Impact of Interest Rate, Inflation and Money Supply on Exchange Rate Volatility in Pakistan

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Abstract: Exchange rate is one of the most important indicators of economic growth of a country and its volatility has significant impact on international trade. The present study investigates impact of inflation, interest rate and money-supply on volatility of exchange rate in Pakistan. To estimate short and long run relationship among variables, monthly data for the period ranging from July-2000 to June-2009 have been analyzed by applying Johansen Cointegration (trace test & eigenvalue) Tests) and Vector Error Correction Model (VECM). Granger Causality Test and Impulse Response Function (IRF) have also been applied to determine effect and response to shock of variables on each other. The results reveal that the short run as well as long run relationships exist between inflation and exchange rate volatility. High money supply and increase in interest rate raises the price level (inflation) which leads to increase in exchange rate volatility.

INTRODUCTION

The major objectives of monetary policy are to control the prices and to reduce level of unemployment. To achieve these objectives, the monetary authorities use the policy variables (interest rate, money supply etc.) to enhance the economic growth.

Increase in interest rate leads to prevent capital outflows which bring about obstruction of economic growth; resultantly, economy is harmed [1]. In global network age, no country can ignore the interaction of its economy with rest of the world. In developing countries, Real Exchange Rate (ER) plays an imperative and decisive role in the level of trade in free market economy of the world. Pakistan's economy has a significant openness to foreign trade; hence, the domestic inflation cannot be protected from external price shocks i.e. variation in import prices, appreciation / depreciation of exchange rate [2]. Due to this reason, exchange rate is considered to be one of the economic measures which is closely observed, analyzed and manipulated by the government [3].

Most of the countries impose restrictions on exchange rate volatility to control instability of the domestic currency [4]. Excessively huge fluctuation in the exchange rate may be created by unexpected monetary shocks [5]. Sometimes, management of the exchange rate by monetary authorities becomes very costly and even pointless, when speculators attack a currency, even under government protection. Efforts are made to achieve economic growth and price stability, by the policy makers, because the exchange rate volatility is linked with the impulsive movements in comparative price economy. Reliability of exchange rate is one of the key factors that promote the stability in price, investment and economic growth in economies. In Pakistan, monetary policy is formulated not only to achieve the price stability but also to stable the domestic and external value of the currency [2].

Therefore, it would be appealing to investigate the causes of exchange rate volatility in Pakistan. The current study was planned to find out the causes of exchange rate movements in Pakistan through investigation of

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association of exchange rate variation with changes in interest rate, money supply and inflation rates. The International Fisher Effect theory states that the future spot rate of exchange can be determined from nominal interest rate differential. In other worlds, the future spot exchange rate is affected by the differences in expected inflation that are entrenched in the nominal interest rate [6].

Brief Background: When the Bretton Wood system failed in 1971, most of industrial economies adopted floating exchange rate instead of fixed exchange rate system which accounted for great volatility in both real and nominal exchange rates [7] and [35]. Then debate began about the impact of exchange rate volatility on international trade and domestic price stability. Most economists consider that monetary authorities were responsible for great volatility in real exchange rate in 1970s.

In 1970s, major policy shift also occurred in Pakistan, when economic managers nationalized all the private sector institutions. In 1980s those policy decisions were reverted back and the policy of liberalization, deregulation and decentralization was followed. In that era, policy of exchange rate was also revised and Pakistan adopted managed float exchange rate system in 1982 which resulted in 20% depreciation in Pakistani rupee. In 1988, the agreement entitled "Medium Term Standby Extended Fund Facility (EFF)" was signed with IMF. That agreement had clauses regarding devaluation, import liberalization, tariff reduction and financial sector reforms, like deregulation of interest rate structure etc [8].

In 1990s, Pakistan had to face series of adjustment and stabilization restructuring. During that period, it was also ranked at the lowest in South Asia in terms of GDP growth. Although, it had observed a little improvement in macroeconomic indicators by the end of 1990s, its exchange rate instability and volatility remained very high. Trade deficit increased due to economic sanctions (after nuclear explosion of 1998) and exports decreased turning the current account deficit into negative. As per State Bank of Pakistan, *"foreign exchange reserves have never remained sufficient and hardly covered six weeks imports during 1990s"* [9].

During 2000s, the government continued trade liberalization policy to increase exports and to participate in the world economy. To strengthen and revive the economy, government continued the structural reform programs designed and initiated in 1990s [10]. Till 2006, Pakistan economy seems to be stable in terms of exchange rate. However, it did face numerous domestic and external shocks during this decade.

The per capita income of Pakistan in dollar terms has risen from $ 897 in 2005-06 to $ 1,368 in 2012-13. The main factors, which are responsible for this increase, include acceleration in real GDP growth, relatively lower growth in population and the stable exchange rate. However, in 2013, the government followed the policy of printing of new notes to control price level. Resultantly, the price level became higher and higher, exchange rate showed high instability and volatility, in response to inflation, reached to its maximum level as Pakistani rupee plunged to its historic lowest level of 113 against the US dollar.

Objectives of the Study:

- To explore exchange rate volatility and to look at the factors influencing exchange rate movements in Pakistan.
- To analyze relationship between exchange rate & interest rate and money supply & inflation. And to investigate whether long run and short run relationship exist between exchange rate and other policy variables like interest rate, money supply etc.?
- To find answers of the questions like, can volatility of exchange rate be controlled by monetary policy? How much interest rate, money supply and interest rate impact on exchange rate volatility?

The paper has been organized into five sections. First section gives introduction and provides some basic information about the background of the study, while second section reviews the relevant literature. In the third section, data sources and methodology have been presented. The results have been described in details in the fourth section. In the final and fifth section, conclusions and some policy guidelines have been furnished.

Literature Review: Causes of exchange rate volatility have always been a subject of interest of macroeconomists around the world. However, this area in Pakistan still remains more or less unexplored. Some of the studies, conducted in other countries, are being presented below in chronological order.

Research on exchange rate volatility began with Optimal Currency Area hypothesis [11]. This hypothesis described that a country may attain benefits by common currency if it has a large bilateral trade and correlated economic shocks. Later on it was proved [12] that positive relationship exists between money growth rate and inflation rate. One study about ASEAN countries reported that inflation rate is not affected by the change in exchange rates in ASEAN countries excluding Thailand [13], however, for many countries in Asia and Latin America, it has been proved statistically that inflation and the real exchange rate have relationship [14]. It has also been observed, in many industrial and developing countries, that no change occurs in inflation stability in spite of high oscillation in exchange rate.

[15] and [16] proved, by applying GARCH (Generalized Auto-Regressive Conditional Heteroscedasticity) model, that exchange rate is persistent and serially correlated. A large amount of macroeconomic literature supports that macroeconomic variables are affected by the instability of real exchange rate of the country. It has been reported that for most of the developing countries, exports are hampered by higher volatility of exchange rate [17]. It has also been reported that future volatility can be envisaged by using present and past volatility of exchange rates [18] and [19] described that the best interference instrument in exchange is change in interest rate. It is an explanatory variable which explains the sensitivity of exchange rate. Negative impact of exchange rate volatility on the trade flow has been observed by [20] and [21]. Whereas, [22] proved that exchange rate volatility is also affected by financial variables (i.e external debt).

Irving Fisher proposed a theory about relationship between exchange rate and interest rate, known as the "Fisher Effect", that describes interest rate differential tend to reflect the exchange rate expectation. The International Fisher Effect (IFE) theory illustrates that an expected change in the current exchange rate between any two currencies of countries is about equivalent to the difference between the two countries nominal interest rates for that time [23]. Spot exchange rate is expected to change equally but in the opposite direction of the interest rate differential; thus, the currency of the country with the higher nominal interest rate is expected to depreciate against the currency of the country with the lower nominal interest rate, as higher nominal interest rates reflect an expectation of inflation [24]. In the literature, it has been found in many studies that interest rate differential influences changes in exchange rates

based on IFE theory [6]. High real interest rate significantly reduces exchange rate volatility [4].

[25] proved that in the long run, it is not ideal relationship between exchange rates and inflation rates differential, however, he argued that in the long run, inflation differentials may be used for forecasting of exchange rate volatility. He also observed that in the global economy stock return is influenced by the common external factors is the stock prices. Exchange rate is not only determined by the domestic interest rate but it is also influenced by the changes in the interest rate by the major world economies. Hence, it may be concluded that in case of single economy, negative correlation exists between exchange rate volatility and interest rate [26].

Commonly, it is considered that the price stability is measured by the inflation rate. [27] explained that inflation may be classified into two types: demand pull inflation (demand side inflation) and cost push inflation (supply side inflation). [28] in their study about Malaysia, concluded that exchange rate volatility may be obstructed by increasing the interest rate. He also concluded that the interest rate contains the information regarding the future path of the inflation or inflation is determined, at least to some extent, by the interest rate.

MATERIALS AND METHODS

Theoretical Model: The model composes of four variables which depict the exchange rate is the function of money supply, interest rate and inflation rate.

$$Er_t = F(IR_t, Cp_t, MS_t) \qquad (1)$$

whereas ER, IR and MS represent monthly exchange rate in Pakistan (Rs/USD), monthly interest rate and monthly money supply in Pakistan while CP represents consumer price index used as proxy for inflation and, 't' represents time trend.

Data: The monthly data of all variables from 2000 to 2009 have been retrieved from IFS database and the sample consisted of 108 observations. The data of all the variables, except the interest rate, were transformed into log form to reduce the variance, so that the coefficient can be interpreted as elasticity. The data of interest rate was not transformed into log form as it is not logical to change the data into log form for those variables which are used as percentage / rate / ratio. Mathematically, model can be written as:

$$LnER_t = \beta_0 + \beta_1 IR_t + \beta_2 LnCP_t + \beta_3 LnMS_t \qquad (2)$$

EViews has been applied for estimation. To establish the long run as well as short run relationship among different variables, Johansson cointegration, error correction model and vector error correction model have been applied. To analyze whether inflation, interest rate, money supply have any effect on exchange rate volatility and vice versa, Granger casualty and impulse response test have also been performed.

RESULTS AND DISCUSSION

Stationarity Testing: Stationarity testing is a pre-requisite for cointegration and ECM. The data used in the present study are time series which are mostly integrated. The estimates of ordinary least square (OLS) are misleading and spurious when the series are non-stationary (integrated). Therefore, first step is to check the order of integration of the series. For stationarity testing, unit root test have been used. General equation for unit root testing, as given below, is used by adding lags of dependent variable by applying Augmented Dickey–Fuller (ADF) test, whether the series have unit root or not.

$$\Delta Y_t = \alpha + \beta x_t + (\lambda - 1)Y_{t\_1} + \sum_{t=1}^{k} \theta \Delta Y_{t-1} + u_t \qquad (3)$$

If series were stationary, the OLS was applied and if unit root existed, cointegration was applied to check whether long run relationship among variables exist or not?.

The results of Augmented Dickey–Fuller test (ADF) have been presented in Table 1 which shows that all the 'P' values for each series are greater than 0.05 at level. So, null hypothesis that all series has unit root (H_o), is rejected and alternative hypothesis is accepted which means that all the series have no unit root. Thus, all, time series are non-stationary having integrated order I (0). While the first difference null hypothesis of unit root is not rejected because all series are significant at 5% significance level. Hence, all the time series are stationary and integrated order is I (1).

Residual Analysis: The result of stationarity test for residual, shown in Table 2, reveal that residual is stationary. This testifies that model is not spurious and regression equation may have long run cointegration relationship between exchange rate volatility and other variables.

Graph of residual, presented in Figure 1, clearly indicates that residual is stationary and has high volatility around its equilibrium level (fitted). It can be seen in the figure that exchange rate shows much fluctuation around its fitted line and high misalignment after 2001M3. But its converge to equilibrium level confirms the *shocks are persistent,* → LONG MEMORY [If the series are not UR: shocks are not persistent, *transitory* - → *SHORT MEMORY*], which elucidates that socks are corrected to equilibrium level bit by bit. It means that the speed of adjustment is not fast.

Stability Test: To check the stability of dependent variable, the Ramsey RESET test and CUSUM & CUSUM square were applied. The results for these tests are shown in Table 3 and Figure 2, respectively. Ramsey's RESET test of functional misspecification is intended to provide a simple indicator of evidence of nonlinearity. *F* statistic for the coefficient is significant. It indicates that some kind of nonlinearity may be present. The result of CUSUM and CUSUM square are presented in Fig. 2 which show that equilibrium of coefficient of exchange rate is not stable over time.

Lag Length Criteria for Cointegration and Unrestricted VAR: Schwarz information criterion test has been preferred for selection of lag length.

The results, shown in Table 4, indicate that lag one is appropriate for the unrestricted stable VAR model. Proper lag length is necessary condition for VECM and cointegration analysis. VAR may become stable only if roots of modulus is less than one and inside the circle. All outcomes like impulse response, SE are not pragmatic if VAR is not stable [29].

If two time series are co-integrated then long run relationship exists between the variables and possibility of short run relationship also exists [30]. Therefore, to verify whether the long run relationship exists between exchange rate and other variables, Cointegration techniques like Johansen Cointegration and Vector Error Correction Model (VECM) have been followed for long run and short run relationships, respectively.

Table 1: Augmented Dickey-Fuller Test Statistics At Level

Null Hypothesis	Test critical values			t-Statistic	Prob.*	Decision
	1% level	5% level	10% level			
LER has a unit root	-3.4937	-2.8892	-2.5816	1.1553	0.9977	Reject
IR has a unit root	-3.4925	-2.8886	-2.5813	-2.3297	0.1646	Reject
LCP has a unit root	-3.4931	-2.8889	-2.5815	2.7449	1.0000	Reject
LM2 has a unit root	-3.5007	-2.8922	-2.5832	-1.6320	0.4624	Reject
At First Difference						
D(LER) has a unit root	-3.4937	-2.8892	-2.5816	-6.9009	0.0000	Does not reject
D(IR) has a unit root	-3.4931	-2.8889	-2.5815	-11.9748	0.0000	Does not reject
D(LCP) has a unit root	-3.4931	-2.8889	-2.5815	-6.6559	0.0000	Does not reject
D(LM2) has a unit root	-3.5014	-2.8925	-2.5834	-1.4736	0.0000	Does not reject

*MacKinnon (1996) one-sided p-values.

Table 2: Unit Root Test for Residual At Level

Null Hypothesis	Test critical values			t-Statistic	Prob.*	Decision
	1% level	5% level	10% level			
Residual has a unit root	-3.4931	-2.8889	-2.5815	-10.5224	0.0000	Does not reject

Table 3: Ramsey RESET Test

F-statistic	Prob. F(1,103)	Log likelihood ratio	Prob. Chi-Square(1)
45.45317	0.0000	39.47838	0.0000

Table 4: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	130.1221	NA	8.49e-07	-2.627544	-2.520696	-2.584354
1	769.0269	1211.257	1.96e-12	-15.60473	-15.07049*	-15.38878*
2	782.7038	24.78933	2.07e-12	-15.55633	-14.59470	-15.16762
3	805.6927	39.75168	1.79e-12	-15.70193	-14.31291	-15.14047
4	824.3246	30.66510	1.71e-12	-15.75676	-13.94035	-15.02254
5	841.4682	26.78686	1.69e-12	-15.78059	-13.53678	-14.87361
6	856.6084	22.39488	1.76e-12	-15.76268	-13.09148	-14.68293
7	880.7328	33.67365	1.53e-12*	-15.93193	-12.83335	-14.67943
8	894.5650	18.15473	1.66e-12	-15.88677	-12.36079	-14.46151
9	905.0696	12.91194	1.96e-12	-15.77228	-11.81891	-14.17427
10	928.8723	27.27389	1.78e-12	-15.93484	-11.55408	-14.16406
11	946.2154	18.42703	1.89e-12	-15.96282	-11.15467	-14.01929
12	974.5559	27.75003*	1.62e-12	-16.21991*	-10.98437	-14.10362

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Johansen Cointegration: The Johansen cointegration approach [31] based on the VAR Model, has been adopted to verify whether long run relationship exists among series or not? When dependent and independent variables cannot be identified it is called endogenity. To overcome endogenity problems, VAR model has been applied. The estimated results of the trace test and maximum eigenvalue test have been presented in Table 5 & 6, respectively. The results depict the long run coefficient (β of the matrix) for the rank (r) that tells about the number of co-integrating vectors between variables.
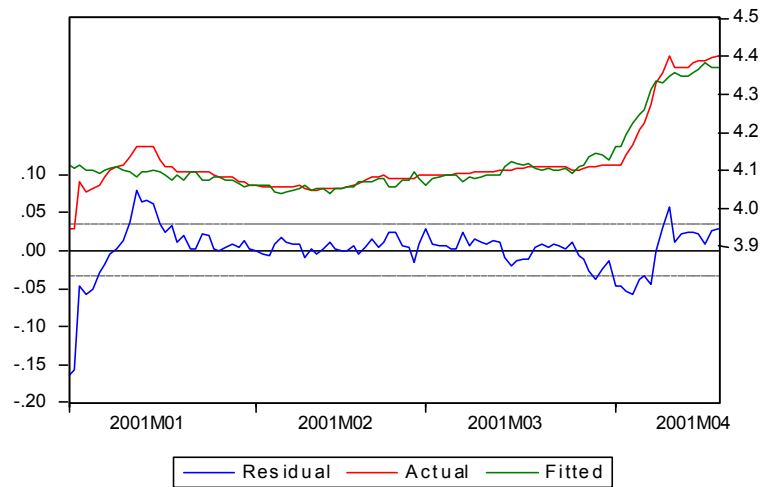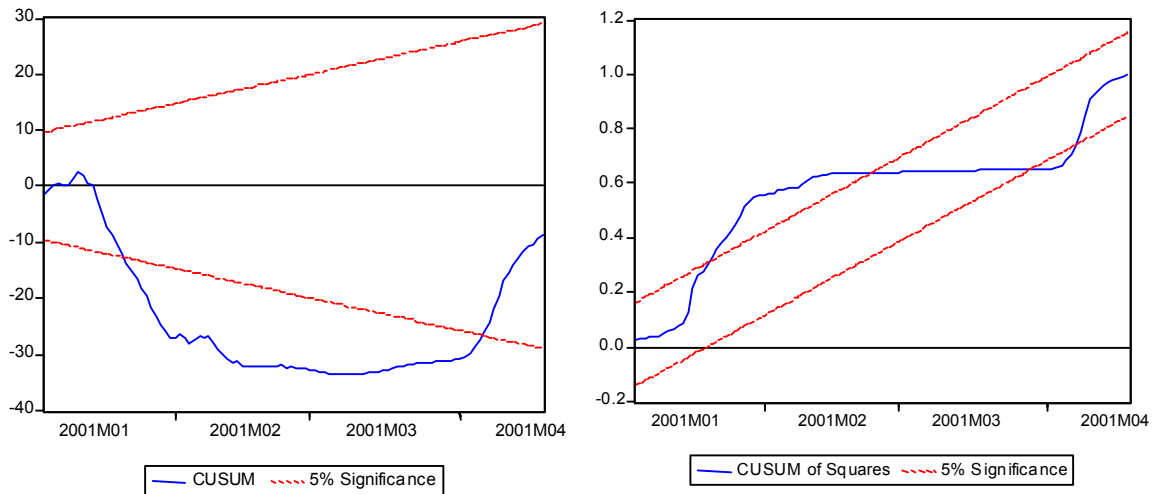
Fig. 1: Residual analysis

Fig. 2: CUSUM and CUSUM of Square Test

Table 5: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.464643	95.22096	47.85613	0.0000
At most 1	0.165447	28.98987	29.79707	0.0617
At most 2	0.085741	9.818800	15.49471	0.2949
At most 3	0.002984	0.316810	3.841466	0.5735

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 leve

l**MacKinnon-Haug-Michelis (1999) p-values

Table 6: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.464643	66.23109	27.58434	0.0000
At most 1	0.165447	19.17107	21.13162	0.0920
At most 2	0.085741	9.501990	14.26460	0.2467
At most 3	0.002984	0.316810	3.841466	0.5735

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 7: Vector Error Correction Estimates

a) Cointegrating Eq:				CointEq1
LER(-1)				1.000000
IR(-1)				0.004006
				(0.00143)
				[2.79446]
LCP(-1)				-1.428249
				(0.07366)
				[-19.3887]
LM2(-1)				0.543884
				(0.03269)
				[16.6395]
C				-5.615781
b) Error Correction:	D(LER)	D(IR)	D(LCP)	D(LM2)
CointEq1	-0.385648	-2.349974	-0.026721	-0.006724
	(0.04362)	(5.52847)	(0.02504)	(0.05004)
	[-8.84035]	[-0.42507]	[-1.06719]	[-0.13437]
D(LER(-1))	-0.045826	25.61803	0.023617	-0.156278
	(0.07970)	(10.1002)	(0.04574)	(0.09143)
	[-0.57500]	[2.53638]	[0.51629]	[-1.70934]
D(IR(-1))	0.000678	-0.208064	0.000479	0.000357
	(0.00077)	(0.09783)	(0.00044)	(0.00089)
	[0.87832]	[-2.12683]	[1.08018]	[0.40259]
D(LCP(-1))	-0.071556	13.97606	0.366982	-0.001323
	(0.18112)	(22.9537)	(0.10396)	(0.20777)
	[-0.39507]	[0.60888]	[3.53010]	[-0.00637]
D(LM2(-1))	0.050607	-4.797983	0.074250	-0.172007
	(0.09191)	(11.6479)	(0.05275)	(0.10543)
	[0.55061]	[-0.41192]	[1.40748]	[-1.63141]
C	0.004281	-0.093807	0.003207	0.014729
	(0.00212)	(0.26822)	(0.00121)	(0.00243)
	[2.02280]	[-0.34974]	[2.63973]	[6.06686]

Standard errors in ( ) & t-statistics in [ ]

Result of the trace test, presented in Table 5, show that P-value is significant (less than 0.05) for rank (r) = 0, thus null hypothesis of no cointegration is rejected. While for rank (r) = 1, the P-value is not significant (greater than 0.05); thus, null hypothesis of no cointegration cannot be rejected. Table 6 presents cointegration rank test results based on maximum eigenvalue. The results show that there is no variable in the sample that has no cointegration.

Results of the Table 5 & 6 attested the presence of one cointegration equation at 5% level which depicts that long run relationship exists among exchange rate and other monetary variables. Reduced form of model for real exchange rate is suitable to estimate the numerical long run relationship between exchange rate, determinants and short-run variables that can be attained through VECM approach. It has been proved by Johansen cointegration test that when one cointegration equation exists, it shows that use of VAR model is not a good strategy. Therefore, VECM was a better option rather than VAR to investigate the long run and short run relationship of exchange rate volatility and other variables.

Vector Error Correction Model (VECM): VECM was estimated in two steps: In first step, the cointegrating relation was estimated by Johansen procedure. While in second step, error correction terms was calculated by estimated cointegration relation and VAR in first difference, including error correction term (ECT) that was estimated from the first step (denoted cointEq1).

The results of cointegrating equation and error correction have been presented in Table 7. Estimated cointegration equation (cointEq1) is:

LER +0.0040IR-1.4282LCP+0.5438LM2-5.6157 = 0

which can be written as:

LER = -0.0040IR +1.4282LCP - 0.5438LM2+5.6157 = 0

Coefficient of cointegration equations represents the long run relationship among variables while coefficient of that term in VECM shows how deviations from that long run relationship affect the changes in the variable in the next period. The coefficients of all the variables is being considered as long run elasticities because all the variables except interest rate have been taken in log form and have one cointegrating vector.

In the long run, results show that all variables in cointegration equation significantly influenced the exchange rate at 1% level in Pakistan during period from 2002 to 2009. It is commonly considered that increase in interest rate and inflation brings about appreciation and depreciation of exchange rate, while our results do not support this statement. Our results indicate that interest rate and money supply negatively influence the exchange rate at 1% significance level. 0.004% and 0.54% depreciation of exchange rate has taken place due to one unit increase in interest rate and money supply, while inflation has significant positive impact on exchange rate as one unit change in inflation lead to 1.47% increase in exchange rate.

The results of error correction have been presented in Table 7(b). The value of error correction term should lie between (0, 1). If it has negative sign, it shows convergence and, evaluates the speed of adjustment towards equilibrium. The results indicate that error correction term for all the variables has right sing (negative sign) and values' lines within range 0 and -1, except that for the interest rate. This shows the convergence towards equilibrium level. The main feature of error term is its capability to correct for any disequilibrium that may occur due to shock in the system from time to time. If disequilibrium exists in system then

Table 8: Granger Causality Tests

Null Hypothesis:	F-Statistic	Prob.	Decision
IR does not Granger Cause LER	5.0833	0.0263*	Reject
LER does not Granger Cause IR	2.1960	0.1414	Does not Reject
LCP does not Granger Cause LER	5.1973	0.0247*	Reject
LER does not Granger Cause LCP	6.6137	0.0115*	Reject
LM2 does not Granger Cause LER	0.9765	0.3254	Does not Reject
LER does not Granger Cause LM2	0.2235	0.6373	Does not Reject
LCP does not Granger Cause IR	4.8856	0.0293*	Reject
IR does not Granger Cause LCP	3.3733	0.0691	Does not Reject
LM2 does not Granger Cause IR	2.5509	0.1133	Does not Reject
IR does not Granger Cause LM2	0.0029	0.9573	Does not Reject
LM2 does not Granger Cause LCP	3.8134	0.0535	Does not Reject
LCP does not Granger Cause LM2	0.2250	0.6363	Does not Reject

* at 5% significant level

error correction term corrects such disequilibrium and provides guidance to variables of the system to come back towards equilibrium. It can be seen that correction of 38.56%, 235.00%, 2.60% and 0.67% of disequilibrium was "corrected" each month by changes in exchange rate, interest rate, inflation and money supply, respectively. It is evident that the interest rate and exchange rate are showing high volatility than the other variables.

Xt cause Yt or not.

$$Y_t = \alpha_1 y_{t-1} + \ldots\ldots\ldots + \alpha_k y_{t-k} + \beta_1 x_{t-1} + \ldots\ldots\ldots +$$
$$\beta_k x_{t-k} + \delta_1 w_{t-1} + \ldots\ldots\ldots + \delta_k w_{t-k}$$

Test: $H_o = \beta_1 = \beta_2 = \ldots\ldots\ldots = \beta_k = 0$

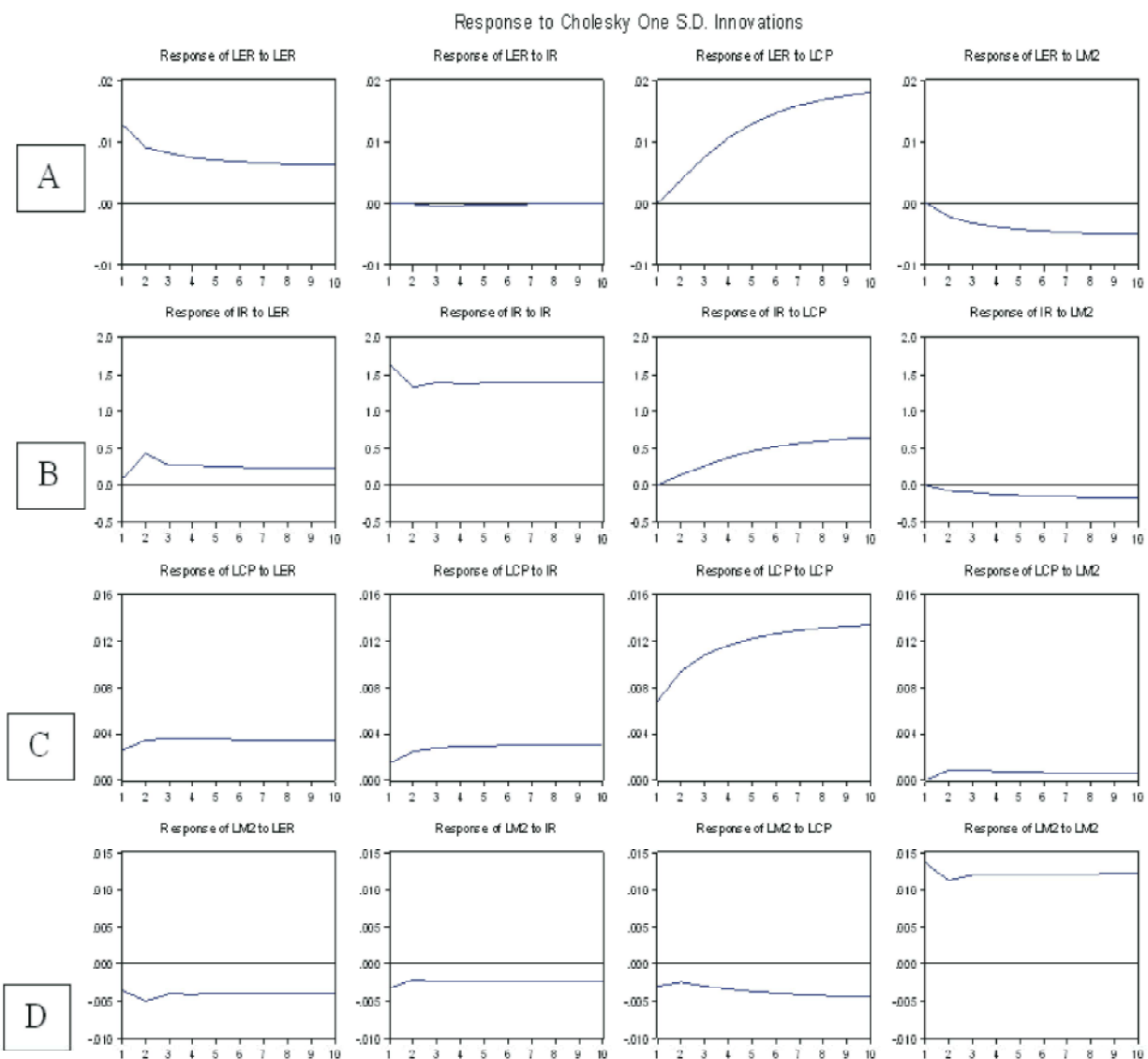Fig. 3: Impulse Response analysis

Granger Causality: 'x' is a granger cause of 'y' (denoted as x----> y), if present 'y' can be predicted with better accuracy by using past value of 'x' rather than by not doing so, other information being identical [32]. This definition can be extended to instantaneous causation, denoted as x ==> y. Instantaneous causation exists if present 'y' can be predicted better by using present and past values of 'x', ceteris paribus. Suppose we have series, X_t, Y_t and W_t.

If there is no effect of X_t on Y_t, then H_o is not rejected ==> Lags of X_t have no role in Y_t ==> X_t does not granger cause Y_t (information of present value is not present).

Although cointegration and VECM results show that long run and short run relationship exist among variables but both results do not indicate the direction of casual relation (if any) between variables. The literature pledges that unidirectional granger casualty always exist [33]. Economists also testify the granger causality among exchange rate, interest rate and inflation. Estimation results for granger causality between the variables are presented in Table 8.

The results show that inflation granger causes the exchange rate at 5% significance level. It has been reported by [32] that if other information is same, exchange rate appreciation can be predicted with better accuracy by using past value of inflation. Exchange rate granger causes inflation also means that inflation follows its counterpart in short run as there is lead-lag relationship between them [28]. There is bidirectional causality running from exchange rate to inflation implying that past values of both (exchange rate & inflation) have a predictive ability in determining the present values of inflation and exchange rate.

The results show that interest rate granger causes exchange rate volatility and in reward exchange rate volatility does not granger cause interest rate which shows the unidirectional relation between interest rate and exchange rate volatility. The results do not support the argument of the previous study by [28], that interest rate has no effect on exchange rate volatility in short term. Interest rate granger causes inflation [34], whereas our results do not favor this argument. From our results it can be seen that inflation granger cause interest rate volatility while interest rate does not granger cause inflation which depicts that only one way causality exists between interest rate and inflation.

Impulse Response: Impulse response has been adopted to verify the cointegration results. Impulse response

function is shown in Figure 3. In panel A(1-4) of Figure 3, the graph shows relationship between LER and IR, LCP & LM2 taking LER as dependent variable and IR, LCP & LM2 as independent variable. The graph line in panel A(2) exhibits that initial response of exchange rate to a unit shock in interest rate is not significant at 1st period. After 2nd period change in IR will lead to affect LER negatively up to 6 periods and after that effect of LIR would disappear slowly.

CONCLUSION

On the basis of empirical evidence it is concluded that inflation has positive relation while interest rate and money supply have inverse relationship with exchange rate volatility. Short run and long run relationships exist between exchange rate volatility and inflation.

As per economic theories, increasing interest rate leads to increase output, investment and excess supply in goods market, resultantly price level is increased. It means interest rate lays the information regarding prospects of inflation. Interest rate may be proficient in limiting the exchange rate volatility indirectly by hand of inflation. It has also been found that money supply (policy variable) has inverse relationship with exchange rate volatility. Therefore, to restraint the exchange rate volatility money supply may be efficient. Perhaps, government would raise money supply upto 20% as per economy size of Pakistan. Increase in money lead to decreased price level, resultantly enhancement in exchange rate volatility may be restraint.

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