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Exchange Rate Channel and Economic Growth: Empirical Investigation in a Developing Country's Setup

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Abstract: Developing economies are different than developed economies in many aspects, i.e., in terms of institutional framework and political situation etc. Thus, the monetary policy needed in developing countries is also different than developed countries. The goal of this study is to investigate exchange rate channel of monetary transmission mechanism in a developing country's setup. The variables included in our analysis are interest rate, exchange rate, exports, consumer price index and gross domestic product. Johansen cointegration technique is applied to analyze the long run relationship among variables while multivariate VECM granger causality test is used to explore the direction of causality among the set of our variables. We use annual data ranging from 1980 to 2015 while taking account of the limitations of time series data. Our findings suggest that output has a negative long run relationship with exchange rate and interest rate, positive relationship with exports and no statistically significant relationship with inflation. Interest rate granger causes all four of our variables thus showing the power of this policy tool. Exchange rate causes exports, consumer price index and output which means exchange rate is the second most powerful variable in our analysis. Output is granger caused by interest rate, exports and exchange rate which confirms the sensitivity of output to these variables. Consumer price index is granger caused by all four of our variables and came out to be the most sensitive variable in our analysis.

Keywords: Exchange rate channel; Monetary transmission mechanism; Interest rate; Exchange rate; Inflation, Exports; Output; Economic policies; Cointegration; Granger causality.

1. Introduction

Since the seminal work by Friedman (1968), the role of monetary policy in macroeconomic stabilization is an inconclusive issue. Besides the development on theoretical grounds, a substantial body of empirical literature has contributed to the ongoing debate by providing significant evidence on how monetary policy impacts economic growth, prices and exchange rates. Undoubtedly, the implementation of the floating exchange rate system, financial reforms, the trade liberalization and comparatively more independent central banks have improved the significance of monetary policy. For further theoretical debates about monetary transmission mechanism, see Goodfriend (2005). Recent empirical work such as Bernanke *et al.* (2005), Bernanke and Mihov (1998), Eichanbaum and Charles (1995) and Sims (1992) have significant contributions in the measurement of monetary policy and its innovations. These studies mostlyapply the vector autoregressive (VAR) methodology to explore the response of macroeconomic variables to monetary policy shocks. Even though the findings of these papers providesignificant evidence on the effect of changes in monetary policy on macroeconomic variables, such as real economic activity, price levels and exchange rates, there are various measurement problems and inconsistencies. These inconsistencies mostly include price, liquidity and exchange rate puzzles.In developing economies, monetary policy is more complicated and challenging because of the lack of well-developed financial markets and weak channels of monetary transmission. Due to the small financial markets and relatively weak channels of monetary transmission in developing economies, the relationship between money supply and macroeconomic variables tends to be weak and inconsistent. In particular, most of the empirical studies have focused on developed economies. Therefore, we know relatively little about howmonetary policy shocksaffect macroeconomicvariables, i.e. output, price levels and exchange rates, respond to in developing economies. Yet, understanding the effects of monetary policy on macroeconomic variables of developing economies is of importance to policymakers and academiciansin order to enhance macroeconomic

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stability. Evidence on the effectiveness of monetary policy in developing economies would improve our overall understanding of using monetary policy as a tool ofmacroeconomic stabilization.

Unlike most of the previous literature that have mainly focused on developed economies, this study focuses on a developing and comparatively small open economy, namely, Pakistan. Exactly, the paper empirically examines the exchange rate channel of monetary policy. There is very little empirical literature for Pakistan on this issue. Salman Ali *et al.* (2015) explored the asset price channel of monetary transmission mechanism in case of Pakistan. They used quarterly data from 1993 to 2013 and they found a weak asset price channel. Qayyum (2008) computes the monetary condition index (MCI) for Pakistan based on the estimated weights of the measures of monetary policy, such as the interest rate and exchange rate. But MCI index works when there are no supply shocks therefore, the dominance of supply shocks in Pakistan puts questions on the application of MCI. Thus, the findings of Qayyum's paper may not bereliable. Another study by Agha *et al.* (2005) uses six-month Treasury bill (T-bill) rates as a measure of monetary policy and the Vector Autoregressive technique to test the effects of monetary policy over a comparatively short time span. Finally, recently, Khan (2008) has made an effort to examine the effect of unanticipated changes in monetary policy on output and inflation by estimating structural Vector Autoregressive technique(SVAR). The paper used nominal shocks in SVAR as a proxy for unanticipated changes in monetarypolicy. However, this measure lacks theoretical rationales.

2. Literature Survey

Forni and Gambetti (2010) study the dynamic exogenous effect of monetary policy by applying a standard recursive scheme through a dynamic structural factor model for USA for the period between 1973-2007. They claim that the factor analysis model is superior to FAVAR proposed by Bernanke *et al.* (2005) because it helps in removing the puzzles in monetary policy analysis. They argue that a positive change to Federal Funds Rate (FFR) leads to an increasein real exchange rate. This approves overshooting hypothesis of Dornbusch (1976). Calculating impulse response graphs, they present the absence of price puzzle. Further, they claim that industrial production decreases, although on temporary basis, to a great extent with a humped-shaped response.

Ansari and Ahmed (2007) explore the relationship between money income and domestic prices by estimating VECM. They use both narrow and broad money as measures of monetary policy. Using quarterly data, they document that for any divergence from long-run equilibrium; output will increase by 6 per cent to adjust toward its long-run equilibrium. Moreover, the paperargues that a positive change in money policy results in adjustments in output after 5 quarters. Bernanke *et al.* (2005) introduce a combination of VAR model and factor model to capture large information set. They claim that a simple VAR analysis is unable to incorporate such information. They use a diffusion index developed by Stock and Watson (2002) to estimate the factors by utilizing a balanced panel of 120 monthly macroeconomic series (1959:1-2001:8).As in Forni and Gambetti (2010), as the study did not distinguish between the number of static factors and structural shocks, a large number of economic restrictions are imposed to reach the identification. Jang and Ogaki (2004) analyze the relationship between monetary policy shocks and Dollar/Yen exchange rates, prices and output level for USA. The empirical analysis is carried out, following the model of (Jang and Ogaki, 2004), through structural VECM and VAR by employing long- and short-run restrictions on the model. They argue that an increase in exchange rate is caused by a contractionary monetary policy. Moreover, they argue that output in domestic as well as in foreign country significantly drops due to the long-run neutrality restrictions with an exception of USA where a fall in output becomes negligible after 4 years. Lastly, a decline in price is observed as caused by tight monetary policy. While, estimating VECM and VAR with short-run restrictions for variables in their levels, they fail to accept the UIP condition, they find strong evidence in support of the presence of price puzzle. Fullerton *et al.* (2001) apply an error correction model to study the behavior of the exchange rate for Mexican peso over the period 1976-2000. They use nominal exchange rates, consumer price index, money supply, liquid international reserves, and real gross domestic product (GDP) as non-policy variables while the policy variables used in their study are one-and three-month T-bills rates. Their findings based on the balance of payment framework and monetary model of exchange rate do not give any support to the established theory. Though, balance of payment framework having one-month T-bill rate is slightly better than the monetary model of exchange rate. Wong (2000) empirically examines the effect of monetary policy on macroeconomic variables by using a time-varying parameter model for USA for the period 1959:1-1994:12. Output and prices are assumed to have lagged effect but FFR and reserves are considered to have only contemporaneous effects. The rolling VAR has been estimated with maximum three lags. The empirical findingspropose that output increases as a result of a contractionary shock to monetary policy. The output is more responsive to shocks during phases when the central bank adopts inflation controlling policy, while, it is less responsive when the central bank plans at promoting economic growth. Overall, the plots of Impulse Response Function provide the evidence of the existence of price puzzle. Bernanke and Mihov (1998) develop a VAR-based methodology to measure and assess the impact of monetary policy on macroeconomic variables. The measure of monetary policy is derived from an estimated model of Central Bank's operating procedures and the market for commercial bank reserves, which makes it more consistent as compared to the previously used tools of monetary policy. The impulse response functions show that output increases as a result of an expansionary monetary policy. Further, the plots provide evidence of a slower but a persistent rise in the prices. Yet, their results considerably vary across different measures of monetary policy. Although the study attempts to capture all the possible measures of monetary policy, it fails to notify which of the measure is relatively more effective. Eichanbaum and Charles (1995) analyze the exchange rate transmission

mechanism of monetary policy for the period 1974:1-1990:5. They use 3 measures of monetary policy commonly used in the literature. These measures are Federal fund rate, the narrative measureandnon-borrowed reserves of. They estimate a multivariate VAR model by using the ordering of the variables based on the Wold decomposition. The estimates on Impulse response functions indicate that a contractionary monetary policy results in a significant and continual fall in US interest rate, a sharp and persistent appreciation in US exchange rate, which is contradictory with the overshooting hypothesis of exchange rate.

3. Theoretical Background

The presupposition of this study is that a positive monetary policy shock to the interest rate appreciates exchange rate. Appreciation of exchange rate lowers the prices imports both of consumer and capital goods and hence the domestic prices through pass-through effect of exchange rate. The demand for imported goods (both consumer and capital) increases and that of exports falls in the international market. If the demand for imports of capital goods increases, the productivity of the economy increases, however the fall in exports has contractionary impact on aggregate output. The net-exports (Exports minus Imports) finally determine the overall change (fall or rise) in aggregate output (Mishkin, 1995). In the current analysis, we are interested to investigate the exchange rate pass-through effect; therefore we are taking imports instead of net-exports. Symbolically,

$$\uparrow Interest\ Rate \rightarrow \uparrow Exchange\ Rate \rightarrow \downarrow CPI \rightarrow \downarrow NetExports \rightarrow \downarrow Output$$

4. Empirical Methodology, Data and Variable Definitions

4.1. The Model

The workhorse of this analysis is the vector auto regression model as it envelopes most of the characteristics of the data (Babić, 2000). To analyze the monetary transmission mechanism, this model has been commonly used in literature. This model is best suit to the system of equations in which simultaneity and interdependence between the variables exist that is where we want to check the response of the other variables when there is a shock to one of the time series variables. Different economists have used this model to examine the monetary transmission mechanism in different countries. For example, Morsink and Bayoumi (2001), Disyatat and Vongsinsirikul (2003), Sims (1980); Sims (1992); Christiano *et al.* (1999) and Peersman and Smets (2001) have used this model for the monetary transmission mechanism in different countries.

4.2. Estimation Methods

We use the Johansen (1995) procedure to test whether there is any long-run association among the variables. The Johansen's method is based on the relationship between the rank of matrix and its characteristic roots (Enders, 2010).

As in Engle and Granger (1987), the dynamic behavior of a set of integrated variables can be empirically analyzed through the VECM, which is the reduced form of the model. The selected model is based on the backward-looking behavior of output, domestic prices and the exchange rate. The study uses a bivariate closed-economy model as in Sims (1980) and Christiano *et al.* (1999), which is first extended to a multivariate and finally to an open-economy model to measure the relationship between macroeconomic aggregates – output, domestic prices and the exchange rate – and monetary policy.

4.3. Data and Definition of Variables

To examine the role of exchange rate in monetary transmission mechanism in Pakistan, we use annual data covering the period 1980-2015. All the data are taken from the International Financial Statistics database of International Monetary Fund. All the variables are in log form except money market rate rate. All the variables are on annual basis with millions of Pak Rupee as unit of measurement. Following variables are used in our analysis.

GDP: Gross domestic product
CPI: Consumer Price Index
Exr: Exchange rate
Exports: Net exports (Exports minus imports)
MMR: Money market rate

5. Empirical Findings

In this section, we will report and discuss our empirical findings.

5.1. Augmented Dickey Fuller Test

We use the ADF test to discover the order of integration of the underlying time series. The results are shown in Table 1. The augmented dickey fuller test results do not show any significant evidence to reject the null hypothesis of unit root for level series. However, the first difference of all the series appears to be stationary. Thus, the results suggest that the variables are integrated of order one.

Table-1. Augmented Dickey Fuller Test

Variables	Trend	Intercept	Lag Length	t value/critical value	Order of integration
mmr	Yes	Yes	4	2.10 (4.26)	Level
Δmmr	Yes	Yes	4	5.02 (4.27)***	First difference
exr	Yes	Yes	8	2.03 (4.33)	Level
Δexr	Yes	Yes	8	4.78 (4.33)***	First difference
Lexports	No	Yes	6	3.09 (4.32)	Level
ΔLexports	No	Yes	6	3.29 (3.23)*	First difference
Cpi	Yes	Yes	4	3.06 (4.30)	Level
Δcpi	Yes	Yes	4	2.34 (2.64)***	First difference
Lgdp	No	Yes	3	1.34 (4.26)	Level
ΔLgdp	No	Yes	3	6.03 (4.28)***	First difference

5.2. Optimal Lag Length

Since the results of the cointegration test are very sensitive to the lag length, we choose the optimal lag length suggested by majority Criterion. The optimal lag length for our analysis is 2.

Table-2. Optimal Lag selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1517.612	NA	9.15e+33	95.22572	95.50055	95.31682
1	-1325.947	299.4757	5.68e+29	85.49670	87.42048	86.13438
2	-1251.953	87.86866*	6.83e+28*	83.12203*	86.69476*	84.30629*

5.3. Johansen Cointegration Test

In this step, we find out the number of cointegrating vectors using trace statistics and maximum eigen value statistics. As evident from table 4, there is one cointegrating vector in our analysis.

In order to find out long run cointegrating relationship between and the other 4 variables, we normalize our cointegrating vector on GDP. As reported in table 4, the reduced form equation shows the relationship between GDP and each of the 4 variables, i.e. exports, exchange rate, inflation and interest rate. Our cointegration equations shows there is a positive relationship between exports and gdp. The implications of these results are quite straightforward, that is to say, an increase in exports will help balance of trade and thus appreciating gdp. Moreover, exchange rate is found to have negative long run relationship with gdp. The implications for these results could be the fact that decline in exchange rate causes the wealth of foreign investors to decrease in the stock market thus they will be reluctant to invest in the country. There was no statistically significant relationship found between inflation and gdp while a long term negative relationship between money market rate and gdp was found.

Table-3. Johansen Cointegration Test

Number of cointegrating vectors based on Trace statistics and Maximum Eigen value statistics	Hypothesized No. of CE(s)	Trace statistics	Critical value at 0.05	Maximum Eigen Value statistics	Critical value at 0.05
	H0: r = 0	82.93002*	69.81889	37.43952*	33.87687
	H0: r ≤ 1	45.49050	47.85613	17.79410	27.58434
	H0: r ≤ 2	27.69640	29.79707	13.54670	21.13162
Cointegration Equation					
gdp= 7.5 +	0.023LExports -	0.53Exr -	2.33cpi	-	0.66MMR
(-5.21)	(-5.19)*	(5.42)*	(1.24)		(2.34)**

5.4. Multivariate VECM Granger Causality

The Granger causality test helps us to determine the weak exogeneity among variables. This test shows us the causal relationship of one variable with the other variable. The results of multivariate VECM Granger causality test are provided in Table 4. The significant chi-square statistic represents that the dependent variable is Granger caused by independent variable. It is evident from the table that exports granger causes gdp while gdp doesn't granger cause exports.These findings are in line with Mishkin (1995) that argues that net exports determine the overall change in aggregate output. Two-way causality is found between gdp and exchange rate. Cpi doesn't granger cause output while output granger causes Cpi. Money market rate granger causes output which is very much in line with our theoretical framework. Money market rate granger causes exchange rate, exports, inflation and gdp which means it has the power to affect all 4 of our variables. One way granger causality is found from exchange rate to exports and cpi. Exports granger causes cpi while cpi granger causes interest rate.

Table-4. Multivariate VECM Granger Causality Test

			Independent variables		
Dependent variables					
	MMR	EXr	Lexports	CPI	Lgdp
MMR	-------	1.15	3.12	7.67*	0.51
EXr	10.72**	------	2.29	0.61	18.49***
Lexports	14.23***	6.07**	------	1.44	2.87
CPI	10.26**	18.51***	7.27*	------	18.97***
Lgdp	6.62***	8.71**	5.93*	1.78	------

6. Conclusion and Policy Recommendations

The current study has been designed to test the role of exchange rate channel in monetary transmission mechanism in Pakistan with a big and updated data set. For this reason, Johansen co integration test, VECM and Granger causality tests were performed. The stationarity of the time series data was verified in the first step. The findings of co integration test reveal that there is a negative long run relationship between output and interest rate. Exchange rate also negatively impacts output in the long run. Consumer price index which is used as a measure of inflation has no statistically significant relationship with GDP. Output is positively affected by exports as evident from our cointegration analysis. The findings of VECM Granger causality test reveal that GDP is Granger caused by interest rate, exchange rate and exports. These findings are also evident from the cointegration analysis which shows sensitivity of output to interest rate, exchange rate and exports. Interest rate causes 4 out of 4 variables in our analysis. These findings show the power of interest rate in affecting other macroeconomic variables. Thus, the government should take these findings into account and be cautious while fluctuating interest rate. Consumer price index is granger caused by all 4 of the variables in our analysis which proves it is the most sensitive variable in our analysis. Exchange rate granger causes exports, consumer price index and output. These finding are also of very important nature and we propose that the central bank should reduce fluctuations in exchange rate. Decline in exchange rate causes the wealth of foreign investors to decrease in the stock market thus they will be reluctant to invest in the country.

Finally, we suggest that further analysis should be run that explores other channels of monetary transmission mechanism. More variables should be included in the analysis to expose output and inflation to other economic and non-economic factors. More developing countries should be included to have a more generalized understanding of the monetary transmission mechanism.

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