ninety percent of the variations in inflation. Interest rate and exchange rate contribute only marginally to variation in overall inflation.

Likewise, variance decomposition of interest rates and exchange rates are predominantly explained by their own lags. Other variables have a minimal role in the variations of these two financial variables.

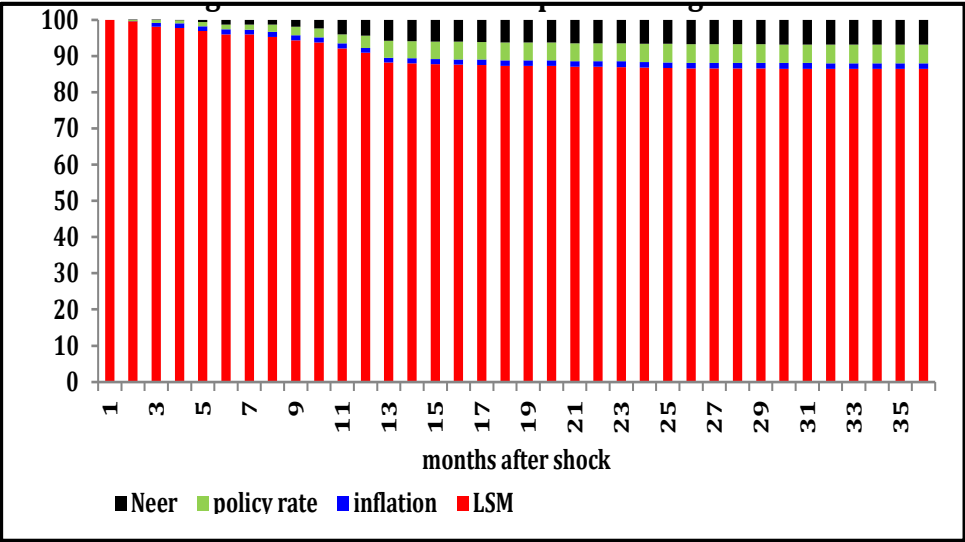**Fig. 8a. Variance Decomposition of Growth**
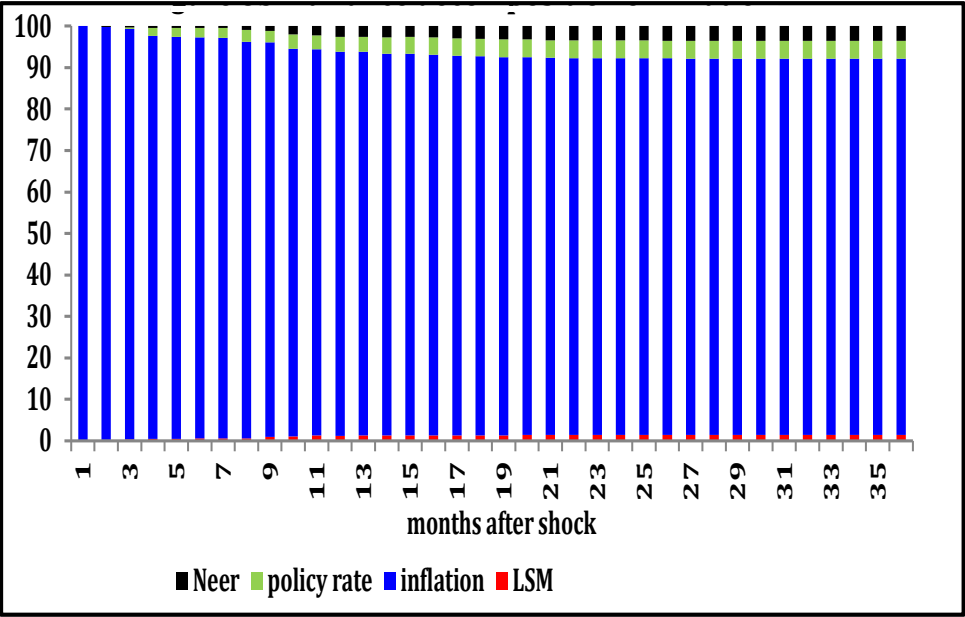

Fig. 8b. Variance Decomposition of Inflation
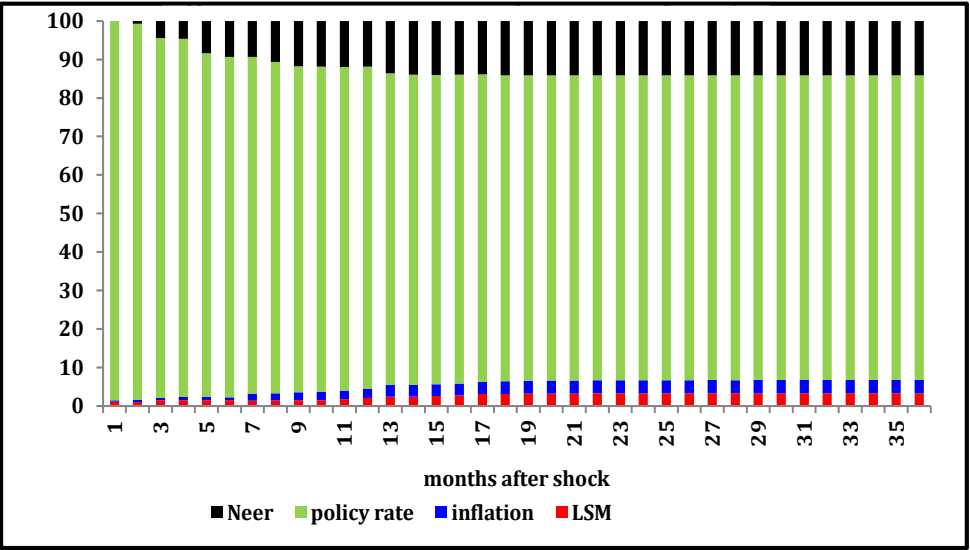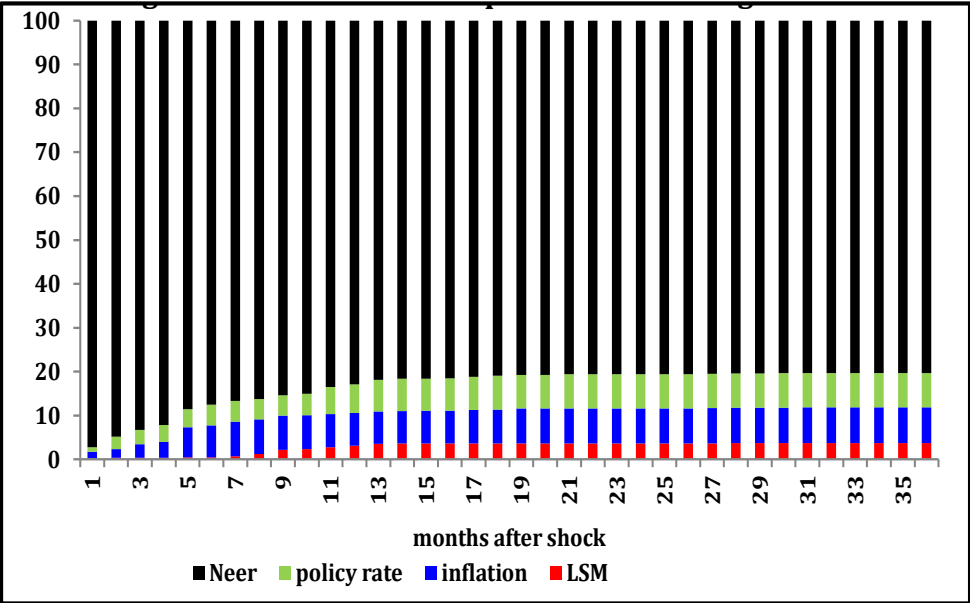
Fig. 8c. Variance Decomposition of Policy Rate

months after shock

■ Neer ■ policy rate ■ inflation ■ LSM

Fig. 8d. Variance Decomposition of Exchange Rate

months after shock

■ Neer ■ policy rate ■ inflation ■ LSM

7.4. Diagnostics

In order to check the stability of VAR, we have plotted the AR roots graph. Inverse roots of the AR characteristics polynomial lie within the unit circle that shows the stability of the VAR. We have also applied the autocorrelation LM test to serial correlation in the errors. We fail to reject the null hypothesis of no serial autocorrelation.

Fig. 9. Inverse Roots of AR Characteristic Polynomial
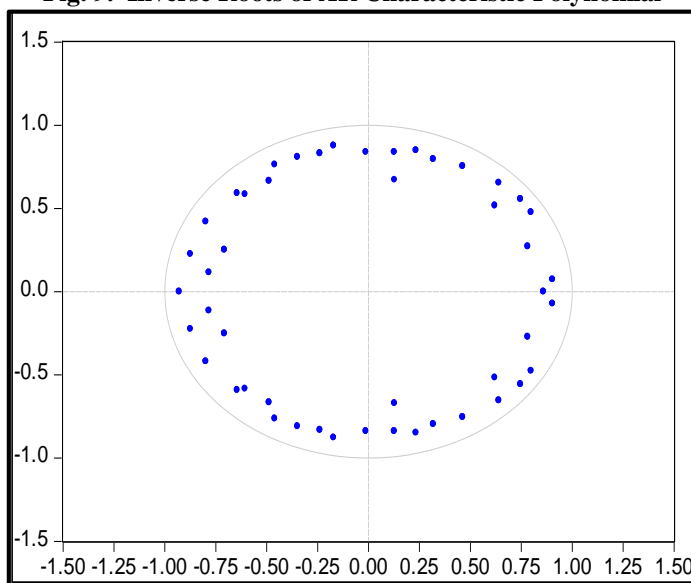
8. CONCLUSION

This study empirically evaluated the effectiveness of the exchange rate channel of monetary policy transmission. Following the literature on the subject, we benefitted from Vector Autoregressive models for this investigation. We used monthly data on key indicators for the economy that are important for inflation and growth and from a monetary policy formulation and implementation point of view. The data spanned from July 1995 to December 2020.

We did the necessary transformation before using the data in regression. This transformation included seasonal adjustment, taking logs, and differences in the data (for stationary purposes). We also controlled for the exchange rate regime dummy and monetary policy regime dummy in our regression.

The impulse response function showed that monetary policy shocks impact inflation and growth (SBP's goals). It takes almost a year for policy shock to have a significant impact on growth and four months to affect inflation. The impact of monetary policy actions is more pronounced on inflation than growth. One standard deviation positive shock to the exchange rate reduces inflation by around 30 basis points.

Importantly, the effectiveness of the exchange rate channel improves under flexible exchange rate regimes. We also tested the strength of the exchange rate channel of monetary policy transmission by shutting down the exchange rate channel. The impulse response functions showed that the exchange rate channel is relatively stable in impacting inflation. However, its impact on growth is minimal.

Variance decomposition showed that variation in LSM growth was contributed by all the factors like exchange rate and policy shocks. However, variations in inflation were mainly driven by inflation inertia.

Our results passed all the relevant diagnostics, such as inverse roots of AR characteristics polynomial and serial autocorrelation tests.

These findings suggest that adopting a market-based flexible exchange rate by the State Bank of Pakistan will strengthen the effectiveness of the exchange rate channel of monetary policy transmission. Moreover, SBP measures to further liberalise foreign exchange controls would integrate Pakistan with the global financial system. Global financial integration also bodes well for the working of the exchange rate channel.

ANNEXURE 1

Table A1

Cross Correlations of Important Variables in Level

	LSM Index	Consumer Price Index	Policy Rate	NEER	World Food Price	US IPI	Federal Fund Rate	PSB	Global Oil Price
LSM Index	1								
Consumer price index	0.94	1							
Policy rate	-0.66	-0.62	1						
NEER	-0.94	-0.99	0.61	1					
World food price	0.80	0.79	-0.23	-0.79	1				
US IPI	0.82	0.83	-0.67	-0.84	0.50	1			
Federal fund rate	-0.57	-0.67	0.45	0.68	-0.57	-0.32	1		
PSB	0.87	0.97	-0.53	-0.93	0.82	0.69	-0.70	1	
Global oil price	0.88	0.79	-0.47	-0.84	0.84	0.71	-0.49	0.72	1

Except forthe policy rate and federal fund rate, all the variables are seasonally adjusted and in log form.
LSM: Large Scale Manufacturing, NEER: Nominal Effective Exchange Rate, IPI: Industrial Production Index, PSB: Public sector borrowing from the banking system, CPI is used with 10th lag while NEER is used with 6th lag

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