Impact of oil price volatility on macroeconomic variables: an ARDL approach

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Impact of oil price volatility on macroeconomic variables: an ARDL approach

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Abstract:

The impact of oil price shocks on the macro economy has received considerable attention for many decades. Although a majority of initial empirical studies found a significant negative influence between oil prices shocks and GDP, however more recently, empirical researches have showed an insignificant relationship between oil shocks and the macro economy. In fact, while most of the existing research applies to advanced, oil importing countries, results for oil exporting countries are expected to be different. However, this only can be ascertained empirically. Therefore, this study makes an attempt to examine the impacts of oil price shocks on an oil-exporting country such as, Russia by applying an ARDL model which has taken care of a major limitation of the conventional co-integrating tests in that they suffer from pre-test biases between the variables. The data in this study is quarterly for major macroeconomic variables such as GDP, real exchange rate, government expenditure, net exports, and inflation rate. The standard time series techniques are applied. The results showed that with the exception of net exports, other macroeconomic variables did not experience considerable changes following the oil price shocks. Therefore, by controlling the net exports, the policy makers can reduce the negative impacts of oil prices shocks on the macroeconomy of the country.

Keywords: oil price volatility, macroeconomic variables, VECM, VDC

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1 INTRODUCTION

The oil price attracts a great deal of attention for many decades. Many attempts have been undertaken to explain the behaviour of the oil price as well as to evaluate the macroeconomic outcomes of oil price shocks. Constant oil shocks could have severe macroeconomic implications, hence bringing challenges for policy making either fiscal or monetary in both the oil exporting and oil importing countries for past three decades. Therefore, policymakers are concerned with oil price levels and large movements in oil prices (Kim and Loughani, 1992; Hamilton, 1996).

Significant oil prices fluctuations are an important factor influencing real economic variables, especially in the countries which are significantly dependent on the oil and energy-intensive sectors. Russia is absolutely within this group where crude oil revenues account for roughly one third of total export. Table 1 shows some indicators for the importance of oil exports to Russia's economic development. Therefore, oil prices have implication not only to the GDP of Russia and export/import growth of the country but also to the budget deficit and other related issues like social policy and inequality. For instance, negative oil prices shocks during recent financial crises can be considered as the key factors that led to significant welfare losses and poverty increase in Russia, while positive shocks have counter effects during before the crises period (World Bank, 2008; Cerami, 2009). Moreover, periods of abrupt fall of oil prices (especially in 1998, 2008 and 2014) corresponded with economic crises in Russian economy. Thus, significant impact of oil prices and oil export dynamics on important Russian macroeconomic variables should be expected. In such conditions, it is natural to consider the possibility of economic policy to fine tune the real economy, achieve inflation stability and to weaken the negative influence of oil prices shocks.

However, the current academic literature suffers from a paucity of research on the macroeconomic impact of oil price fluctuations on the economic growth of Russia and the correlation between the GDP growth rate and oil prices. However still, discussion concerning Russia's oil dependence has become more interesting and controversial. In several occasions during fall 2001, it was argued that decreases in oil prices have no negative impact on real GDP growth.[1]Because these views were based on a macroeconomic model developed for the Russian Ministry for Economic Development and Trade, they might have an influence on decision-makers. Therefore, there is an additional motivation to examine and elaborate on the issue.

[1]For example, Rudiger Ahrend, "Better Low than High" The Moscow Times, 16 October 2001

Date	Total exports	Gov't revenues	Employment
2001	24.5	15.4	2.1
2002	27.0	14.7	1.8
2003	29.2	15.1	1.9
2004	32.2	19.0	1.8
2005	34.1	26.2	1.8
2006	33.8	32.7	1.7
2007	34.2	30.1	1.9
2008	36.0	31.3	1.9

Table 1. Oil's Share of Exports, Government Revenues and Employment (in %)

Therefore, it would be very interesting and useful to investigate the impact of oil prices shocks to macroeconomic variables in Russia since it will give benefits to policymakers as well as investors and also helps the country to prosper well. That is why, this study attempts to examine the relationship between oil price shocks and major macroeconomic variables and to investigate how the volatility will impact the variables.

Formally, this study has two research questions:

1. Is there is any relationship between oil prices volatility and macroeconomics variables? (GDP, net exports, real exchange rate, inflation rate and government expenditure)
2. If there is a relationship between oil prices volatility and macroeconomic variables, which variables will be impacted most by the oil price shocks and should be controlled first by the policy makers?

This study will be another version from previous studies which we focus on five macroeconomic variables (GDP, Net Export, Real Exchange Rate, Inflation Rate and Government Expenditure) and see how oil price volatility impact on those variables using Auto-Regressive Distributive Lag (ARDL) approach. We found some contradicting results between Error Correction Model and Variance Decompositions. Not surprisingly that we found net export to be exogenous and rank as the most leading variable, from this observation we can come to conclusion that oil price volatility gives a big impact on the net exports of Russia, while other macroeconomic variables did not show considerable changes following the oil price shocks. This finding confirms the earlier studies and also the nature of Russian economy itself which is oil export dependent.

The rest of the paper is organized as follows. The section 2 will be the literature review on some studies that has been carried out regarding the oil price shocks on the macroeconomics variables. The section 3 will discuss on the model and the methodology that we have employed for this study, while section 4 will present the findings of our study. The section 5 proposed some policy implications that can be derived from our findings and the sections 6 and 7 will be our concluding remarks and address on the limitation of our study.

2 LITERATURE REVIEW

The impact of oil price shocks on the macro-economy has received a great deal of attention over the past three decades when the recessions occurred in USA and some European countries were preceded by oil shocks, which mainly arose as a result of Middle East conflicts. This caused to an increasing of studies that attempted to draw the causal link between oil prices shocks and macroeconomic activities. Therefore, there are several studies addressing the question of whether there is a relationship between oil price shocks and macroeconomic key variables.

Early study on oil price effects done by Darby (1982) and Hamilton (1983) focused on the economy of the US. While Darby could not find a particular relationship between oil prices and macroeconomic key variables, based on the Hamilton's work, oil price shocks were an important factor in almost all US depressions from 1949 to 1973. Hamilton concludes that fluctuations in oil prices Granger-caused changes in unemployment and GNP of the US economy.

After the Hamilton's work in 1983, two fundamental questions arose in the literature for net oil importing countries. First, is the relationship between oil prices and economic output constant over time? And second, is there an asymmetric relationship between oil price fluctuations and economic activity?

As an answer for the first question, studies done by Burbridge and Harrison (1984), Gisser and Goodwin (1986), Hooker (1996), Rotenberg and Woodford (1996) and Schmidt and Zimmermann (2007) have pointed that oil price shocks have a significant negative impact on industrial production for several industrial countries. However, they all came with the same answer that oil price fluctuations have different impacts on economies over time.

As an answer for the second question, Mork (1989) suggests an asymmetric definition of oil prices and differentiates between positive and negative oil price changes. Based on the Mork, there is an asymmetry in the responses of macroeconomic variables to oil price rises and declines. He came with the conclusion that while negative oil price changes do not show significant effects, positive oil price changes have a strongly negative and significant relationship with changes in real GNP.

According to Hooker (1996), neither the linear relation between oil prices and output suggested by Hamilton (1983) nor the asymmetric relation based on oil price increases alone supported by Mork (1989) is subsequent with observed economic performance over the last decade. Hooker's evidence is very large and his conclusion is impregnable. Oil price fluctuations are obviously an uncertain instrument for macroeconomic analysis of data subsequent to 1986.

Later, in his new study Hamilton (1996) proposed a different form of asymmetric transformation of real oil prices. He specified that most of the oil price upturns are just modifications of earlier drops. He argued that if researchers want to measure how unsettling an increase in the prices of oil is likely to be for the spending decision of consumers and firms, it seems more appropriate to compare the current price of oil with that during the previous year rather than during the previous quarter alone.[2]

Besides that, Lee, Ni and Ratti (1995) did a research to examine the relationship between oil prices shocks and the macroeconomic variables and they argue in their paper that an impact of oil price change is larger on real GNP in countries where oil prices have been constant, than in countries where oil price movement has been frequent and unstable. An oil price shock variable reflecting both the unexpected element and the time-varying conditional variance of oil price change (forecasts) is built and found to be highly important in explaining economic growth across different sample periods, even when matched against various economic variables and other functions of oil price.[3] They found that negative normalized shocks do not have a strong effect on growth while positive normalized shocks have.

There is also a study done by Lardica and Mignon (2006) which examined the presence of a long-term relationship between oil prices and GDP in twelve European countries. They suggested an approach based on asymmetric co-integration to account for the fact that economic activity reacts asymmetrically to oil price shocks. Based on their results, when standard co-integration is rejected, there is proof for asymmetric co-integration between oil prices and GDP in most of the twelve countries.

[2]M.R. Farzanegan et al. “The effects of oil price shocks on the Iranian economy”, Energy Economics 31 (2009) 134–151

[3]Kiseok Lee, Shawn Ni, and Ronald A. Ratti (1995)

Other than that, there is a research done by Jbir and Ghorbel (2009), where they employed the vector auto-regression (VAR) to study the oil prices and macro-economy relationship by the analysis of the role of subsidy policy. They used the data over the period 1993Q1-2007Q3. Their results, using both linear and non-linear specifications, show that there is no direct impact of oil price shock on the economy and instead, oil prices shocks affect economic activity indirectly. The government's spending is the most significant channel by which the effects of the shock are transmitted.

3 DATA, METHODOLOGY AND MODEL

3.1 Data

All the data for this study are traced from the Thomson Reuters Data Stream which is a 10 year time series data covered from first quarter of 1996. This study use quarterly data which has a total of 80 observations. The data comprise of the output as measured by the Gross Domestic Product (GDP), Net export (NEX), Inflation rate as measured by consumer price index (CPI), Government Expenditure (GOV), Real Exchange Rate (RER) and Oil Price (OIL). While for the Oil Price Volatility (OILVOL) we apply the GARCH model [1.1] to compute for the volatility of the oil prices by using the application of E-views. We also include two dummies which is D1998 and D2008.

3.2 Methodology

We first run the unit root test to examine the properties of the time series data that need the data to be non-stationary to enables us to test the theory. As this study has employed Auto-Regressive Distributive Lag (ARDL) approach from Pesaran and Pesaran (1997), we run both Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test as to determine the order of integration of the variables.

Both ADF and PP test are done to make sure whether the variables are I(0) or I(1). If we find that the variables are I(1) we will proceed to examine the long-run relationship between the variables by conducting the cointegration tests. However, our variables are a combination of both I(0) and I(1), we then proceed with ARDL Approach to Cointegration in order to test for long-run relationship between the variables, where we compare the F-statistic from the output with the values from F Table of Pesaran.

By using ARDL, we do not have to categorize the variables into either I(0) and I(1), as is the case in the standard cointegration analysis procedure which require the variables to be I(1).

ARDL also involves establishing a lag order, which we choose lag order of 1 based on the suggested values of Shwarz Bayesian Criterion (SBC).

The following step is the Error Correction Model. At this stage we are encourage to look at the value of speed of adjustment (the coefficient of ECM [-1]). As according to Pesaran and Shin (1999), if the value of speed of adjustment is zero it means that there exist no long-run relationships, while if it falls between -1 and 0, there exists partial adjustment. On one hand, if the value is smaller than -1, it indicates that the model over adjusts in the current period, on the other hand a positive value implies that the system moves away from equilibrium in the long-run.

The difference between ECM and traditional cointegration techniques is that it allows drawing of outcome for long-run estimates while other traditional cointegration techniques do not provide such types of inferences. The ECM integrates the short-run dynamics with the long-run equilibrium without losing long-run information (Pesaran and Shin, 1999) and also provides unbiased and efficient estimates.

3.3 Model Specification

Based on other studies that has been carried out and our motivation to carry out this study, our estimation of model would be to make the output of Russia (since GDP is a main macro-economic variable, we take it as a dependent variable and check how oil price shocks impact to GDP as well as to other independent variables in the same time) to be dependent not only to the oil price shocks but also to the net export, government expenditure, real exchange rate and inflation rate. Thus, our functional form and estimated of the model can be written as follow:

The functional form of the model:

GDP=f (NEX, OILVOL, RER, CPI, GOV, OIL)

OILVOL= Oil price volatility as measured using GARCH model
NEX= Net exports of Russia
GDP= Output (Gross Domestic Product of Russia)
RER= Real exchange rate local currency/USD
CPI= Inflation rate as measured by Consumer Price Index
GOV= Government Expenditure
OIL= Oil price
While, the following estimated relationship is examined as follow:

$$LGDP = \alpha + \beta_1 LNEX_t + \beta_2 OILVOL_t + \beta_3 LRER_t + \beta_4 LCPI_t + \beta_5 LGOV_t + \beta_6 LOIL_t + D1998_t + D2008_t + \varepsilon_t$$

At this initial stage, we have however refrained from putting the equality sign as we wanted to see the relationship between the variables. The variables D1998 and D2008 represent our two dummies variables while the last variable ε_t is meant to represent the error term of the equation.

For this study, we expect the relationship between LNEX and LGDP to have a positive relationship with OILVOL while a negative relationship with LRER, LCPI and LGOV.

The error correction model based on ARDL can be written as follow:

$$\Delta LGDP_t = \alpha + \beta_1 \Delta LNEX_{t-1} + \beta_2 \Delta OILVOL_{t-1} + \beta_3 \Delta LRER_{t-1} + \beta_4 \Delta LCPI_{t-1} + \beta_5 \Delta LGOV_{t-1} + \beta_6 \Delta LOIL_{t-1} + D1998_{t-1} + D2008_{t-1} + \varepsilon_{t-1}$$

Where Δ indicates the first difference of variables, while'‘t-1’ indicates the optimal number of lags as determined by SBC values which is we choose the optimal lag order of 1. Our null hypothesis is that there is long-run relationship and this is defined by H_0=δ_1=δ_2= δ_3= δ_4=δ_5=δ_6= 0 while the alternative is that H_1=δ_1=δ_2= δ_3= δ_4 = δ_5=δ_6≠ 0.

4 EMPIRICAL RESULTS AND DISCUSSION

4.1 Unit Root Test

The first and foremost step that we have to do is to make sure that all the variables are non-stationary in their level form and stationary in the first difference form. This is because, for time series technique, we need the data to be non-stationary in their original level form for us to test the theoretical relationship in the cointegration step. For this study, we have conducted the Augmented Dickey Fuller (ADF) and Phillip-Perron (PP) test for both level form and first difference form.

In order to decide whether the variables are non-stationary or stationary, we have chosen the result from the highest value of AIC and SBC. The null hypothesis for this test is that the variables are non-stationary in their level form and stationary in their first difference form. The result shows that, only the variables LGDP, LRER, LCPI & LOIL are non-stationary in their level form with t-statistics less than the critical value. On the other hand, the variables LNEX, LGOV and OILVOL are stationary in their level form with t-statistic greater than critical value.

With the conflicting of the variables happen which showing a combination of I(0) and I(1) variables in the ADF test for both level and first difference form, it's suggest that we need to employ the ARDL approach instead of Engle-Granger test and Johansen test. The excerpts of the result from this test are shown in the table below.

LEVEL FORM OF VARIABLES					
VARIABLE	**ADF**	**VALUE**	**T-STAT**	**CV**	**RESULT**
LGDP	ADF(5)=SBC	100.4265	-1.8177	-3.3872	Non-stationary
	ADF(5)=AIC	109.6427	-1.8177	-3.3872	Non-stationary
LRER	ADF(1)=SBC	145.9339	-2.4112	-3.463	Non-stationary
	ADF(1)=AIC	150.5421	-2.4112	-3.463	Non-stationary
LNEX	ADF(1)=SBC	-2.3083	-3.6961	-3.463	Stationary
	ADF(1)=AIC	2.2998	-3.6961	-3.463	Stationary
LGOV	ADF(3)=SBC	84.6385	0.17073	-3.4316	Stationary
	ADF(3)=AIC	91.5507	0.17073	-3.4316	Stationary
LCPI	ADF(2)=SBC	208.8386	-2.835	-3.3319	Non-stationary
	ADF(4)=AIC	215.0625	-2.7267	-3.4124	Non-stationary
LOIL	ADF(1)=SBC	65.8278	-1.8821	-3.463	Non-stationary
	ADF(1)=AIC	70.4359	-1.8821	-3.463	Non-stationary
OILVOL	ADF(1)=SBC	162.8277	-4.1413	-3.463	Stationary
	ADF(2)=AIC	167.577	-4.3915	-3.3319	Stationary

Table 2: ADF Test for Level Form of Variables

FIRST DIFFERENCE OF VARIABLES					
VARIABLE	ADF	VALUE	T-STAT	CV	RESULTS
DGDP	ADF(4)=SBC	100.9443	-4.2251	-2.8319	Stationary
	ADF(4)=AIC	107.8157	-4.2251	-2.8319	Stationary
DRER	ADF(1)=SBC	143.342	-6.2042	-2.904	Stationary
	ADF(1)=AIC	146.7777	-6.2042	-2.904	Stationary
DNEX	ADF(1)=SBC	-4.9316	-8.4231	-2.904	Stationary
	ADF(2)=AIC	-1.4591	-7.0251	-2.8695	Stationary
DGOV	ADF(3)=SBC	82.516	-5.6463	-2.8639	Stationary
	ADF(5)=AIC	89.2469	-2.6501	-2.8072	Non-stationary
DCPI	ADF(1)=SBC	202.3749	-4.9998	-2.904	Stationary
	ADF(2)=AIC	206.7262	-3.3784	-2.8695	Stationary
DOIL	ADF(1)=SBC	65.4791	-7.2198	-2.904	Stationary
	ADF(1)=AIC	68.9147	-7.2198	-2.904	Stationary
DOILVOL	ADF(1)=SBC	-71.6464	-6.261	-2.904	Stationary
	ADF(3)=AIC	-68.1753	-5.6291	-2.8639	Stationary

Table 3: ADF Test for First Difference of Variables

Because the presence of unit root makes the regression results spurious and thus disturbs the accuracy of the parameters estimated. Although the ARDL testing approach does not necessitate unit root tests, it is important to perform the unit root test in order to ensure that no variable is integrated of order two or higher. This is because the ARDL procedure assumes that all variables are either I(0) or I(1). If one of the variables in the model is found to be I(2), then the computed F-statistics produced by Pesaran et al, (2001) and Narayan (2005), can no longer be valid.

However, before we proceed to the next step, we run the PP test in order to confirm whether the variables are non-stationary in the level form and stationary in the first difference form but unfortunately the variables still in the combination of both I(0) and I(1) variables. The variables LNEX, LGOV and OILVOL still stationary in the level form. However, after we test for the first difference of the variables, all the variables are showing stationary, which is same with our ADF test. The excerpts of the result from the PP test are shown in the table below. At this stage, we have decided to proceed to the ARDL approach due to the above mentioned issues with the variables.

PP TEST			
LEVEL FORM OF VARIABLES			
VARIABLE	T-STAT	CV	RESULT
LGDP	-1.9135	-3.4307	Non-stationary
LRER	-1.8684	-3.4307	Non-stationary
LNEX	-4.3249	-3.4307	Stationary
LGOV	-9.6535	-3.4307	Stationary
LCPI	-1.642	-3.4307	Non-stationary
LOIL	-2.1044	-3.4307	Non-stationary
OILVOL	-4.0761	-3.4307	Stationary
FIRST DIFFERENCE OF VARIABLES			
VARIABLE	T-STAT	CV	RESULT
DGDP	-7.5863	-2.8798	Stationary
DRER	-7.358	-2.8798	Stationary
DNEX	-16.4443	-2.8798	Stationary
DGOV	-36.8654	-2.8798	Stationary
DCPI	-3.7034	-2.8798	Stationary
DOIL	-9.5479	-2.8798	Stationary
DOILVOL	-15.7309	-2.8798	Stationary

Table 4: PP test for Level Form and First Difference of Variables

4.2 VAR Order Selection

At this stage, we need to determine the vector auto regression (VAR order), all variables used are in first difference form. Here we found some conflicting with the optimal order depending on the criteria of choice, AIC give an optimal order of six while both SBC and the Adjusted LR test give an optimal order of one. For Adjusted LR, the optimal order is chosen based on the p-value which is higher than the 5% critical value.

Since there is conflict between the recommendation of AIC and SBC, it will be more efficient to select the result according to the nature of the data set which we used in this study. The SBC is more concerned on over-parameter. It tends to choose lower order of lags. Therefore, for proceeding to the next stage, we have decided to choose the lowest order which is based on the SBC which shows an optimal order of one. The excerpt of the result are summarize in the table below. Once we have decided the optimal VAR order selection, we now ready to test for the long-run relationship among the variables using the ARDL approach.

VAR ORDER SELECTION				
OPTIMAL ORDER	**AIC**	**SBC**	**ADJUSTED LR (P-VALUE)**	**CV**
6	744.4596			
1		548.1673		
1			0.078	**5%**

Table 5: VAR Order Selection

4.3 Bound Test

In order to investigate the existence of a long-run relationship among the variables in the bounds cointegration procedure, the first step is to apply ordinary least squares (OLS) regression by performing a F statistics for the joint null hypothesis that the coefficients of these level variables are zero; H_0=δ_1=δ_2= δ_3= δ_4=δ_5=δ_6= 0 implying there exists no long-run relationship between them.

Pesaran et al. (2001) present two sets of asymptotic critical values for testing cointegration for a given significance level. The set with lower value is computed assuming that the regressors are I(0) and the other set with upper value is computed assuming that the regressors are I(1). If the computed F statistics exceeds the upper critical value, the null hypothesis of no long-run relationship can be rejected. If it falls below the lower critical value the null hypothesis cannot be rejected. Finally, if the F statistics value falls between the lower and upper critical values the result is inconclusive.

According to table 6 below, the F-statistics of DCPI shows that the F-statistics exceeds the upper bound where the null hypothesis will be rejected and therefore a long run relationship exists. This result has its economic interpretation where it indicates that in the long-run, the variables in this study which are CPI, GDP, GOV, NEX, RER and OIL are moving together in a particular direction and this shows that the relationship among the variables is not spurious. In other words, there is a theoretical relationship among the variables and this indicates that the each variable has information for the prediction of other variables and they are in equilibrium in the long-run. Besides that, this result has an important implication for policy makers. Since there is relationship between inflation rate, real exchange rate, government consumption, net export, and oil prices, the policy makers of Russia can encourage or discourage investment in oil industry by adjusting the inflation rate, the real exchange rate. However, there is a need to know which variables are the leaders and which variables are the followers and this will be determined by the next step which is error correction model.

BOUND TEST			
VARIABLE	F-STAT	UPPER BOUND	RESULT
DGDP	2.8930[.016]	4.0712	INCONCLUSIVE
DRER	3.2258[.009]	4.0712	INCONCLUSIVE
DNEX	3.7303[.003]	4.0712	INCONCLUSIVE
DGOV	1.4324[.220]	4.0712	There is no long-run relationship
DCPI	4.9460[.000]	4.0712	There is long-run relationship
DOIL	2.4288[.036]	4.0712	There is no long-run relationship
DOILVOL	.94895[.481]	4.0712	There is no long-run relationship

Table 6: Bound Test

4.4 Error Correction Model

The next step would be to obtain short-run dynamic parameters by estimating an error correction model (ECM) associated with the long-run estimates. This is done in order to estimate the speed of adjustment of the dependent variable to independent variables. If the value of speed of adjustment is zero it means that there exist no long-run relationships, if it's between -1 and 0, there exists partial adjustment. A value smaller than -1 indicates that the model over adjusts in the current period and finally a positive value implies that the system moves away from equilibrium in the long-run.

ERROR CORRECTION MODEL BASED ON AIC					
ecm1(-1)	COEFFICIENT	S.E	T-RATIO (PROB)	CV	RESULT
dLCPI	0.031053	0.012432	2.4977[.016]	5%	ENDOGENOUS
dLGDP	0.057344	0.12347	0.46444[.644]	5%	EXOGENOUS
dLGOV	-1.3128	0.25367	-5.1753[.000]	5%	ENDOGENOUS
dLNEX	-0.37346	0.21771	-1.7154[.091]	5%	EXOGENOUS
dLOIL	-0.50594	0.18647	-2.7133[.009]	5%	ENDOGENOUS
dLRER	-0.071818	0.12254	-.58609[.560]	5%	EXOGENOUS
dOILVOL	-0.53646	0.086753	-6.1837[.000]	5%	ENDOGENOUS

Table 7: Error Correction Model Based on AIC

The table above show the result from our test based on AIC. The ECM reveals the endogeneity and exogeneity of the variables given by the p-value of the ECM. The null hypothesis for this test is that the variable is exogenous and the p-value should be higher than the 5% critical value. Based on the above ECM test, the inflation rate, government expenditure, oil price and oil price volatility is found to be endogenous while the output, net export and real exchange rate are exogenous. In addition, the size of the coefficient of the ECM indicates the speed of short-run adjustment of the dependent variable to bring about the long-run. At the same time, the intensity of the arbitrage activity to bring about the long-run equilibrium is also shown by the size of the coefficient of the ECM. From the result above, it shows that the ECM coefficient of government expenditure is highly significant than other variables which is estimated at -1.3128(0.000). This shows that it has the correct sign and implies a moderate speed of adjustment to equilibrium after a shock. Moreover, in short run, whether the effects of these variables on the dependent variable are significant or not is indicated by the t-value or p-value of the coefficients of the differenced variables.

However, our findings are somewhat contradicting with previous studies. After we get the information on the exogeneity and endogeneity of the variables from the previous step, we are encourage to know which variables are the most leader and the most followers is. In order to reconfirm the results of ECM, we will carry out Variance Decompositions (VDC) in order to determine the ranking of the variables.

4.5 Variance Decompositions (VDCs)

As we know that both the orthogonalized and the generalised variance decompositions (VDCs) are designed to indicate the relative exogeneity or endogeneity of a variables by decomposing the variance of the forecast error of a variable into proportions attributable to innovations in each variable in the system including its own. However, they do differ in some ways where the orthogonalized VDCs are more biases toward the particular ordering of the variables in the VAR and give higher rank for first variable order.

On the other hand, the generalised VDCs are invariant to the ordering of the variables, and generalised VDCs also do not put restriction when a particular variable is shocked, the other variables in the system are more or less switched off. But the orthogonalized are the other way around. The relative exogeneity or endogeneity of a variable can be examined by the proportion of the variance explained by its own past. The most exogenous variables which is the most leader and independent than others is explained mostly by its own shocks (and not by others) while the least endogenous variable is thus the variable whose variation is explained mostly by its own past variations. The summary of the results are shown in the table below.

	HORIZON	DCPI	DGOV	DGDP	DNEX	DRER	DOIL	DOILVOL	TOTAL	RANKING
DCPI	10	72.75%	2.72%	0.97%	21.68%	0.74%	0.21%	0.93%	100.00%	3
DGOV	10	10.91%	41.20%	29.44%	0.83%	15.11%	2.06%	0.45%	100.00%	6
DGDP	10	25.35%	11.21%	53.10%	4.83%	3.77%	0.85%	0.89%	100.00%	5
DNEX	10	7.75%	2.07%	8.57%	79.18%	0.17%	0.40%	1.85%	100.00%	2
DRER	10	28.03%	9.46%	11.63%	7.69%	40.61%	0.45%	2.13%	100.00%	7
DOIL	10	3.12%	1.22%	28.77%	3.23%	1.30%	62.19%	0.18%	100.00%	4
DOILVOL	10	2.73%	1.11%	6.95%	1.40%	3.27%	4.23%	80.32%	100.00%	1

	HORIZON	DCPI	DGOV	DGDP	DNEX	DRER	DOIL	DOILVOL	TOTAL	RANKING
DCPI	20	72.74%	2.72%	0.98%	21.68%	0.74%	0.21%	0.93%	100.00%	3
DGOV	20	10.91%	41.15%	29.46%	0.83%	15.14%	2.06%	0.45%	100.00%	6
DGDP	20	25.34%	11.22%	53.09%	4.83%	3.78%	0.85%	0.88%	100.00%	5
DNEX	20	7.75%	2.07%	8.57%	79.18%	0.17%	0.40%	1.85%	100.00%	2
DRER	20	28.03%	9.46%	11.63%	7.69%	40.61%	0.45%	2.13%	100.00%	7
DOIL	20	3.12%	1.22%	28.77%	3.23%	1.30%	62.18%	0.18%	100.00%	4
DOILVOL	20	2.73%	1.11%	6.95%	1.40%	3.28%	4.23%	80.31%	100.00%	1

	HORIZON	DCPI	DGOV	DGDP	DNEX	DRER	DOIL	DOILVOL	TOTAL	RANKING
DCPI	30	72.74%	2.72%	0.98%	21.68%	0.74%	0.21%	0.93%	100.00%	3
DGOV	30	10.91%	41.15%	29.46%	0.83%	15.14%	2.06%	0.45%	100.00%	6
DGDP	30	25.34%	11.22%	53.09%	4.83%	3.78%	0.85%	0.88%	100.00%	5
DNEX	30	7.75%	2.07%	8.57%	79.18%	0.17%	0.40%	1.85%	100.00%	2
DRER	30	28.03%	9.46%	11.63%	7.69%	40.61%	0.45%	2.13%	100.00%	7
DOIL	30	3.12%	1.22%	28.77%	3.23%	1.30%	62.18%	0.18%	100.00%	4
DOILVOL	30	2.73%	1.11%	6.95%	1.40%	3.28%	4.23%	80.31%	100.00%	1

	HORIZON	DCPI	DGOV	DGDP	DNEX	DRER	DOIL	DOILVOL	TOTAL	RANKING
DCPI	40	72.74%	2.72%	0.98%	21.68%	0.74%	0.21%	0.93%	100.00%	3
DGOV	40	10.91%	41.15%	29.46%	0.83%	15.14%	2.06%	0.45%	100.00%	6
DGDP	40	25.34%	11.22%	53.09%	4.83%	3.78%	0.85%	0.88%	100.00%	5
DNEX	40	7.75%	2.07%	8.57%	79.18%	0.17%	0.40%	1.85%	100.00%	2
DRER	40	28.03%	9.46%	11.63%	7.69%	40.61%	0.45%	2.13%	100.00%	7
DOIL	40	3.12%	1.22%	28.77%	3.23%	1.30%	62.18%	0.18%	100.00%	4
DOILVOL	40	2.73%	1.11%	6.95%	1.40%	3.28%	4.23%	80.31%	100.00%	1

	HORIZON	DCPI	DGOV	DGDP	DNEX	DRER	DOIL	DOILVOL	TOTAL	RANKING
DCPI	50	72.74%	2.72%	0.98%	21.68%	0.74%	0.21%	0.93%	100.00%	3
DGOV	50	10.91%	41.15%	29.46%	0.83%	15.14%	2.06%	0.45%	100.00%	6
DGDP	50	25.34%	11.22%	53.09%	4.83%	3.78%	0.85%	0.88%	100.00%	5
DNEX	50	7.75%	2.07%	8.57%	79.18%	0.17%	0.40%	1.85%	100.00%	2
DRER	50	28.03%	9.46%	11.63%	7.69%	40.61%	0.45%	2.13%	100.00%	7
DOIL	50	3.12%	1.22%	28.77%	3.23%	1.30%	62.18%	0.18%	100.00%	4
DOILVOL	50	2.73%	1.11%	6.95%	1.40%	3.28%	4.23%	80.31%	100.00%	1

Table 8: Orthogonalized VDCs

For our study, we have run both the orthogonalized VDC and generalised VDCs to see how the variables are rank. We choose horizon 10, 20, 30, 40 and 50 months for our study where our data is a quarterly data; we define the period at 50. The variable that is explained mostly by its own shocks and depends relatively less on other variables is the leading variable and vice versa. From the orthogonalized VDCs result, we found that, oil price volatility is first ranking and this really shows a contradiction with our ECM result that oil price volatility is endogenous.

However, we found that, the result between the orthogonalized and generalised VDCs also different where the ranking of the variables are change in the generalised one. By referring to the generalised VDCs result, net export has taken the first rank and oil price volatility are in second rank. This differences might be because of the nature of orthogonalized VDCs itself which is it depends on the particular ordering of the variables in the VAR while generalised VDCs does not depend on the particular ordering of the variables in the VAR. Thus, this study decided to agree with the generalised VDCs result taking net export to be the most exogenous one and then followed by the oil price volatility, oil price, real exchange rate, output, inflations rate and government expenditure. These results are very important for policy makers of Russia and investors because it will help them to make a decision. The implication of these results will be discussion in details at section five of this paper.

	HORIZON	DCPI	DGOV	DGDP	DNEX	DRER	DOIL	DOILVOL	TOTAL	SELF-DEP	RANKING
DCPI	10	47.49%	7.18%	14.37%	14.53%	15.35%	0.46%	0.63%	100.00%	47.49%	6
DGOV	10	10.36%	46.54%	26.97%	3.16%	9.22%	3.53%	0.22%	100.00%	46.54%	7
DGDP	10	16.25%	7.26%	47.49%	5.06%	14.59%	8.45%	0.89%	100.00%	47.49%	5
DNEX	10	6.46%	3.02%	6.99%	74.82%	2.13%	3.72%	2.85%	100.00%	74.82%	1
DRER	10	16.27%	10.35%	15.29%	4.97%	47.78%	2.44%	2.90%	100.00%	47.78%	4
DOIL	10	2.53%	1.71%	20.67%	7.18%	6.78%	60.55%	0.57%	100.00%	60.55%	3
DOILVOL	10	2.34%	1.09%	7.76%	2.39%	5.17%	7.00%	74.25%	100.00%	74.25%	2

	HORIZON	DCPI	DGOV	DGDP	DNEX	DRER	DOIL	DOILVOL	TOTAL	SELF-DEP	RANKING
DCPI	20	47.49%	7.18%	14.37%	14.53%	15.35%	0.46%	0.63%	100.00%	47.49%	6
DGOV	20	10.37%	46.51%	27.00%	3.16%	9.21%	3.53%	0.22%	100.00%	46.51%	7
DGDP	20	16.25%	7.27%	47.49%	5.07%	14.59%	8.45%	0.89%	100.00%	47.49%	5
DNEX	20	6.46%	3.02%	6.99%	74.82%	2.13%	3.72%	2.85%	100.00%	74.82%	1
DRER	20	16.27%	10.35%	15.29%	4.97%	47.78%	2.44%	2.90%	100.00%	47.78%	4
DOIL	20	2.54%	1.72%	20.67%	7.18%	6.78%	60.54%	0.57%	100.00%	60.54%	3
DOILVOL	20	2.34%	1.09%	7.77%	2.39%	5.17%	7.00%	74.25%	100.00%	74.25%	2

	HORIZON	DCPI	DGOV	DGDP	DNEX	DRER	DOIL	DOILVOL	TOTAL	SELF-DEP	RANKING
DCPI	30	47.49%	7.18%	14.37%	14.53%	15.35%	0.46%	0.63%	100.00%	47.49%	6
DGOV	30	10.37%	46.51%	27.00%	3.16%	9.21%	3.53%	0.22%	100.00%	46.51%	7
DGDP	30	16.25%	7.27%	47.49%	5.07%	14.59%	8.45%	0.89%	100.00%	47.49%	5
DNEX	30	6.46%	3.02%	6.99%	74.82%	2.13%	3.72%	2.85%	100.00%	74.82%	1
DRER	30	16.27%	10.35%	15.29%	4.97%	47.78%	2.44%	2.90%	100.00%	47.78%	4
DOIL	30	2.54%	1.72%	20.67%	7.18%	6.78%	60.54%	0.57%	100.00%	60.54%	3
DOILVOL	30	2.34%	1.09%	7.77%	2.39%	5.17%	7.00%	74.25%	100.00%	74.25%	2

	HORIZON	DCPI	DGOV	DGDP	DNEX	DRER	DOIL	DOILVOL	TOTAL	SELF-DEP	RANKING
DCPI	40	47.49%	7.18%	14.37%	14.53%	15.35%	0.46%	0.63%	100.00%	47.49%	6
DGOV	40	10.37%	46.51%	27.00%	3.16%	9.21%	3.53%	0.22%	100.00%	46.51%	7
DGDP	40	16.25%	7.27%	47.49%	5.07%	14.59%	8.45%	0.89%	100.00%	47.49%	5
DNEX	40	6.46%	3.02%	6.99%	74.82%	2.13%	3.72%	2.85%	100.00%	74.82%	1
DRER	40	16.27%	10.35%	15.29%	4.97%	47.78%	2.44%	2.90%	100.00%	47.78%	4
DOIL	40	2.54%	1.72%	20.67%	7.18%	6.78%	60.54%	0.57%	100.00%	60.54%	3
DOILVOL	40	2.34%	1.09%	7.77%	2.39%	5.17%	7.00%	74.25%	100.00%	74.25%	2

	HORIZON	DCPI	DGOV	DGDP	DNEX	DRER	DOIL	DOILVOL	TOTAL	SELF-DEP	RANKING
DCPI	50	47.49%	7.18%	14.37%	14.53%	15.35%	0.46%	0.63%	100.00%	47.49%	6
DGOV	50	10.37%	46.51%	27.00%	3.16%	9.21%	3.53%	0.22%	100.00%	46.51%	7
DGDP	50	16.25%	7.27%	47.49%	5.07%	14.59%	8.45%	0.89%	100.00%	47.49%	5
DNEX	50	6.46%	3.02%	6.99%	74.82%	2.13%	3.72%	2.85%	100.00%	74.82%	1
DRER	50	16.27%	10.35%	15.29%	4.97%	47.78%	2.44%	2.90%	100.00%	47.78%	4
DOIL	50	2.54%	1.72%	20.67%	7.18%	6.78%	60.54%	0.57%	100.00%	60.54%	3
DOILVOL	50	2.34%	1.09%	7.77%	2.39%	5.17%	7.00%	74.25%	100.00%	74.25%	2

Table 9: Generalised VDCs

4.6 Impulse Response Functions (IRFs)

Impulse Response Functions (IRFs) generally produce the same information with the VDCs where the only different in that the information can be plotted and shows in graph which can give a clear visualization about the information. IRFs essentially map out the dynamic response path of a variable owing to a one-period standard deviation shock to another variable. We choose to plot the graph for both the Orthogonalized and Generalised Impulse Responses for all the variables with the same period with VDCs. All graphs are shown below.

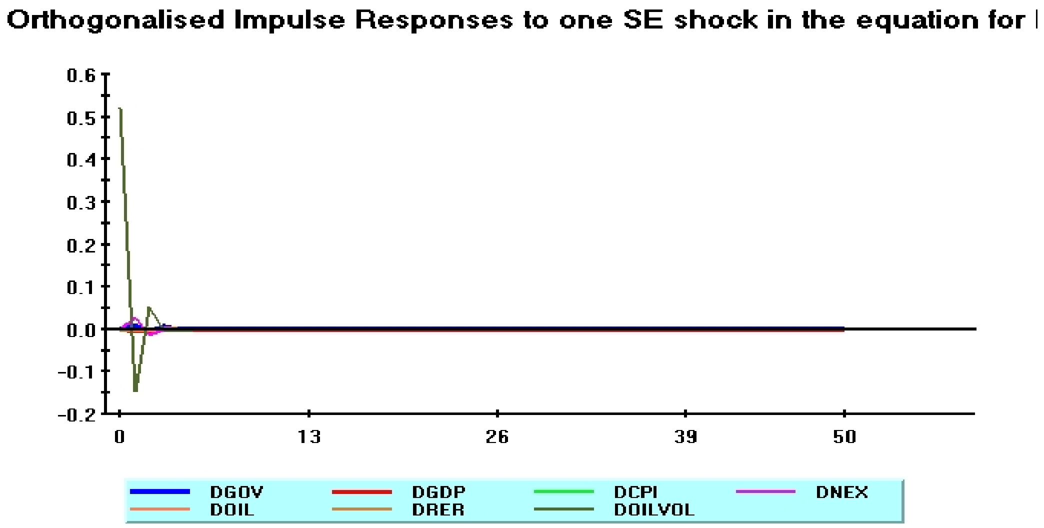

Figure 1. Orthogonalised Impulse Responses to one SE shock in the equation for DOILVOL

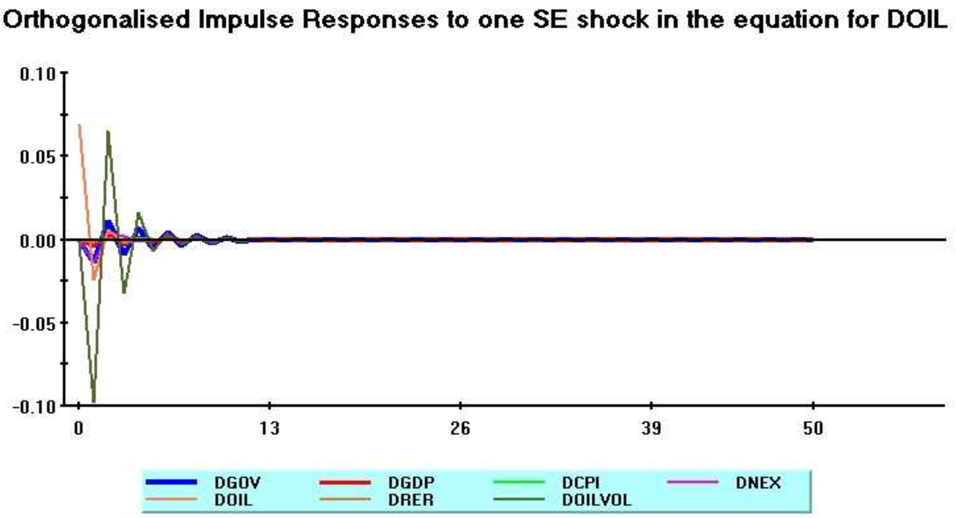

Figure 2. Orthogonalised Impulse Responses to one SE shock in the equation for DOIL

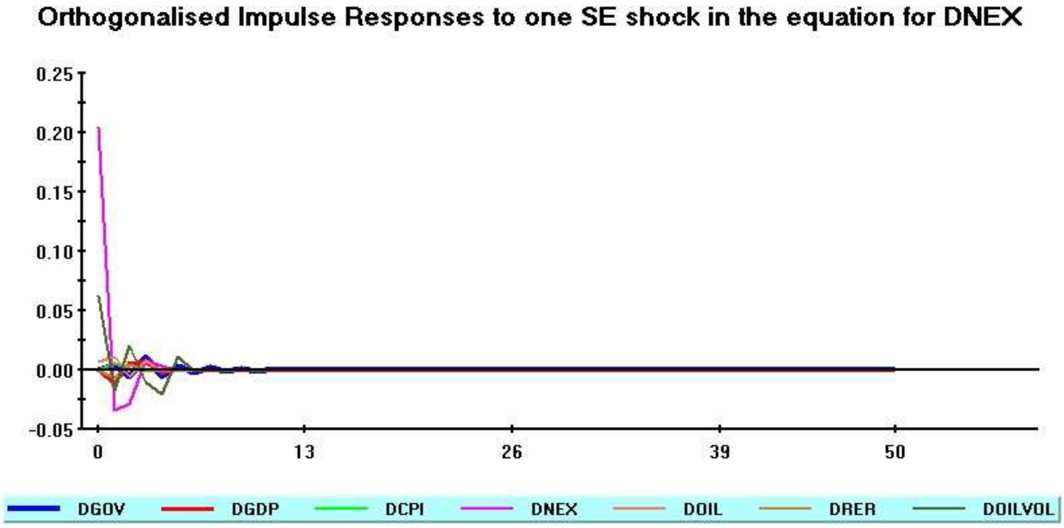

Figure 3. Orthogonalised Impulse Responses to one SE shock in the equation for DNEX

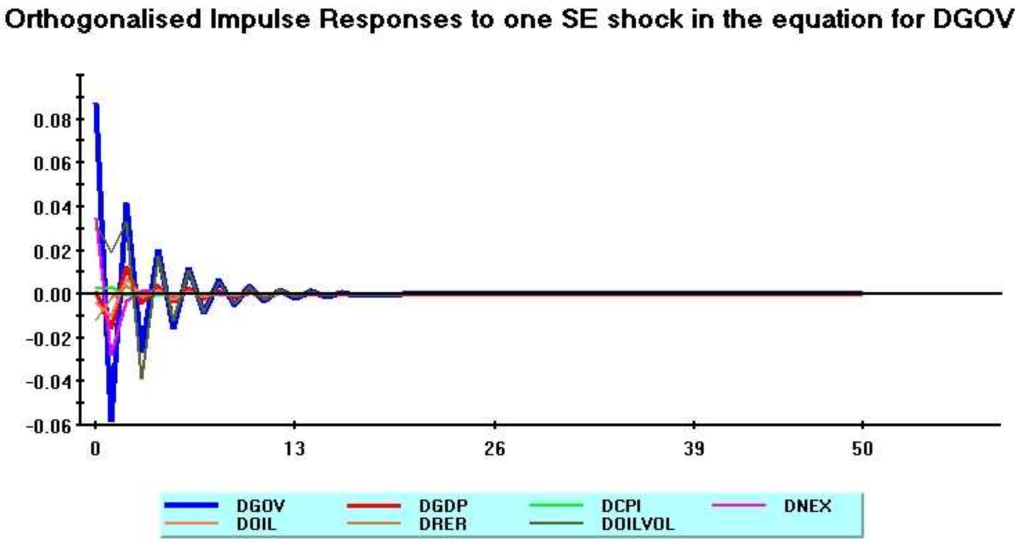

Figure 4. Orthogonalised Impulse Responses to one SE shock in the equation for DGOV

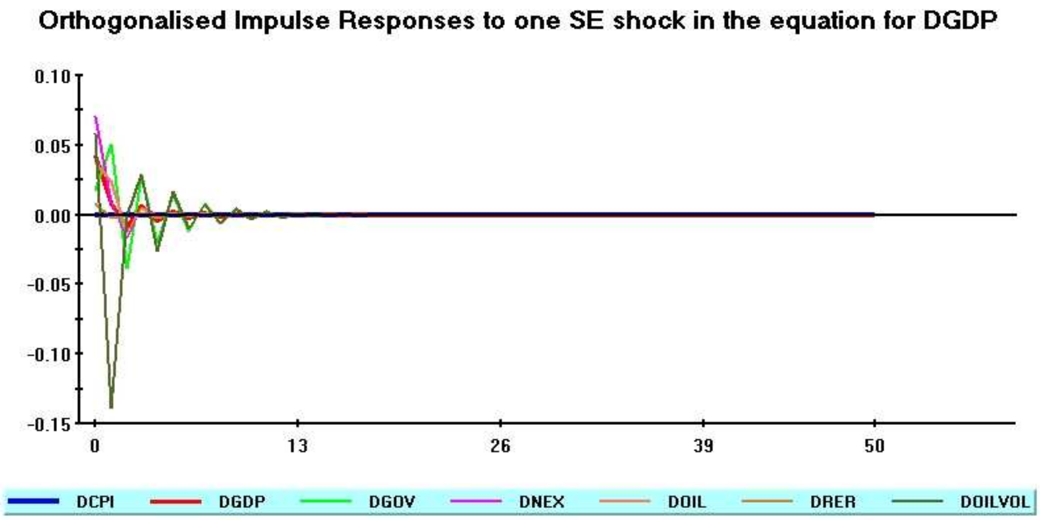

Figure 5. Orthogonalised Impulse Responses to one SE shock in the equation for DGDP

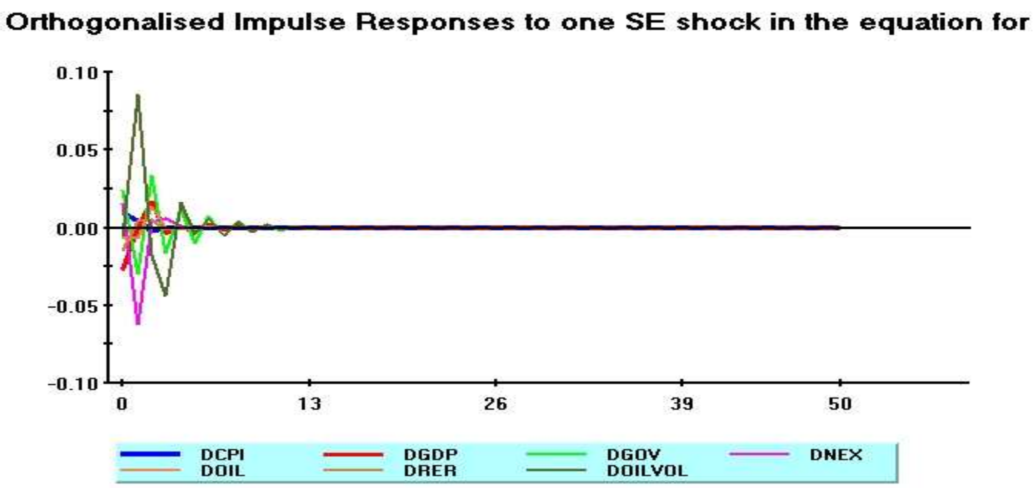

Figure 6. Orthogonalised Impulse Responses to one SE shock in the equation for DCPI

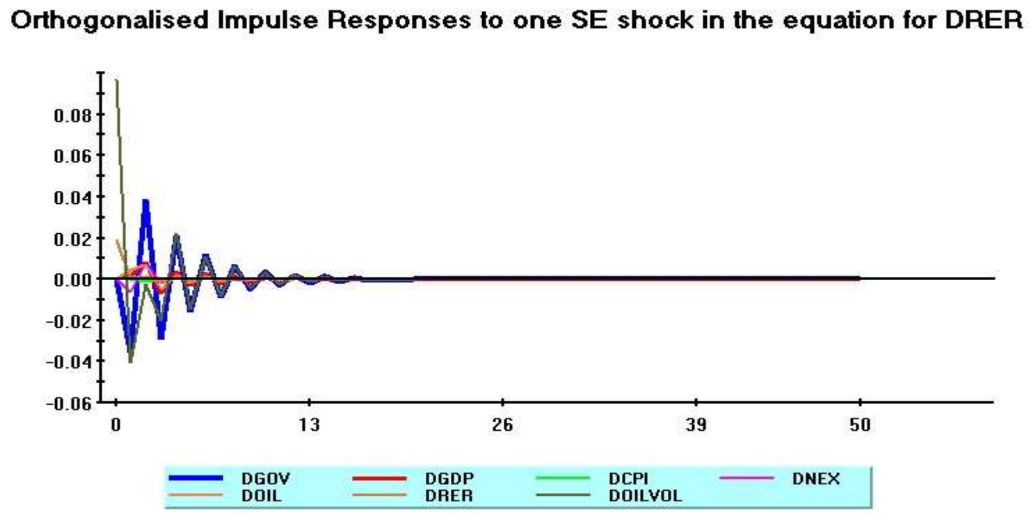

Figure 7. Orthogonalised Impulse Responses to one SE shock in the equation for DRER

Below is the graphical form of generalized impulse response results:

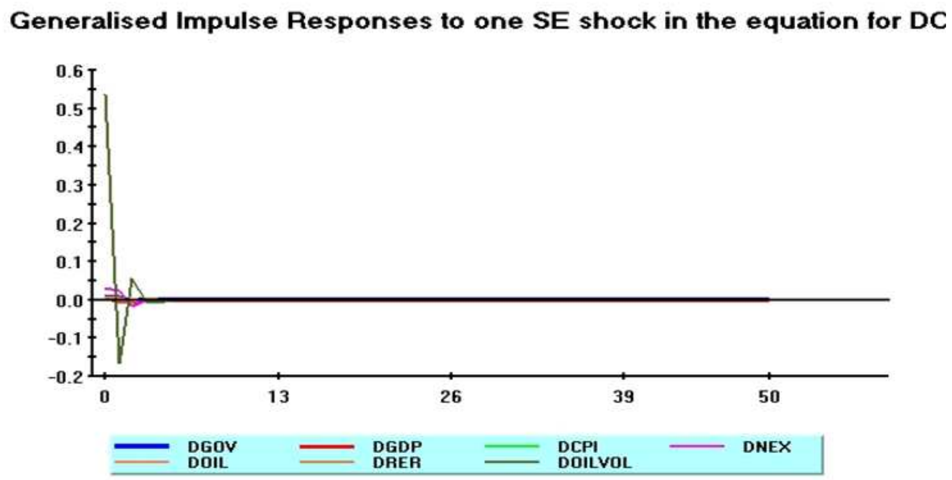

Figure 8. Generalised Impulse Responses to one SE shock in the equation for DOILVOL

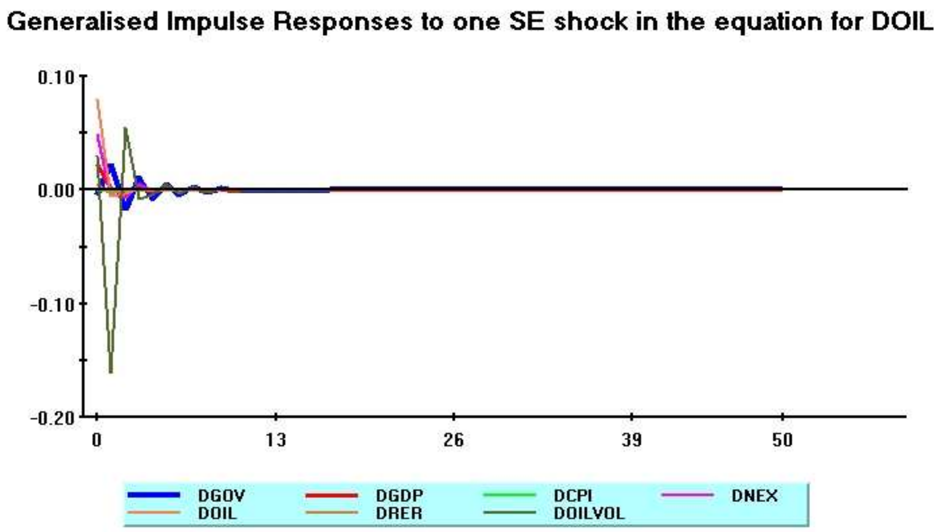

Figure 9. Generalised Impulse Responses to one SE shock in the equation for DOIL

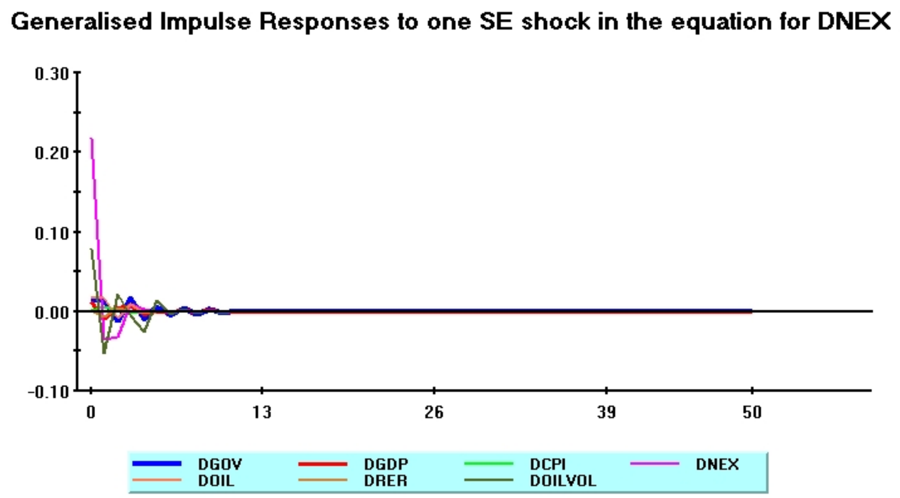

Figure 10. Generalised Impulse Responses to one SE shock in the equation for DNEX

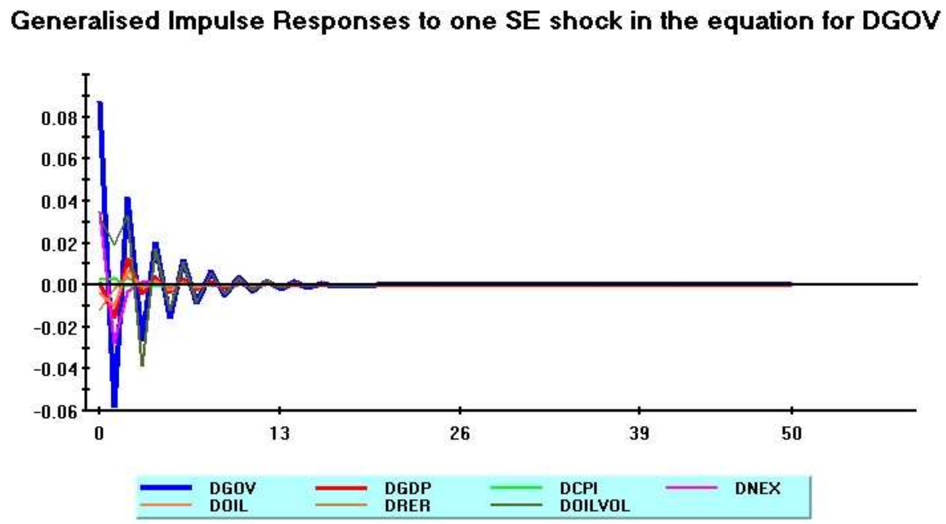

Figure 11.Generalised Impulse Responses to one SE shock in the equation for DGOV

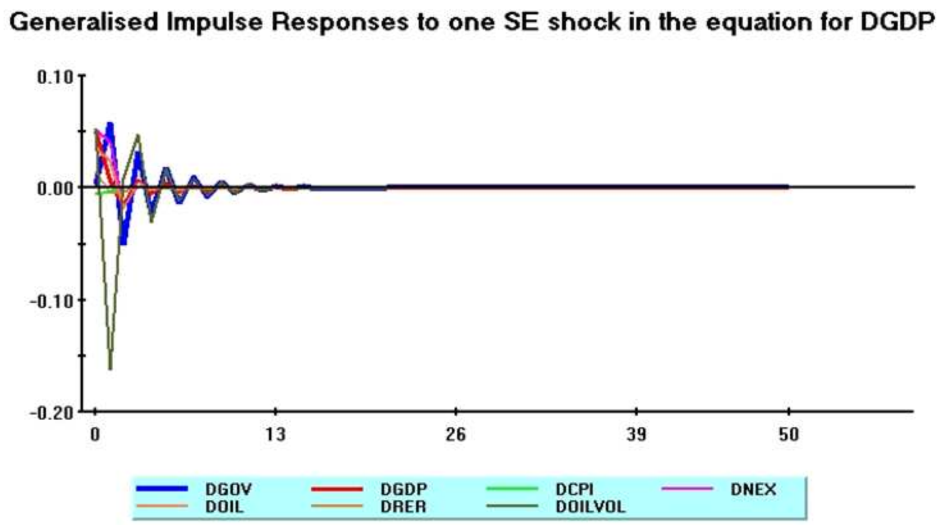

Figure 12. Generalised Impulse Responses to one SE shock in the equation for DGDP

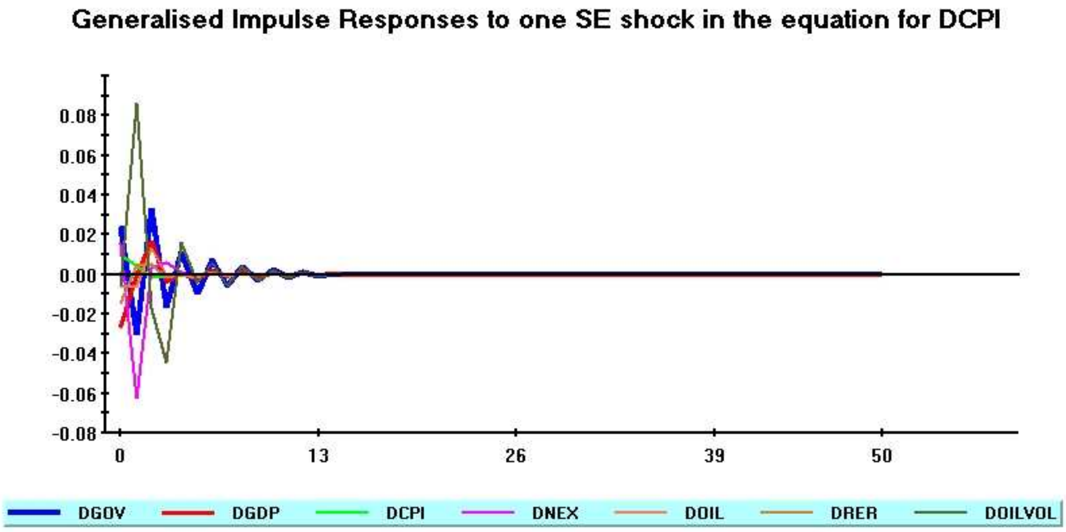

Figure 13. Generalised Impulse Responses to one SE shock in the equation for DCPI

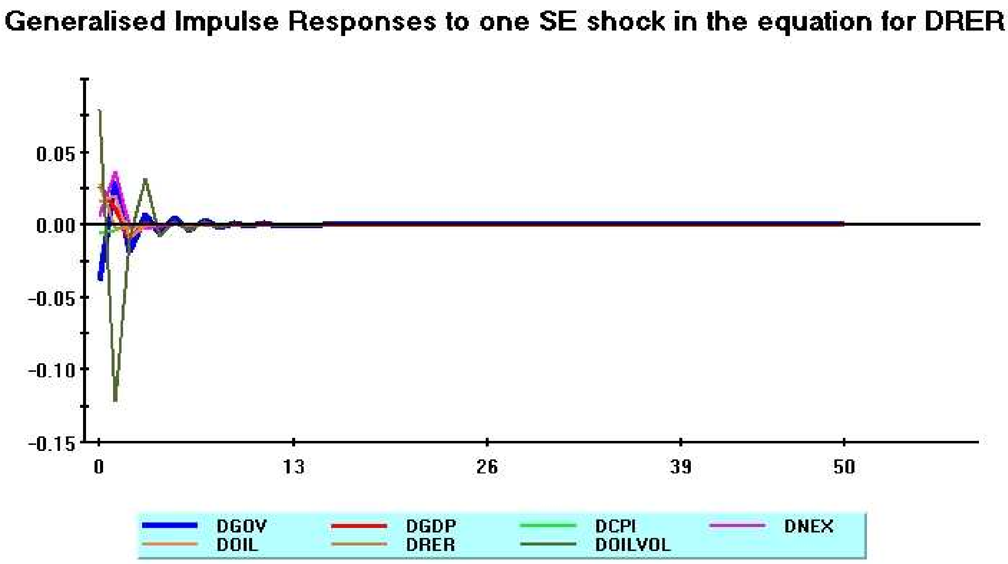

Figure 14. Generalised Impulse Responses to one SE shock in the equation for DRER

5 POLICY IMPLICATIONS

As mentioned in the previous section, the outcome resulted from the generalised VDCs which it indicates that the exogeneity of variables started with net exports and followed by oil prices volatility, oil prices, real exchange rates, GDP, inflation rate and government expenditure in this study. Our result is not really surprising as it confirms the study done by Iwayemi & Fowowe (2011) that with the exception of net exports, most macroeconomic variables did not show considerable changes following the oil price volatility. It is not surprising that net exports from Russia respond to oil price shocks. This is because oil and gas exports account for almost 70% of Russia's total exports and thus shocks in oil prices play a major role in affecting oil exports. Therefore, since Russia has been ranked as the second largest oil exporting country after the Saudi Arabia, our findings are supported by the fact that net exports gives a big impact on other macroeconomic variables. An increase in oil prices will increase their net exports and decline of oil prices will reduce the net exports keeping other variables constant (ceteris paribus).

This result may help the policy makers of Russia for making wise and right decisions and in this way can be useful for investors as well. Policy makers need for policies to put in place to increase the net exports (increase export shares of sectors other than oil sector) and limit the effects of oil shocks on the economy. Such policies might include a diversification and enlargement of the economy's productive base, reducing public debt and managing oil revenues through an oil revenue fund. In other words, policymakers must establish institutional mechanisms to control oil booms and busts through expenditure restraint, self-insurance, and diversification of the real sector. To reach sustainable growth in the future, the country must take policy measures that substantially enlarge and diversify its economic base. Additionally, to insulate the economy from oil revenue volatility requires delinking fiscal expenditures from current revenue (Mehrara 2008, Mehrara and Oskoui, 2007).

The second implication would be on the real exchange rate and the result shows that it is fourth in rank in terms of exogeneity. It means that the real exchange rate is affected by those three variables before it. For instance, when oil prices fall, this will cause the Russian currency to depreciate against the US dollar. The most recent collapse in oil prices showed evidence that it has hurt the Rouble, which has lost more than half its value compared with the U.S. dollar since the summer of 2014. However, in the last few months, oil prices started to rise and the trends is showing that the Rouble is slightly appreciating again now against the US dollar. Therefore, it is very important for the policy maker to ensure increase in oil price in order to appreciate of the Russian currency. However, since oil prices are controlled by globally and by not only Russia, policy makers cannot set up oil prices and therefore they need to search an alternative ways to not allow the currency depreciate a lot or at least minimize the depreciation impacts.

On the other hand, when the Russian currency is depreciating, this will cause an increase in cost for the companies since the most companies usually get their raw materials from wide variety of sources outside the country and this will eventually cause the profit of the company to decrease.At the same time, a large scale of depreciation can lead to increase in the inflation rate of Russian currency. Therefore, the Russian government should consider the problem of oil price shocks and depreciation of their currency as a serious issue because this problem can bring about towards lowering their net exports as well as output and high inflation rate.

6 CONCLUSION

Now we have come to the conclusion of our study where at this section we revisit the two research questions that have been posed at the beginning of this paper. Based on the above quantitative analysis, we found the answers as follows:

1. There is a long term relationship between oil prices volatility and net exports.

2. The variable that will be impacted most by the oil prices shocks is net exports of Russia. Therefore, policy makers should control net exports first to reduce the negative impacts of the oil price shocks. This can be done by reducing the dependency of the economy on the revenues from oil exports and increasing the shares of the real sector in export.

7 LIMITATION OF THE STUDY

This paper has found many limitations while conducting the study. The first limitation is that, the number of observation where our study only has 80 observations which we think this is a small observation and the result that we get may not be robust as compared to previous study. The second limitation would be in terms of the macroeconomic variables itself, where we found some are conflicting in terms of stationarity of the variables in our first step.

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