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Nexus between Exchange Rate Volatility and Oil Price Fluctuations: Evidence from Pakistan

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Abstract

Pakistan experienced too much variation in crude oil prices in the last decades and this variation received a great attention because it uses all the sectors of the economy. The purpose of this study is to ascertain the determinants of Real Exchange Rate and analyze the impact of Real Oil Price Volatility on Real Exchange Rate Volatility in Pakistan over 1983-Q_1 to 2014-Q_2. Various econometric techniques like Johansen Cointegration and Vector Error Correction Model have been used for short run and long run analysis respectively. Our findings explores that productivity differential, real foreign exchange reserves, interest rate differential, real exports and oil prices are the determinants of exchange rate. While, Real Foreign exchange reserves volatility, CPI volatility and Real Oil Price Volatility have positive and NEWS has a negative effect on Real Exchange Rate Volatility. Volatility results through EGARCH (1, 1) shows the presence of leverage effect in Real Oil Price Volatility and Real Exchange Rate Volatility. The government should make suitable policies for equilibrium of oil demand and supply in order to keep the exchange rate stable. Future research can be made on cross sectional countries by using monthly data of variables.

Keywords: exchange rate, real exchange rate volatility, oil price fluctuations, impulse response, exponential generalize autoregressive conditional hetroscedasticity (EGARCH).

1. Introduction

The exchange rate is an important macroeconomic variable in any economy because it maintains international competitiveness (Jhingan, 2002). The importance of this variable can be recognized from the fact that it does play its major role to trim down domestic price level (Mordi, 2006) but also has an adverse impact on international trade and capital flows (Abrams, 1980; Hilton, 1984). On the same way, exchange rate volatility has

become an imperative issue between developing countries because it creates hurdles to achieve two main policy maker's objectives: price stability and economic growth.

Most of the traders produce goods and services and sell them internationally. They measure their benefits and costs in term of the US Dollar. Similarly, all the developing countries receive funds, assistances and grants in term of dollar and they reimburse their money in the same currency. So, US dollar is acceptable in all over the world when transactions are made internationally. Normally, central bank of a country decides whether the exchange regime should be fixed or floating. It is important to clear here the scenario behind the exchange rate in nominal and real term. The real exchange rate can be distinguished from nominal through the value of county's product in term of another; while the price of a currency in term of another is termed as nominal exchange rate.

The phenomenon of volatility can be defined as fluctuations and uncertainty in asset pricing, portfolio optimization and risk management. Volatility tends to increase if elasticity of demand and supply is high and vice versa (Obadan, 2006). Exchange rate volatility is linked with flexible exchange rate. Variability in itself is not a critical problem. If variability is predicable then volatility has not significant undesirable effect on international trade and capital flows (Hakkio, 1984).

Pakistan is one of those agrarian based economies that are gradually switching towards industrialization. This country examined multiple exchange rates since its independence. Before 1973, there was fixed exchange rate in Pakistan, but after that it was firstly linked by the pound. History of exchange rate has shown a continuous trend of depreciation since 1982 to 2001 but this depreciation changed in appreciation in 2002 due to development and events since 1998. Stability can be seen in the fiscal year 2005-2006. The average nominal exchange rate was Rs. 91 US dollars from July 2012 to June 2013 and it depreciated by 6.87 percent when exchange rate rose by Rs. 98 US dollar in July 2014. Exchange rate reached to its peak at Rs. 107 US dollars in March 2014 when Loan has paid for the International Monetary Fund (IMF) Rs. 76.54 million as interest. After March 2014, exchange rate appreciated to Rs. 101 US dollar till June 2015. The main reason for this appreciation was a downward trend in oil prices.

Oil market plays a vital role in all sectors of the economy (Azid et al., 2005). Pakistan, as an oil importing country, experienced large oil price shock (Siddquia a a huge share2001) and it has huge share of cost of oil in GDP. Its users have less ability to lessen their consumption. The first oil price shock was observed in 1973 because of the OPEC oil embargo. The crude oil price was $4.20 per barrel in 1973. Crude oil price remained constant between 12$ to 14$ per barrel in 1974 to 1978. From 1979 to 1985, oil price fluctuated due to the Iranian revolution, Iraq war, OPEC quotas, and Iraq invasion of Kuwait. Their price has been increasing continuously since 2003 and reached at its peak (126$/barrel) in July 2008. However, after that, a declining trend can be seen. In June 2014, crude oil price was $115/ barrel, but it declines to $50/ barrel in the first month of 2015 that in returns appreciates exchange rate. This appreciation reduces inflation from 8 to 9 percent. This decrease in prices improves import bill by $ 691US million, but this positive impact vanished when imports of petroleum products increased by 6.3 US$ million. Even though, oil prices in Pakistan reached at its lowest level, but it has not any positive impact on import bill. The import bill during June 2015 was 12.3$ billion. The main reason is that exports are decreasing due to energy shortage (GOP, 2015).

As the demand for crude oil has been increasing day by day in all over the world, the influence of oil price on exchange rate and exchange rate volatility will become more and more obvious. So, it has become more requisite to study further on the impact of oil price variability on exchange rate fluctuations.

This study contributes to fill the gap in literature regarding oil price variability and exchange rate fluctuations. This paper explores that oil price is also the key variable that determine the real exchange rate of Pakistan. The importance of this study is due to the usage of latest quarterly data from 1983-Q1 to 2014-Q4. In this study, there is the introduction of new variables like CPI volatility, Real Foreign Exchange Reserves, NEWS and Oil Price Volatility. These variables used in the studies of oil exporting countries, but not used in case of Pakistan.

Our study applies EGARCH models to measure exchange rate volatility, CPI Volatility, Real Foreign Exchange reserves and Oil Price Volatility. EGARCH models are free for non-negativity constraints and leverage effect can be analyzed from these models. On the other hand, former studies used ARDL, ARCH, GARCH, IGARCH and TGARCH, models to measure volatility in case of Pakistan. These models measure the symmetric effect in conditional variance only and they do not provide any idea about good news or bad news.

This paper explores the determinant of real exchange rate and the significance of this study can be stated as it will help us to find whether oil price volatility have any impact on exchange rate volatility or not in the presence of control variables like CPI volatility, Real Foreign Exchange Reserves and NEWS. Secondly, this study also determines the influence of regime, political regime and news on exchange rate volatility. After giving detail overview of the exchange rate and oil prices in the introduction, this paper is arranged as follows. Second chapter explains the work of other studies related to the determinants of exchange rate, oil price and its volatility. Third chapter consists of models, description of the variables, estimation techniques and methodology. Chapter forth empirically explores the determinants of exchange rate and investigates the impact of oil price volatility on exchange rate volatility in the context of Pakistan. Finally, chapter fifth deals with conclusions and policy recommendation to higher authorities.

2. Literature Review

Various researchers explored the factors that affect exchange in the presence of oil price by using time series as well as cross sectional data. The empirical analysis on the impact of oil price variability on exchange rate fluctuations has always been a great concern to macroeconomists. Before discussing the literature review, firstly we will highlight some theoretical background of exchange rate. RudigerDornbusch (known as monetarist) presented his Dornbusch Overshooting Hypothesis (sticky price monetary model) or exchange rate overshooting model in 1976. According to this model, if exchange rate disturbance is more than its long run response, this situation is called overshoot (Dornbusch, 1976). Moreover, if a country experience shock (real or nominal), its exchange rate may start to diverge from its equilibrium level because of purchasing power parity (PPP) condition. PPP states that prices are rigid in short run and it adjust slowly in long run. This adjustment of prices directly affects real money balance and indirectly demand for money. Real money balance increases due to a slower moment of prices and in order to compete the money balance, interest rate should have to decrease.

This will increase the demand for money. When prices settle after the disturbance happen, exchange rate shifts back to their original position. Interest rate and exchange rate are attached to the interest rate parity condition. Interest rate differential works as an ancillary factor to determine exchange rates. This relationship is based on uncovered interest rate parity condition. This condition states that the anticipated exchange rate and home and foreign country interest rate should be equal.

In 1964, Balassa- Samuelsson expressed the relationship between equilibrium exchange rate and productivity. The assumption of Balassa- Samuelssonstates that those sectors who exports the goods to another market, has higher productivity as compared to those sectors who have not share in exports. Wages in the tradable sector tend to increase and put pressure on the wages of non-tradable sector. Thus, wages are expected to rise as a whole. This increase in wages will raise prices of non-tradable only because tradable good have one fix price internationally. As a result, home currency real exchange rate will appreciate.

Hau (2002) proved the theoretical essence of Obstfeld-Rogoff model by finding the association between trade integration and exchange rate instability. Adubi and Okunmadewa, (1999), Calderon and Kubota (2009) and Mwangi et al. (2014) verify this model. These studies conclude that exchange rate volatility has an inverse relationship with agriculture exports and if the prices are more elastic, then nominal and real shocks have less impact on the volatility of real exchange rate.

The observed literature showed that there are two main approaches to investigate the impact of news on exchange rate variability; innovation in interest rate and the difference between actual interest rate and expected interest rate (Frenkel, 1981). Galati and Ho (2001) conducted a study on US and Euro area to explore that how much level of daily movements in euro/dollar determined by about the macroeconomic condition in 1999 to 2000. Results demonstrated that there is an appreciable correlation between macroeconomic news and daily movements of the euro against the dollar. Stancik (2006) analyzed on the determinants of exchange rate volatility by six Eastern European Countries and six central countries. Results confirmed that exchange rate volatility have largely affected by the news.

The main findings of Hviding (2004) on the panel of 28 countries showed that higher reserves reduced exchange rate volatility. According to him, higher foreign exchange reserves reduce the likelihood of currency, lower external borrowing cost and improve confidence of investors. These findings are similar with respect to Pakistan (Javed and Farooq, 2009; Khan, 2013). Egert (2002) investigated on Balassa- Samuelsson principle and found a weak association of productivity differential and exchange rate. To explore the relationship between exchange rate unpredictability on productivity growth, Aghion (2009) conducted a study on cross-country panel data (47 countries) that covered the period from 1970 to 2000. Results revealed that when productivity growth of undeveloped countries decreased, exchange rate volatility increased due to decrease in exports.

There are many studies on exchange rate and oil price of Nigeria (oil exporting country) that showed the positive relationship between them (Corden, 1984; Akram, 2004). On the same way, oil price fluctuations positively effect on exchange rate volatility in Nigeria (Selmia et al., 2012; Salisu and Mobolaji, 2013; Ogundipe and Ogundipe, 2013). But

Adeniyi et al. (2012) found out the asymmetric effect of oil price on exchange rate instability of Nigeria by using EGARCH model. These results reported by Cheng et al., (2015) in which oil price, exchange rate and electricity price have a causal asymmetric relationship to each other. Unlike these studies, Babatunde (2015), investigated that oil price shocks depreciated the exchange rate because Nigerian government import more refine oil to other countries when oil prices increase. These results were suggested by Fowowe (2014). Omoniyi & Olawale (2015) used bound testing procedure to explored the relationship between Nigerian exchange rate, oil price and inflation. Results revealed that increase in oil prices is associated with the appreciation of the exchange rate and inflation is linked with depreciation in the long run.

There occurred positive link between the rate of interest and exchange rate volatility because higher interest rate attracts foreign capital that increased surplus in the balance of payment thereby appreciated the domestic currency. Moreover, the rate of exchange depreciated with a rise in inflation of the country because when inflation rises, both public and private sectors shift their profits to abroad. Demand of foreign currency increased, which will effect on the domestic currency through depreciation (Messe & Rose, 1983). Izraf and Aziz (2009) estimated the long run effect of real interest rate differential, real oil price on exchange rate by using monthly data of eight countries over the period of 1980 to 2008. Pooled mean group' results exposed that interest rate differential negatively correlate to exchange rate in Pakistan. This study also explored that higher oil price lead to lower exports and consequently has a negative effect on the value of the exchange rate. This oil price results are consistent with Samara (2009). Jamali et al. (2011) also investigated on oil price shocks on Pakistan and scrutinized that it has significantly effect on interest rate and real effective exchange rate.

Asari et al. (2009) considered VECM in order to analyze the relationship between interest rate and inflation in Malaysia that covers the period from 1999 to 2009. Long run relationship suggested that inflation negatively correlate with exchange rate volatility while interest rate positively in the case of Malaysia. These results are consistent with the study of Danmola (2013). Another study on the Malaysian economy exposed that there exists asymmetric effect between conditional volatility of oil price; indicating that bad news have more effect on the conditional volatility of oil prices as compared to good news (Ahmed and Wadud, 2011)

To explore the relationship between exchange rate and oil price, (Berument et al., 2014) investigated their relative effectiveness on the prices of petroleum products. By using weekly data for seven years (2005-2012), they found that depreciation in exchange rate raised the price of petroleum products, but this increase is comparatively less when oil price increased in long-run and vice versa in short-run. In order to deal with the nonlinear causality of oil importing countries (China and India), Bal & Rath (2015) conduct a study on oil price and exchange rate by using monthly data from 1994 to 2013. After the confirmation of nonlinear causality between oil price and exchange rate through the BDS test (for both countries), results found the bi-directional and uni-directional Granger causality between the variables in India and China respectively.

Earth quake played a vital role by distrubing infrastucture for any economy. Li & Jing (2015) analyzed the after effects of Japan Earthquake on yen exchange rate and on crude oil price. This study found that after an Earthquake experienced, exchange rate appreciated sharply in the short run. This appreciation increased oil prices but in the long

run all these changes become stable. Basnet & Upadhyaya (2015) scrutinized on five Asian countries and examined the impact of oil price volatility on inflation, output and exchange rate through SVAR model. Results demonstrated that oil price volatility has not much impact on output because these countries enclosed large inflow of investment and have enormous exports.

3. Data and Methodology

This section examines the description of variables, availability of data and methodology. Firstly, we will generate the model and then we illustrate the variables in detail.

3.1 Model specification

3.1.1 First Model

To explore the determinants of exchange rate, Real Exports (REXP), Productivity Differential (PROD), Interest Rate Differential (DRR), Real Foreign Exchange Reserves (RFER) and Oil Price (OILP) are taken as independent variable.

$$RER_t = \alpha_o + \beta_1 REXP_t + \beta_2 PROD_t + \beta_3 DRR_t + \beta_4 RFER_t + \beta_5 ROILP_t + \mu_t$$

Where α, β's and μ intercepts, slope and white noise error are term respectively.

3.1.2 Second Model

Second model investigates the link between Real Exchange Rate Volatility (RER_VOL) and Oil Price Volatility (ROILP_VOL). While Real Foreign Exchange Reserves Volatility (RFER _VOL), NEWS and CPI Volatility (CPI_VOL) are control variables.

$$RER\_VOL_t = \alpha_o + \beta_1 RFER\_VOL_t + \beta_2 NEWS_t + \beta_3 CPI\_VOL_t + \beta_4 ROILP\_VOL_t + \mu_t$$

Where α, β's and μ intercepts, slope and white noise error are term respectively.

3.1.3 Third Model

For modeling different NEWS, Regime (REG), and Political Regime (POL_REG) in the third model, we used dummy variables.

$$RER\_VOL_t = \alpha_o + \beta_1 DNEWS_t + \beta_2 RGM_t + \beta_3 POL\_REG_t + \mu_t$$

Where α, β's and μ intercepts, slope and white noise error are term respectively. Higher expectations indicate good news and lower expectation shows bad news. If the expected interest rate differential is greater than the actual interest rate differential then values of NEWS will be negative, indicates the good news, which results increased in exchange rate volatility (Frenkle, 1981).

$NEWS_t$ = *(Home country interest rate – foreign country interest rate)*$_t$ – E_{t-1}*(country interest rate – foreign country interest rate)*$_t$

A dummy variable is considered 1 for positive news and 0 for bad news. Pakistan has faced two exchange rate regimes from the period of 1983 to 2014. A dummy variable is equal to 1 for managing floating exchange rates and for flexible exchange rate it is equal to zero. Since the independence of Pakistan, different political regime (Marshal Law and democracy) has been experienced. A dummy variable is equal to 1 for Marshal Law and 0 for democracy.

3.2 Definitions of Variables

3.2.1 Real Exchange Rate

The RER is the ratio of nominal exchange rate to CPI. The real exchange rate has taken in real form because it adjusts the element of inflation and shows more consistency as compare to nominal exchange rate. It is taken as the dependent variable. The equation of real exchange rate can be explained as,

$$\text{RER}= \frac{PAK}{USA} * \frac{CPI(USA)}{CPI(PAK)}$$

3.2.2 Real Exports

REXP has been constructed to the ratio of exports and consumer price index. It is measured in millions of rupees as constructed by Shaheen (2013). According to Jhingan (2005), if country's exports exceed then exchange rate appreciates because of an increase in the demand of its currency and vice versa.

3.2.3 Productivity Differential

PROD is calculated as output per capita of Pakistan in U.S dollar relative to its main trading partner (U.S). Balassa- Samuelsson (1964) states if output per capita of Pakistan is higher than U.S, indicates exchange rate appreciation. It is measured in millions of rupees.

3.2.4 Real Oil Price

ROILP is the ratio of prices of oil in international market per barrel to CPI. An increase in oil price reduces demand and supply of the economy. The demand of consumers and producers decreases as the result of reduction in disposable income and supply also effects because of an increase in the cost of production (Jin, 2008).

3.2.5 News

News variable is calculated as the difference between information prevail at time period t about the interest rate of home and foreign country and information prevail at time period t-1 about the expected interest rate of home and foreign country (Frenkle, 1981). In the second model, if actual interest rate differential is greater than the expected interest rate differential, it is considered good news because higher actual interest rate shows capital inflows and vice versa.

3.2.6 Real Foreign Exchange Reserves

RFER includes gold and other central bank assets that are easy to trade in international financial markets and come entirely within its control (Manchev, 2009). It is calculated in millions of US$.

3.2.7 Interest Rate Differential

Differential of Real interest rate (DRR) is calculated as

$$\text{DRR}_t = \frac{r}{r^*}$$

Where ***r*** is the real interest rate with respect to home country *and* ***r**** is real foreign interest rate with respect to foreign country. If the domestic rate of interest is more than foreign rate of interest then this results the appreciation of the exchange rate due to the inflow of foreign capital.

3.2.8 Exchange Rate Volatility, CPI Volatility and Real Foreign External Reserves Volatility

Volatility in exchange rate, CPI and foreign reserves shows the alteration magnitude. The greater the magnitude of adjustment, more volatile the exchange rates will be. Freely floating exchange rates are usually volatile. RFER and CPI have also volatile nature because of dismissive government policies.

3.3 Data Sources and range

This study used data from 1983Q1 (July- September) to 2014Q4 (April 2015- June 2015). The data of all the variables (above mentioned) are acquired from World development indicators, International financial statistics, State bank of Pakistan, West Texas Research Group (WTRG) and Economic Survey of Pakistan (ESP) 2014-15.

3.4 Methodology

This section has great importance because the selection of appropriate methodologies, which will use further in econometric model, needs great attention. In this study, time series data (Quarterly) have been utilized that contained so much problem of non-stationarity. In order to deal with this problem, we used Johansen Cointegration and VECM. Moreover, the reason of applying this method is that all the variables are integrated of order 1, while applying ADF. EGARCH (1, 1) has been used to estimate the volatility of exchange rate, foreign exchange reserves and CPI as reported by Ahmed and Wadud (2011) andAdeniyi et al. (2012) by applying EViews7 software. GARCH has not used here because it does not provide any idea on asymmetric effect. Nelson (1991) measured the asymmetric effect of time varying variance presented EGARCH.

$$\text{Log } (h_t^2) = \alpha_0 + \sum_{j=1}^{q} \alpha_i \ln \left| \frac{\varepsilon_{t-j}}{\sqrt{h_{t-j}}} \right| + \sum_{j=1}^{q} \xi \frac{\varepsilon t-j}{\sqrt{ht-1}} + \sum_{i=1}^{p} \delta \log (h_{t-i})_t$$

α_0 shows the mean equation of EGARCH. α_i represents the behavior of volatility due to shock. The coefficient δ shows different aspects of shock. If δ is less than one, indicates that the data is stationary. The Coefficient ξ shows the asymmetric response of volatility and informs us about leverage effect. If its value is less than zero, then good news produces lower volatility than bad news. The term log (h_t^2) on the left hand side shows the conditional variance. A significant and negative ξ implies the presence of the "leverage effect". After computing volatility, we determined appropriate lag length by considering VAR (Vector Autoregressive) lag length criteria. Next step is to determine the number of cointegration equations by using Trace Statistics and Maximum Eigen values. If the equations are co integrated to each other than the normalized equation may possibly be used for long run coefficients. In the short run, we must be more concern on the sign of ECM.

4. Results and Discussions

4.1 Residual Analysis through EGARCH

Descriptive statistics is the best technique to analyze volatility. The above figures of RER_VOL_t, $OILP\_VOL_t$, $RFER\_VOL_t$ and CPI_VOL_t shows that the distribution is not normal because values of skewness are negative for all the variables except RER_VOLt and kurtosis's values are more than 3 for all variables. This shows that the distribution is

leptokurtic. Value of Jarque-Bera are 131.9, 203.9, 31.0, 10.7 for RER_VOL_t, $OILP\_VOL_t$, $RFER\_VOL_t$ and CPI_VOL_t respectively, supports that distribution or residual series are not normal.

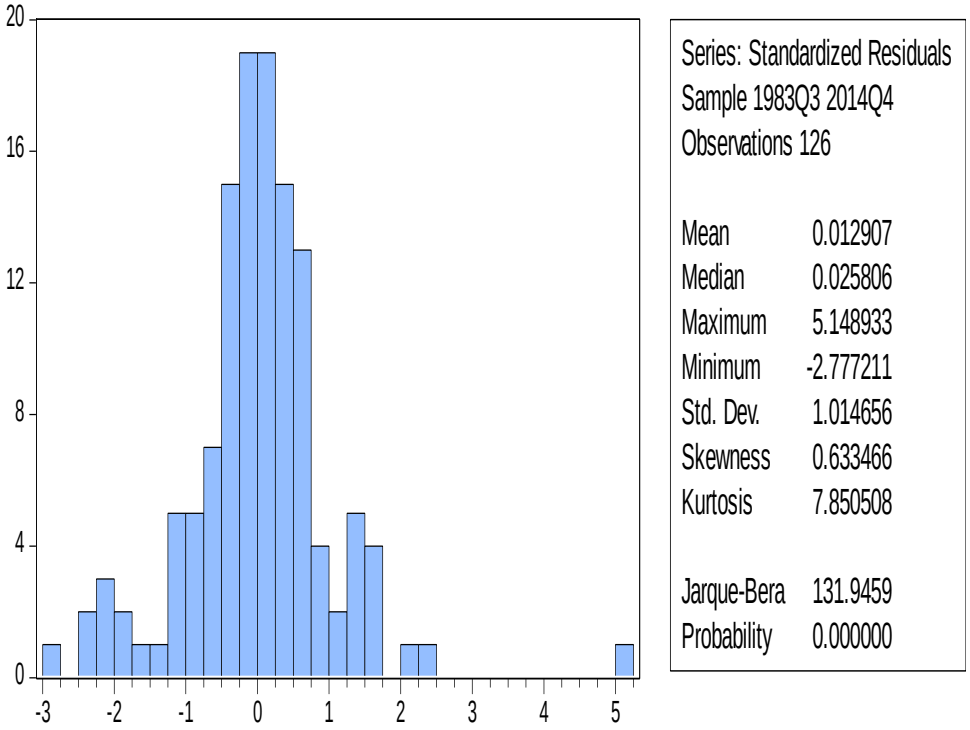

Figure 1: Residual Analysis of RER_VOL_t

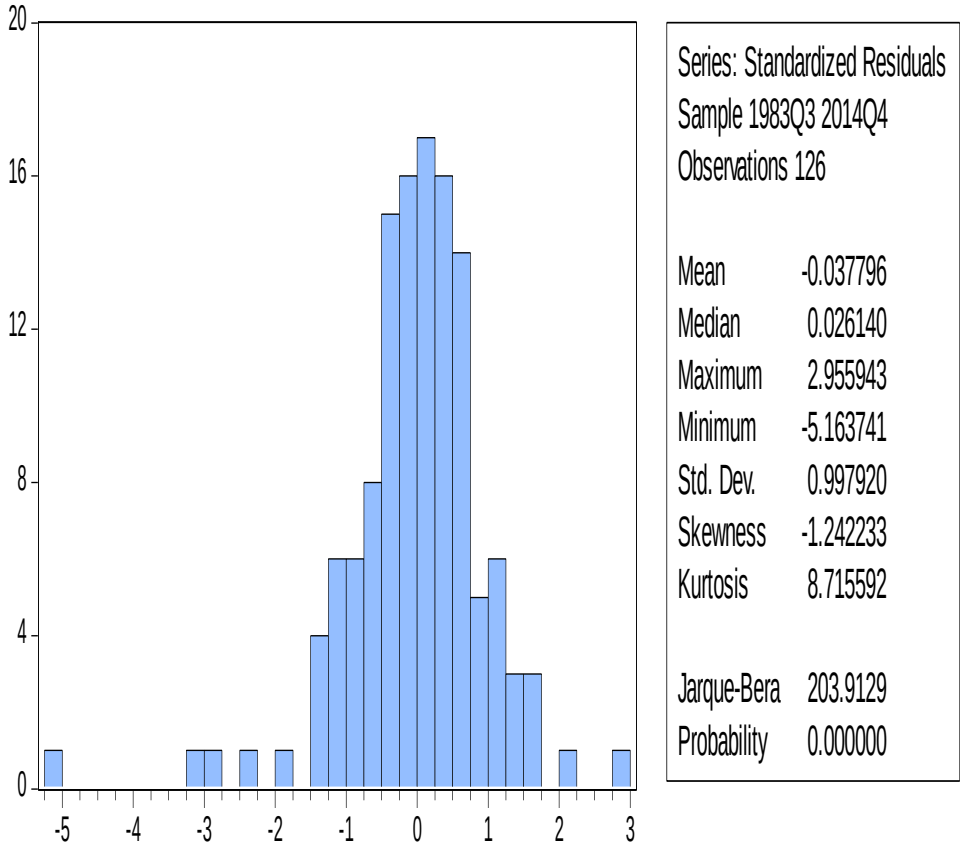

Figure 2: Residual Analysis of $OILP\_VOL_t$

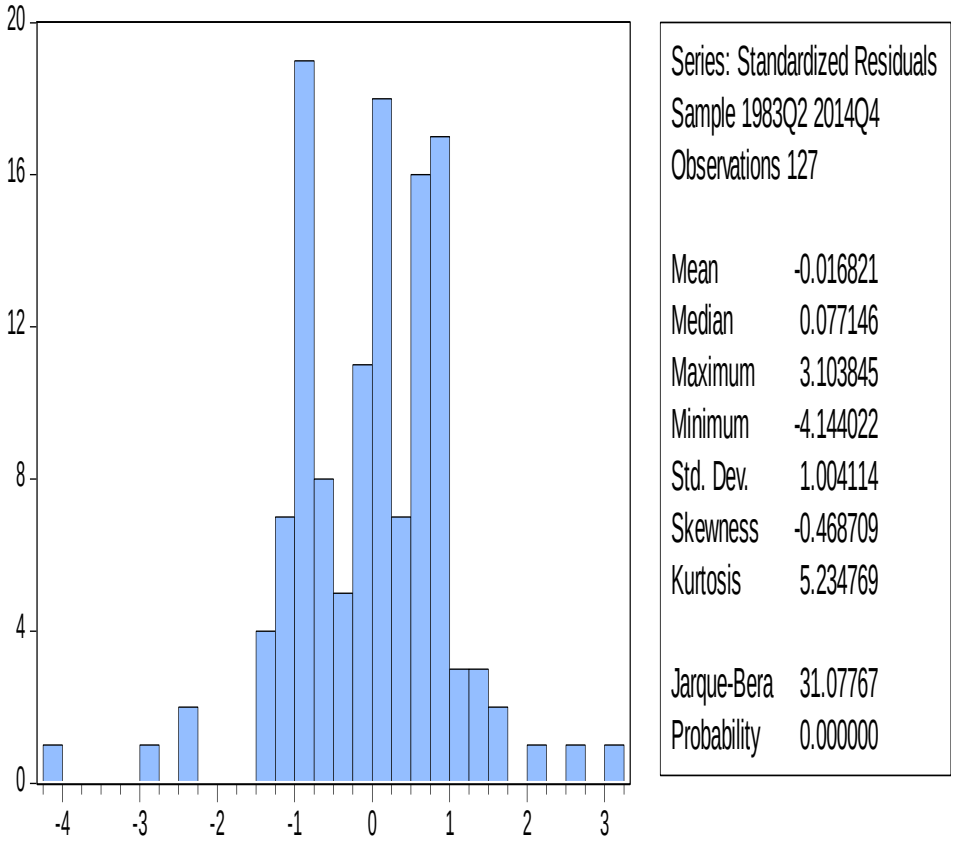

Figure 3: Residual Analysis of RFER_VOL$_t$

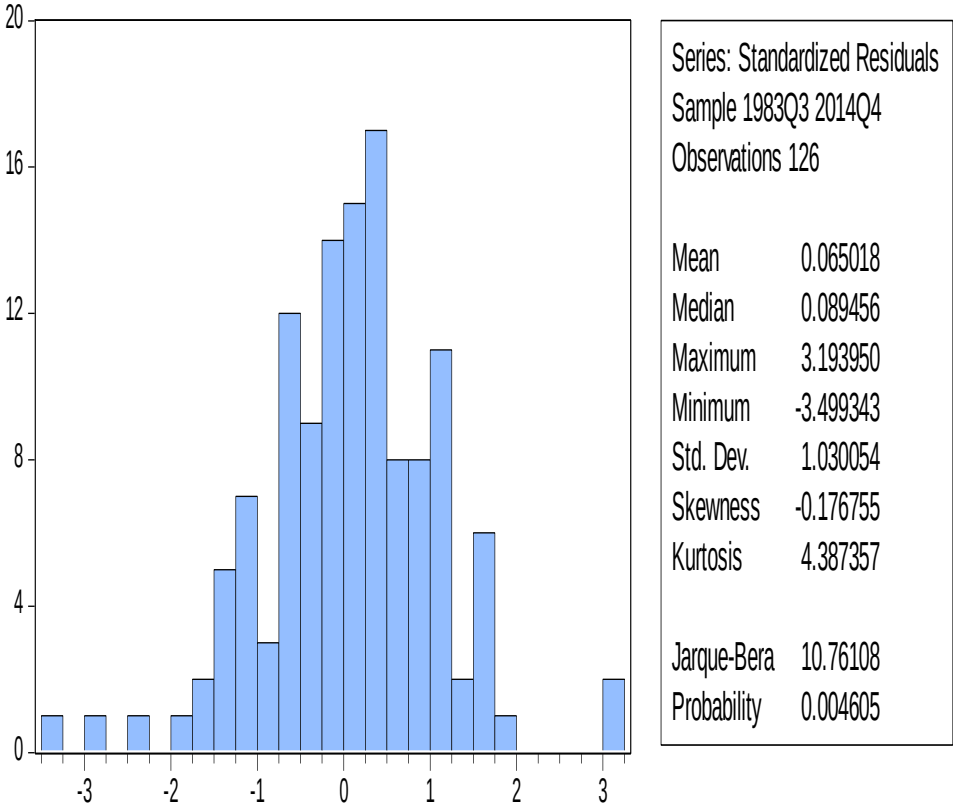

Figure 4: Residual Analysis of CPI_VOL_t

4.2 Estimated Results of RER_VOL_t, $OILP\_VOL_t$, $RFER\_VOL_t$ and CPI_VOL_tthrough EGARCH (1,1)

Estimated results of Exchange Rate Volatility and Oil Price Volatility are reported in the table 1 while foreign exchange reserves volatility and CPI volatility' results are stated in table 2.

Table 1: EGARCH (1,1) Results of Exchange Rate Volatility and Oil Price Volatility

Mean Equation (Dependent Variable) Rer				**Mean Equation (Dependent Variable) Roilp**			
Variables	**Coefficient**	**Sd. Error**	**Probability**	**Variables**	**Coefficient**	**Sd. Error**	**Probability**
C	0.0107	0.002	0.0001	C	0.5241	0.842087	0.3997
Rer(-1)	1.303	0.104	0.0000	Roilp(-1)	1.2527	12.95383	0.0000
Rer(-2)	-0.330	0.100	0.0011	Roilp(-2)	-0.3174	-3.565554	0.0004
Variance Equation				**Variance Equation**			
Parameters	**Coefficient**	**Sd. Error**	**Probability**	**Parameters**	**Coefficient**	**Std. Error**	**Probability**
A_0	-0.936	0.389	0.0160	A_0	-8.727	0.503	0.0000
A_1	0.535	0.1355	0.0001	A_1	-0.130	0.151	0.3883
Ξ_1	-0.2770	0.090	0.0021	Ξ_1	-0.327	0.058	0.0000
Δ_1	0.958	0.027	0.0000	Δ_1	-0.749	0.107	0.0000
R. Squared		0.9989		R. Squared		0.8788	
Adjusted R-Squared		0.9989		Adj. R-Squared		0.8788	
Sum Squared Resid		0.00036		Sum Squared Resid		0.970	
Log Likelihood		656.36		Log Likelihood		138.83	
Durbin-Watson Stat		1.8340		Durbin-Watson Stat		1.9783	

Source: Authors' own calculations

This table shows the mean and variance results of volatility in exchange rate and oil price. EGARCH (1, 1) has been selected because of lowest AIC (Akaike Info Criterion) and SIC (Schwarz Info Criterion) and the series of AR lag models have chosen through skewed t as the distribution. The coefficient of RER (-1) and RER (-2) shows that the first and second lag of real exchange rate has a positive and negative effect on real exchange rate respectively. Value of mean (volatility equation) $\alpha_\circ$ is (-0.93) which is significant at 5% level of significance while a positive sign of "α_1" (information term) shows more uncertainty in time period 't' because of higher volatility of the exchange rate in last period. The absolute value of δ_1 is less than 1, shows that data is stationary. The negative term ξ_1 (-0.277) is statistically insignificant, shows that negative shock (depreciation) in exchange rate put larger impact on volatility than positive shock.

On the other hand, results of oil price (mean equation) show that first lag of oil price has positive and second lag has negative impact on oil prices. Insignificant values of α_1 indicates that volatility in oil prices in the last period have not any impact in time period 't'. Negative value of ξ_1 depicts the leverage effect; means negative shock in oil price has larger effect on volatility than positive shock). The absolute value of δ_1 is less than 1, shows absence of the problem of a unit root.

Table 2: EGARCH (1,1) Results of Real Foreign Exchange Reserves Volatility and CPI Volatility

Mean Equation (Dependent Variable) RFER				**Mean Equation (Dependent Variable) CPI**			
Variables	**Coefficient**	**Sd. Error**	**Probability**	**Variables**	**Coefficient**	**Std. Error**	**Probability**
C	0.052	0.0047	0.0000	C	721.17	6.5046	0.0000
RFER(-1)	0.0963	0.0999	0.0000	CPI(-1)	1.4666	25.249	0.0000
				CPI(-2)	-0.4673	-2.8221	0.0000
Variance Equation				**Variance Equation**			
Parameters	**Coefficient**	**Sd. Error**	**Probability**	**Parameters**	**Coefficient**	**Sd. Error**	**Probability**
α_0	-0.901	0.506	0.0002	α_0	0.2346	0.0869	0.0070
α_1	1.1158	0.261	0.0000	α_1	0.3499	0.1199	0.0030
ξ_1	0.161	0.150	0.2814	ξ_1	0.0915	0.0509	0.0723
δ_1	0.894	0.036	0.0000	δ_1	1.0082	0.0811	0.0000
R. Squared		0.882		R. Squared		0.9955	
Adj. R-squared		0.881		Adj. R-squared		0.9954	
Sum squared resid		0.020		Sum squared resid		3.338	
Log likelihood		681.05		Log likelihood		-185.41	
Durbin-Watson stat		0.867		Durbin-Watson stat		1.4686	

Source: Authors' own calculations

This table illustrates the behavior of foreign exchange rate volatility and CPI volatility. Results show that first lag of real foreign exchange reserves and the CPI have positive effect on current reserves and CPI while second lag (CPI) have a negative impact on CPI. Positive and significant values of α_1 shows that higher volatility in foreign exchange reserves and CPI in last period creates more uncertainty in time period 't' while insignificant values of ξ_1 depicts that positive or negative news of foreign exchange reserves and the CPI have not any impact on their volatilities.

4.3 Unit Root Analysis

ADF test has used to check whether the variables are stationary or not. As, it can be seen in table 3, that all the variables have the problem of unit root at 1% level of significance. On the other hand, table 4 showed that all the variables have become stationary on first difference because all the statistical values are less than critical values and probability is less than 0.05. Therefore, we reject H_o and accept the alternative hypothesis that the data is stationary.

Table 3: ADF Test Result at the Level

Variables	ADF Test Statistics	Probability	Lag Length	Intercept/ Trend and intercept/ None
RER	-3.0659	0.1191	0	Trend and intercept
PROD	0.23492	0.9981	7	Trend and intercept
REXP	-1.24413	0.8962	5	Trend and intercept
RFER	-2.34107	0.4085	7	Trend and intercept
DRR	-2.77227	0.2104	4	Trend and intercept
OILP	-3,07611	0.1167	4	Trend and intercept
NEWS	-3.17226	0.0042	8	Intercept
RER_VOL_t	-3.82057	0.0186	3	Trend and intercept
$ROILP\_VOL_t$	-0.20131	0.6117	6	none
$RFER\_VOL_t$	-0.82859	0.1900	1	Trend and intercept
CPI_VOL_t	5.82510	1.0000	12	Trend and intercept
Critical Values for Unit root test				
Level of significance	**None**	**With intercept**	**With trend and intercept**	
1%	-2.584539	-3.490772	-4.039075	
5%	-1.943540	-2.887909	-3.44902	
10%	-1.614941	-2.580908	-3.14972	

Table 4: ADF Test Result at 1st Difference

Variables	ADF Test Statistics	Probability	Lag Length	Intercept/ Trend and intercept/ None
RER	-9.14889	0.0000	0	Trend and intercept
PROD	-4.73441	0.0010	7	Trend and intercept
REXP	-7.40809	0.0000	4	Trend and intercept
RFER	-4.58775	0.0017	7	Trend and intercept
DRR	-6.06340	0.0000	4	Trend and intercept
OILP	-6.64912	0.0000	4	Trend and intercept
NEWS	-5.54979	0.0000	8	Trend and intercept
RER_VOL_t	-6.60627	0.0000	3	Intercept
$ROILP\_VOL_t$	-8.51750	0.0000	5	None
$RFER\_VOL_t$	-8.90426	0.0000	1	Trend and intercept
CPI_VOL_t	-4.62240	0.0016	11	Trend and intercept
Critical Values for Unit root test				
Level of significance	**None**	**With intercept**		**With trend and intercept**
1%	-2.584539	- 3.490772		-4.039075
5%	-1.943540	-2.887909		-3.44902
10%	-1.614941	-2.580908		-3.14972

Source: Authors' own calculations

4.4 Cointegration Test Results (1st model)

Results of 1st model are estimated through Johansen- Juselius Cointegration because all the variables are I (1). After selecting the lag length (that is Nine based on AIC), next step is to investigate the presence of long-run relationship between the variables that are reported in table 5 and 6.

Table 5: Trace Statistic Results Based on Johansen Cointegration

Hypo. Number of CE(s)	Eigen value	Trace Statistic	0.05Critical Value	Probability
None *	0.473210	175.5674	95.75366	0.0000
At most 1 *	0.257874	101.8577	69.81889	0.0000
At most 2 *	0.231972	67.56051	47.85613	0.0003
At most 3 *	0.167238	37.20860	29.79707	0.0058
At most 4*	0.084861	16.16277	15.49471	0.0396
At most 5*	0.050544	5.964592	3.841466	0.0146

Source: Authors' own calculations

Table 6: Maximum Eigen value Statistic Results Based on Johansen Cointegration

Hypo. Number of CE(s)	Eigen value	Max-Eigen values	0.05 Critical Value	Probability
None *	0.473210	73.70964	40.07757	0.0000
At most 1 *	0.257874	34.29724	33.87687	0.0445
At most 2 *	0.231972	30.35191	27.58434	0.0215
At most 3	0.167238	21.04584	21.13162	0.0514
At most 4	0.084861	10.19817	14.26460	0.1992
At most 5*	0.050544	5.964592	3.841466	0.0146

Source: Authors' own calculations

Trace test statistics results indicate that there exists six-cointegration equation because results are momentous on 5% significance level. The null hypothesis of at most six-cointegration equation is not rejected. Maximum Eigen statistics identify that there subsists three-cointegration equation because probability is greater than 0.05, means null hypothesis of at most three-cointegration equation is not rejected. Therefore, these results show that RER, REXP, PROD, DRR, RFER and ROILP have an equilibrium condition in the long run. The cointegrated results through Johansen- Juselius Cointegration normalized to RER are stated as below.

RER_t= 0.102574- 4.04E-05 $REXP_t$+ 5.266554 $PROD_t$ - 0.001965 DRR_t - 0.385484 $RFER_t$- 0.042452$ROILP_t$

T-statistics = [-4.46658] [2.31885] [-3.43601] [-4.01878] [-1.84773]

All the variables in this equation are significant at the 5 percent level of significance. This equation explains that exports and exchange rate have negative relationship to each other. Higher level of exports depreciate exchange rate rather than appreciate because in case of Pakistan when exports increase, imports also increase that adversely impact on balance of payment. This result is consistent with the results of Genc & Artar (2014). This result can

be explained as 1 percent increase in exports leads to 4.04 percent depreciation in the exchange rate in long run. Results of productivity differential and exchange rate show positive correlation to each other; indicated that increase in productivity differential leads to appreciation in exchange rate. This appreciation proved Balassa-Samuelson principle. This result is consistent with the study of Razi et al. (2012). Similarly, there exist a negative relationship between interest rate differential and exchange rate. 1 percent increase in interest rate differential (r/r*) depreciates the exchange rate by .0019 percent because increase of interest rate reduces the demand for money that plunges the value of currency. This finding is matched with Izraf & Aziz (2009). Significant results of foreign exchange reserves show that 1 million increases in RFER lead to 0.385 percent depreciation of the exchange rate as results suggested by Khan (2013). This depreciation of exchange rate is due to increase in reserves through aid, grant, Extended Fund Facility (EFF) and loans that IMF paid to Pakistan. Results also show that 1 percent increase in oil price leads to 0.04 percent depreciates the exchange rate. This result is similar to the finding of Izraf & Aziz (2009), Ahmed & Wadud (2011), Krugman (1983), Salisu & Mobolaji (2013). This result verifies Dornbusch Model. Theoretically, Dornbusch (1976) stated that if a country experience shock (real or nominal), its exchange rate may start to diverge from its equilibrium level because of purchasing power parity condition and depreciates the exchange rate.

4.4.1 VECM (Vector Error Correction Model) 1st Model Results

First model results prove the existence of long run relationship. Therefore, VECM can be applied to analyze the short run characteristic of cointegrated series. Table 7 shows that ECMterm or the speed of adjustment coefficient for RER is -0.03. ECM suggests that these variables converge towards its long run equilibrium quarterly in moderate speed after an oil price shock or shock in other explanatory variables. Asari (2011) proved these results in his paper.

Table 7: VECM result of 1st Model

Variable	Coefficient	Standard Error	T-Statistics
ECT	-0.035417	0.01138	-3.11316

4.4.2Impulse Response Function (IRF) 1st Model Results

IRF tells us about the variation in RER due to one standard deviation change in PROD, DRR, REXP, RFER and OILP. Some previous studies like Naka & Tufte (1997) and Ahmed & Wadud (2011) have used this approach to examine the variation. So, graphic form is stated as below:

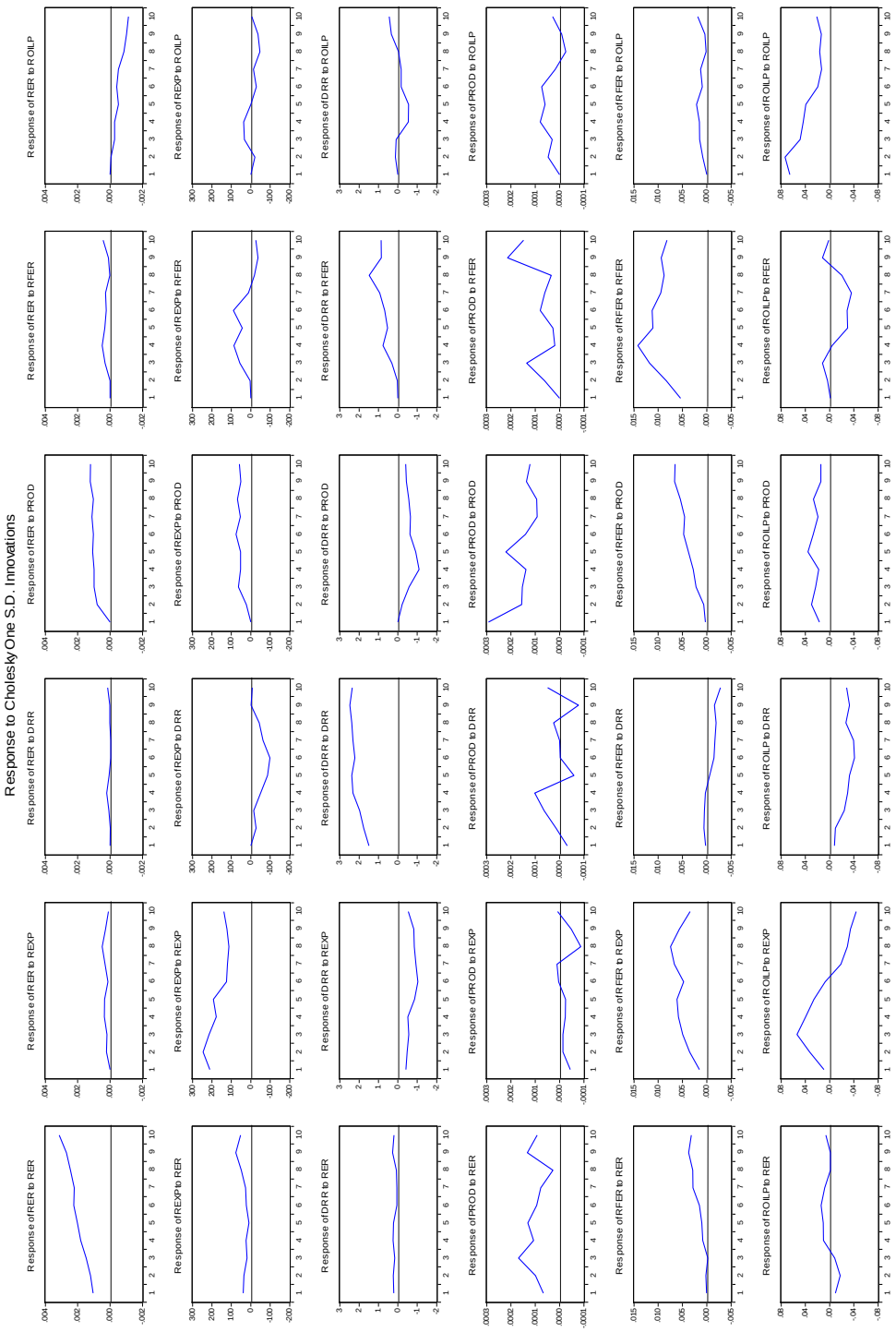

Figure 5: Impulse Response Function Graph (1st Model)

The graph of exchange rate to a unit shock in its own exchange rate is positive throughout the next ten quarters. It can be seen that positive shocks in real REXP, RFER and PROD have positive effect on RER, means a positive shock in exports, foreign exchange reserves and productivity differential lead to appreciation in exchange rate into ten quarters. The variation of RER to a unit deviation in DRR will be positive from third to fifth quarter, while other quarters will not show any response to shock. Similarly, the reaction of RER to positive shock in OILP has negative to overall the selected quarters.

4.5 Cointegration Test Results (2nd model)

Results of second model have estimated through Johansen- Juselius Cointegration. After selecting the lag length (based on AIC), the next step is to find out that how many numbers of cointegration equation exist. Table 8 and 9 exposes the presence of the long run relationship between the variables or not.

Table 8: Trace Statistic Results Based on Johansen Cointegration

Hypo. Number of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Probability
None *	0.871186	313.2991	69.81889	0.0001
At most 1*	0.469061	94.01511	47.85613	0.0000
At most 2	0.174166	26.27250	29.79707	0.1207
At most 3	0.041308	5.796836	15.49471	0.7194
At most 4	0.011919	1.282980	3.841466	0.2573

Source: Authors' own calculations

Table 9: Maximum Eigen value Statistic Results Based on Johansen Cointegration

Hypo. Number of CE(s)	Eigen value	Max-Eigen values	0.05 Critical Value	Probability
None*	0.871186	219.2840	33.87687	0.0001
At most 1*	0.469061	67.74261	27.58434	0.0000
At most 2	0.174166	20.47566	21.13162	0.0615
At most 3	0.041308	4.513856	14.26460	0.8015
At most 4	0.011919	1.282980	3.841466	0.2573

Source: Authors' own calculations

Both Trace statistics and Maximum Eigen values indicates that there exist two cointegration equations at 5% level of significance. A null hypothesis of no cointegration on at most one equation is rejected because calculated value is greater than tabulated value at 5% level of significance. Therefore, these results confirm that RER_VOL, RFER_VOL, NEWS and CPI_VOLhave equilibrium condition in long run. The cointegrated results through Johansen- Juselius Cointegration normalized to RER_VOL are stated as below.

Positive sign of foreign external reserves shows the inverse relationship between real foreign external reserves volatility and real exchange rate volatility. Pakistan receives

loan, aid and grant from different developed countries that creates fluctuations in reserves. Moreover, gold and other assets of central bank like bond and certificates are bought and sold in international and domestic market to fulfill the gap of budget deficit. This fluctuation in reserves affects exchange rate and make it volatile. This result is consistent with Hviding (2004).

RER_VOL_t= -3.94E-05 +0.047 E-08 $RFER\_VOL_t$ -1.00 E-06 $NEWS_t$ +5.46E-07 CPI_VOL_t +0.0055 $ROILP\_VOL_t$

T-statistics = [36.9070] [-4.22846] [8.05686] [14.9096]

Positive sign of NEWS showed that actual values of interest rate are less than expected value. Higher expectation means that investors are more volatile about their decision. So, this uncertain situation highly effect on exchange rate volatility as results suggested by Stancik (2006). Results of CPI volatility indicate higher the volatility in CPI, more volatility will be observed as results reported by Parker, M. (2014). Positive and significant oil price volatility results show that 1 percent increase in volatility of oil price, exchange rate leads to volatile about .0055 percent. This result matched with the study of Selmia et al. (2012), Ogundipe & Ogundipe (2013).

4.5.1 VECM Results

The ECM or speed of adjustment coefficient suggests that these variables converge towards its long run equilibrium level quarterly in a moderate speed after an oil price shock. These results were consistent with Aliyu (2009).

Table 10: VECM result of 2nd Model

Variable	Coefficient	Standard Error	T-Statistics
ECT	-0.874250	0.31891	-2.74140

4.5.2 Impulse Response Function (IRF) 2nd Model Results

Graph of real exchange rate volatility to a unit shock in its own volatility is positive up to six quarter then it becomes negative in seventh quarter to shock. Exchange rate volatility converts negative to positive after seventh quarter. A positive shock in CPI volatility has positive effect on real exchange volatility up to ninth quarter but after this quarter, the positive shock will effect negatively on the volatility of exchange rate. The reaction of real exchange rate volatility to one standard deviation shock in News and foreign exchange reserves is negative and positive respectively throughout the tenth quarter. Shock in real exchange rate volatility has positive on oil price volatility until seven quarter but after this quarter, this shock has negative impact on oil price volatility.

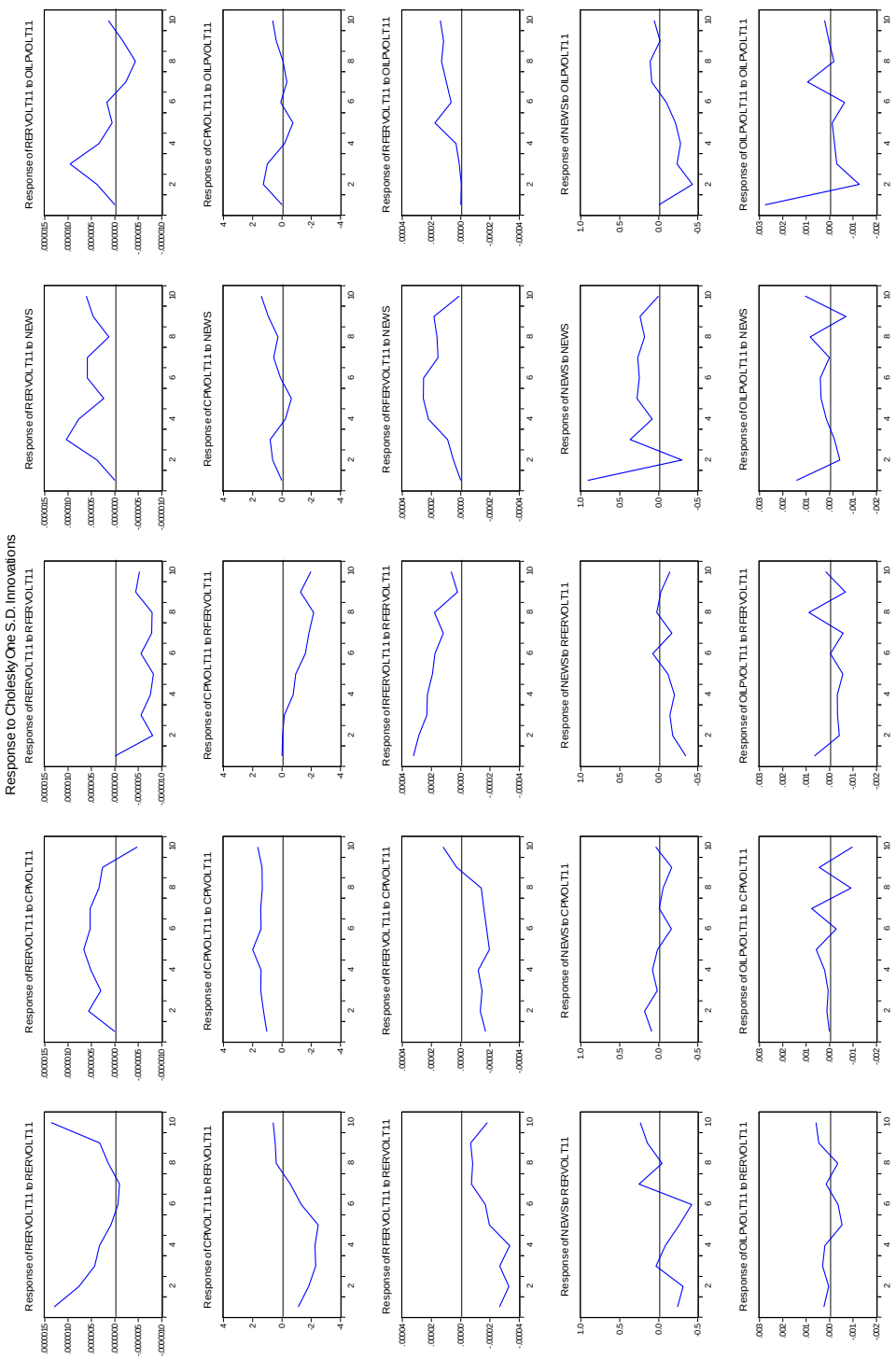

Figure 6: Impulse Response Function Graphs (2nd Model)

4.6 OLS Results (3rd Model)

OLS results show that NEWS and POL_REG has not significant impact on real exchange rate volatility because their t- statistics are insignificant. On the other hand, positive sign of regime variable investigates that floating exchange rate experience more volatility in its regime as compare to managed floating exchange rate. Null hypothesis is rejected at 5% level of significance.

RER_VOL_t= 1.89E-06-2.18E-07 $DNEWS_t$ + 3.12E-06REG_t- 8.94E-07 POL_REG_t

T-statistics = [-0.454299] [5.755780] [-1.538217]

5. Conclusions

Pakistan experienced too much variation in crude oil prices in last decades. Importance of crude oil can be recognized from the fact that it uses in all the sectors of the economy. For this purpose, we focused on crude oil price and their volatilities. This study observes the impact of oil price volatility on exchange rate fluctuations and finds out the determinants that affect real exchange rate. For this purpose, we developed three models by using quarterly data from 1983Q1-2014Q4. This study applied different econometric techniques to capture the appropriate results. ADF test has used to test the stationarity of variables because this technique is considered the best technique to examine unit root. This test confirms that all the variables are integrated in order one. Volatility is measured through EGARCH (1, 1) as it is considered the best technique that restrains the power of non-negativity constraint. Lag length of all models is selected through AIC.

Results of EGARCH (1, 1) shows that negative shock in oil price and exchange rate have larger effect on their volatilities than positive shocks positive. On the other hand, negative news of foreign exchange reserves and CPI has not any impact on their volatilities. Based on the finding of Trace and Max Eigen statistics, first model results show the existence of long run relationship between the variables. Significant results of productivity differential, oil prices, exports and interest rate differential confirm that Balassa Samuelson, Dornbusch Model, Obstfeld Rogoff, and un-covered interest rate parity conditions are applicable in Pakistan. ECM suggests that all the variables in first model converge towards its long run equilibrium quarterly in moderate speed after an oil price shock or shock in other explanatory variables as reported by Asari (2011). On the other hand, second model confirms the results of Selmia et al. (2012) and Ogundipe & Ogundipe (2013); states that oil price volatility positively effect on exchange rate volatility. Furthermore, other control variables like real foreign external reserves volatility, CPI volatility and NEWS also have significant impact on exchange rate variability. These results are suggested by Hviding (2004), Stancik (2006) and Parker, M. (2014). Another important finding regarding exchange rate regime is that during the period of floating exchange rate, exchange rate volatility remains low as compare to managed floating exchange rate.

IRF results depicted that the reaction of RER to a unit shock in RER is positive on exports, foreign exchange reserves and productivity differential, while it has a negative effect on oil price throughout the tenth quarters. Moreover, reaction of real exchange rate volatility to a unit shock in Real exchange rate volatility, NEWS and CPI volatility have

positive while RFER volatility has negatively related to one standard deviation shock in real exchange rate volatility throughout the tenth quarters.

Pakistan has chosen as an oil importing country; future research can be made on cross sectional countries by using monthly data or daily data of variables. This study focused only one oil importing country, so future studies should be extended to oil exporting countries.

5.1 Policy Implications

Finally, some policy recommendations are drawn on the basis of results. Fluctuations in oil prices are the major cause for volatility in exchange rate. Government should not give subsidies on crude oil when oil price goes to decrease because it creates more volatility that directly hits investor's decision. Government should take serious steps to improve market efficiency and make sure that any variability in oil prices is essential and not negligible. Transparency should be improved in demand side and supply side that will help us dwindling the volatility of oil prices. Government should make stable economic policy to keep exchange rate and exchange rate volatility stable. Appreciation is healthier for a country but in case of Pakistan (where there are so many problems of energy crises that lowers the level of exports), it has less beneficial. On the other hand, depreciation has positive impact on a country but it also increase debt burden. Fiscal and monetary policy can play their role for the stability of exchange rate; fiscal policy can contribute by keeping away from large and volatile swings in the size of production and exports while monetary policy can play its role by ensuring that foreign external reserves and interest rate are stable with domestic price level. The burden of increased oil price should not shift to the consumers. Government should bear the expensed of increased oil prices itself in order to keep the domestic demand of oil stable. By ignoring the leverage effect of foreign exchange reserves volatility and CPI volatility, Government should be worried about negative shocks in oil price and exchange rate because negative shocks have larger effect on volatility than positive shock.

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