Testing the long-run relationship between exchange rate, oil price, FDI and GDP: an ARDL approach

Isaacs, Ziyaat and Masih, Mansur

INCEIF, Malaysia, Business School, Universiti Kuala Lumpur, Kuala Lumpur, Malaysia

28 February 2017

Testing the long-run relationship between exchange rate, oil price, FDI and GDP: an ARDL approach

Ziyaat Isaacs[1] and Mansur Masih[2]

Abstract

This paper tests the relationship between exchange rate, oil price, FDI and GDP. South Africa, an energy dependent small open economy with a floating exchange rate is used as a case study using the Autoregressive Distributed Lag (ARDL) approach. The empirical results reveal that there are both long and short run relationship between exchange rate, oil price, GDP and FDI which are bilateral in nature. Since foreign investment can help promote economic growth, the findings tend to suggest that South Africa should make a concerted effort in devising polices that improve the level of FDI. In other words, they should provide more investment friendly climate for trade and efficient monetary policy since exchange rates and oil prices are evidenced to be the key determinants in attracting foreign direct investments.

Keywords: Exchange rate, oil price, FDI, GDP, ARDL, South Africa

---

[1] INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia.

2 **Corresponding author**, Senior Professor, UniKL Business School, 50300, Kuala Lumpur, Malaysia.

Email: mansurmasih@unikl.edu.my

Introduction

The International Monetary Fund (IMF) and World Bank (WB) have reported the decline in oil prices will have a significant macroeconomic policy implication for oil-importing and exporting countries alike in the form of supportive activity and weakening economic activity respectively. The decline was considered an opportunity for the oil-reliant economies to diversify and to reform energy taxes and fuel subsidies. Oriavwote and Eriemo (2012) assert that the exchange rate is one important variable in the growth process of any economy since its level and stability directly affect the trade sector and investment. Although, the link between exchange rate and oil prices has been established before, particularly in the oil exporting countries, the findings cannot be generalized to cases of oil importing countries, given the circumstantial geographic dynamics (Kin 2014). Therefore, the impact of oil prices on exchange rates in oil importing countries such as South Africa is worthy to take into account. Moreover, oil prices are a vital global determinant of economic performance and therefore governments should closely monitor movements in the oil prices fluctuations in order to come up with policies to rein in the volatile exchange rate.

Statistics show that South Africa depends much on oil imports and of the total imports, oil accounts for 6% (EIA 2013). Moreover, South Africa imports more than 90% of its crude oil requirements (Nkomo 2009). It is therefore clear that the substantial dependence on imported crude oil exposes South Africa to external shocks that either disrupts or leads to higher oil prices, thus, negatively affecting economic growth and development.

Nevertheless, as much as the literature discuss the relationship between oil prices and exchange rate, we find that the extension to economic growth has not been addressed

adequately and as such we wish to establish the relationship between exchange rate, oil prices and economic growth. Furthermore, the relationship between FDI and economic growth is one of the thorniest areas in the present day debate. There is a wide spectrum of views on FDI from those who see it uncritically as contributing to economic growth in all circumstances to those, largely from the anti-globalisation movement, who conclude that FDI is pernicious to national development (Kin 2014). Foreign direct investment has played a considerable role in the development of South Africa's economy, although in more recent years FDI has remained at relatively low levels compared with other emerging market countries. Despite an improvement in overall macroeconomic conditions and South Africa's advantages in terms of natural resources and market size, foreign investors have shown limited interest in acquiring, creating, or expanding domestic enterprises (Arvanitis).

Considering the above and the newly found oil block that is located in the Outeniqua Basin, which has brought about considerable foreign direct investment to South Africa, as well as the recent decline in the South African exchange rate against the US dollar, we set out to find out the relationship between FDI, economic growth, exchange rates and oil prices for this study using the autoregressive distributed lag (ARDL) cointegration framework.

The paper is organized as follows: we review previous studies with particular focus on the impacts of oil prices and exchange rate on the GDP as well as the impact of FDI on economic growth and other factors. Subsequently, we explain the objective of the study while we discuss the employed research methods. Furthermore, we explain data and intuitively interpret the empirical results. Finally, we discuss the conclusion and the policy implications of the study.

Literature Review

The global oil price shocks in the 1970s brought about a tremendous academic wave of the relationship between oil prices and economic activity. Among the earliest is the seminal paper of (Hamilton, 1983) who examined the impact of the oil price shocks on the economy of the United States and found the negative shocks that led to seven of the eight recessions since World War II. Later on, Ben S.Bernake et. al (2004) investigated the relationship between oil prices shock and economic growth and found a negative relationship between the two. Moreover, Le viet Trung (2011) further confirmed the significant impact of oil price to GDP in the case of the Vietnam's economy. However, (Elfeituri, 2011) reported the effects of oil prices on the economic growth of countries who are oil-exporters and found that while increase in oil price boost economic growth, its decline causes a damaging impact on these countries. Furthermore, in studying the effects of oil price shocks on both oil-producing and oil-consuming countries (Ledyaeva, 2010) found evidence of positive as well as an indirect negative impacts on the economic activities of the first countries whereas the effects on the latter had revealed diverse results. Furthermore, the negative relationships between oil price and economic activities is further tested theoretically based on the historical oil price fluctuations by (Wirl, 2008) who reported all past oil price shocks were caused due to the global political instability and economic strategies with the exception of 2007-2008 shock which was merely driven by excessive demand shock.

In respect of the relationship between oil prices and exchange rate, Nikbakht (2010) examined the link that exists between oil price and exchange rate using OPEC member states as a case study. The findings of their study showed that oil prices are a dominant

source of real exchange rate movements. The results also revealed that there is a long-run linkage between real oil prices and real exchange rates. Furthermore, Turhan et al. (2012) investigated the role of oil prices in explaining the dynamics of selected emerging countries exchange rates. The findings showed that oil price dynamics impact on exchange rate changes over time and the impact was more pronounced after the 2008 financial crises. However, Ferraro et al. (2012) investigated whether oil prices have a reliable and stable out-of-sample relationship with the Canadian/U.S dollar nominal exchange rate. They found little systematic relation between oil prices and the exchange rate at the monthly and quarterly frequencies.

With respect to FDI, UNCTAD (2004) indicate that over the period 1982-2002 OIC countries on the average have attracted 12 percent FDI inflow to developing countries. In this connection, the countries such as Malaysia, Turkey and Morocco have had the better situation. Chakrabarti (2001) has studied the relationship between FDI and the variables such as tax, wage, openness, exchange rate and economic growth and has shown that these variables influence foreign direct investment. Schneider and Frey (1985) have observed that FDI attraction in different regions has related to economic and political factors. The economic and political tranquility attract foreign direct investment. Froot and Stein (1991) claimed that the level of exchange rate may influence FDI. This is because depreciation of the host country currency against the home currency increases the relative wealth of foreigners thereby increasing the attractiveness of the host country for FDI as firms are able to acquire assets in the host country relatively cheaply.

The above reviewed empirical studies have documented the relationship between oil prices, exchange rate and foreign direct investment and GDP. However, these studies have

investigated the variables independently in their respective combinations. Moreover, there is a clear deficiency in the literature of the exchange rate impacts on real GDP as well as how FDI performs against exchange rate volatility in relation to oil price shocks. Therefore, this study is an attempt to investigate the long-run relationship between oil prices, exchange rate, gdp and fdi of South Africa.

Data, Methodologies and Empirical Results

The data

In order to investigate the relationship between oil prices, exchange rates, foreign direct investment and economic growth, the following quarterly time series data of South Africa was taken from the World Bank Development Indicators (WDI): -

(i) Gross domestic product (GDP) in US$ constant price per capita is used as proxy for economic growth;
(ii) Exchange Rates (EX) are quoted in terms of South African Rands to United States Dollars as proxy for rate of exchange;
(iii) Oil Price (OIL) taken as Crude Oil- Brent FOB AT USD per barrel; and
(iv) Foreign Direct Investment (FDI) is quoted from the South African Balance of Payments as FDI; million USD.

This paper will study the quarterly data for 30 years starting from 1987.

Unit root tests

As an initial step for our process, we need to analyse the relationship between GDP, EX, OIL and FDI, and as such it is essential to conduct a unit root test on the variables. Therefore, we have employed the augmented Dickey Fuller (ADF) and the Phillips and Perron (PP) tests to test whether the variables are non-stationary at their level form (LGDP, LEX, LOIL & LFDI) and/or stationary at their differenced form (DGDP, DEX, DOIL & DFDI).

ADF and PP tests results are provided in Table 1.1 and Table 1.2; respectively, set out below which illustrates that all variables are non-stationary at their level form but stationary at their differenced form. It is therefore clear from the results below that the order of integration for all variables is 1 or I (1) which means that we can proceed to test whether these variables are cointegrated.

Table 1.1 – ADF test results

Variables	Test Statistic	Critical value	Test result
LGDP	-.57925	-3.2905	Non-Stationary
LEX	-2.0605	-3.2905	Non-Stationary
LOIL	-1.3138	-3.3390	Non-Stationary
LFDI	-1.4086	-3.5426	Non-Stationary
DGDP	-5.4155	-3.3901	Stationary
DEX	-4.7971	-3.3901	Stationary
DOIL	-10.5908	-3.4457	Stationary
DFDI	-6.4447	-2.9032	Stationary

Table 1.2 – PP test results

Variables	Test Statistic	Critical value	Test result
LGDP	-1.3717	-3.4327	Non-Stationary
LEX	-1.9445	-3.4327	Non-Stationary
LOIL	-2.7804	-3.4327	Non-Stationary
LFDI	-3.3414	-3.4327	Non-Stationary
DGDP	-9.4274	-3.3786	Stationary
DEX	- -9.4388	-3.3786	Stationary
DOIL	-12.0582	-3.3786	Stationary
DFDI	-41.5505	-3.3786	Stationary

Autoregressive distributive lag (ARDL) method

There are 3 steps in using ARDL method. Firstly, the presence of cointegration among the variables are tested by using the bounds testing procedure. The following 4 regressions are constructed without any prior information as to the direction of the relationship between the variables: -

$$\Delta GDP_t = a_0 + \sum_{i=1}^{p} b_i \Delta GDP_{t-1} + \sum_{i=1}^{p} c_i \Delta EX_{t-1} + \sum_{i=1}^{p} d_i \Delta OIL_{t-1} + \sum_{i=1}^{p} e_i \Delta FDI_{t-1} + \delta_1 GDP_{t-1} + \delta_2 EX_{t-1} + \delta_3 ELOIL_{t-1} + \delta_4 FDI + \varepsilon_t$$

$$\Delta EX_t = a_0 + \sum_{i=1}^{p} b_i \Delta GDP_{t-1} + \sum_{i=1}^{p} c_i \Delta EX_{t-1} + \sum_{i=1}^{p} d_i \Delta ELOIL_{t-1} + \sum_{i=1}^{p} e_i \Delta FDI + \delta_1 GDP_{t-1} + \delta_2 EX_{t-1} + \delta_3 OIL_{t-1} + \delta_4 FDI_{t-1} + \varepsilon_t$$

$$\Delta EL_t = a_0 + \sum_{i=1}^{p} b_i \Delta GDP_{t-1} + \sum_{i=1}^{p} c_i \Delta EX_{t-1} + \sum_{i=1}^{p} d_i \Delta OIL_{t-1} + \sum_{i=1}^{p} e_i \Delta FDI_{t-1} + \delta_1 GDP_{t-1} + \delta_2 EN_{t-1} + \delta_3 EL_{t-1} + \delta_4 FDI_{t-1} + \varepsilon_t$$

$$\Delta CO_t = a_0 + \sum_{i=1}^{p} b_i \Delta GDP_{t-1} + \sum_{i=1}^{p} c_i \Delta EX + \sum_{i=1}^{p} d_i \Delta OIL_{t-1} + \sum_{i=1}^{p} e_i \Delta FDI_{t-1} + \delta_1 GDP_{t-1} + \delta_2 EX_{t-1} + \delta_3 OIL_{t-1} + \delta_4 FDI_{t-1} + \varepsilon_t$$

In this respect, Δ denotes the first differenced operator, a_0 is the drift component and ε_t represents the residuals. The corresponding long run multipliers of the underlying ARDL models (δ_n) are also added as proxy for lagged error terms. The null hypothesis of no long run relationship between the variables is denoted by using F-test models and comparing them with critical values in Pesaran and Pesaran (1997) and Pesaran et al (2001) to determine the joint significance of the lagged levels of all the variables (i.e. F_{GDP} (GDP | EX,

OIL FDI), F_{EX} (EX | GDP, OIL, FDI), F_{OIL} (OIL | GDP, EX, FDI), and F_{FDI}(FDI | GDP, OIL, FDI) is $H_0 : \delta_1 = \delta_s = \delta_3 = \delta_4 = 0$ as against $H_A : \delta_1 \neq \delta_s \neq \delta_3 \neq \delta_4 \neq 0$.

The maximum number of lags imposed on the models are limited to 2. *Table 2* below shows the ARDL bound test results which reveals that all the estimated models are cointegrated as the estimated F-statistics exceed the upper bounds of critical value at 95% significance level (3.793 – 4.855) with the F-statistics of F_{FDI} (FDI | GDP, EX, OIL) being the highest at 8.9539 as well as F_{GDP} (GDP | EX, OIL, FDI), being the second highest and also exceeding the upper bound. As such, the null hypothesis that there is no cointegration between the variables ($H_0 : \delta_1 = \delta_s = \delta_3 = \delta_4 = 0$) is rejected since, in general, there is a long-run relationship that exists between all the variables. The results also indicate that there is cointegration regardless whether the dependent variable is economic growth, exchange rate, oil prices or foreign direct investment. This supports the literature that there is a bi-directional relationship between all these variables.

Table 2 – ARDL bound test results

Models	F-statistics
F_{GDP} (GDP | EX, OIL, FDI)	5.3508
F_{EX} (EX | GDP, OIL, FDI)	.94433
F_{OIL} (OIL | GDP, EX, FDI)	2.1331
F_{FDI} (FDI | GDP, EX, OIL)	8.9539

Subsequent to finding cointegration among the variables of GDP, EX, OIL and FDI, we continue to estimate the long run coefficient of the variables in the regressions identified above. For this purpose, the lag lengths are determined by Akaike Information Criterion (AIC) and a maximum of 2 lags was used due to the limited number of observations.

Table 3 reveals that the f-statistic is above the upper bound and thus the null hypothesis of no level effect is rejected. Furthermore, the estimated long run coefficient results indicate

that both economic growth and foreign direct investment depend on exchange rates and oil prices and as such these variables have significant impact on foreign direct investment. However, this model may not be as reliable as there seems to be a functional form problem but this may be attributed to the limited number of observations (although other models do not seem to suffer from the same functional form problem).

In so far as economic growth and foreign direct investment as the dependent variables, the results show that economic growth, exchange rates and oil prices have a significant impact on foreign direct investment suggesting that the causality runs more towards foreign direct investment and economic growth.

Table 3 – Estimated ARDL models, long run coefficient based on Akaike Information Criterion (AIC) results

Dependent Variable	**F-statistic**	**95% Lower Bound**	**95% Upper Bound**	**90% Lower Bound**	**90% Upper Bound**
LGDP	10.4089	3.3641	4.4495	2.8077	3.8240
LFDI	19.5477	3.3641	4.4495	2.8077	3.8240

Subsequent to the long run coefficient estimation, we continue to examine the short run dynamic coefficients to see if the results are consistent with the long run findings. The results can be seen in *Table 4* below.

Table 4 – Estimated ARDL models, short run error correction model based on Akaike Information Criterion (AIC) results

Dependent Variable	**F-statistic**	**95% Lower Bound**	**95% Upper Bound**	**90% Lower Bound**	**90% Upper Bound**
LGDP	10.4089	3.3641	4.4495	2.8077	3.8240
LFDI	19.5477	3.3641	4.4495	2.8077	3.8240

Since the results of short run dynamic coefficients in *Table 4* are consistent with the finding of the long run coefficients in *Table 3*

Further, the results as per Appendix 6 also show that the negative ecm (-1) values indicate that there is cointegration for all models where the dependent variables are economic growth and foreign direct investment. The low ecm (-1) co-efficient value implies that the variables are slow to converge to the equilibrium and there is partial adjustment to the same.

Notwithstanding these results, the findings tell us that both variables are endogenous whereas oil and exchange rates are exogenous at 5% significance. Given that the variables the variety of endogeneity and exogeneity we will proceed to look at the variance decomposition (VDC) to see which variable is the leader / follower to confirm the finding. The results can be found in Table 5 below.

Table 5 – variance decomposition (VDC) results

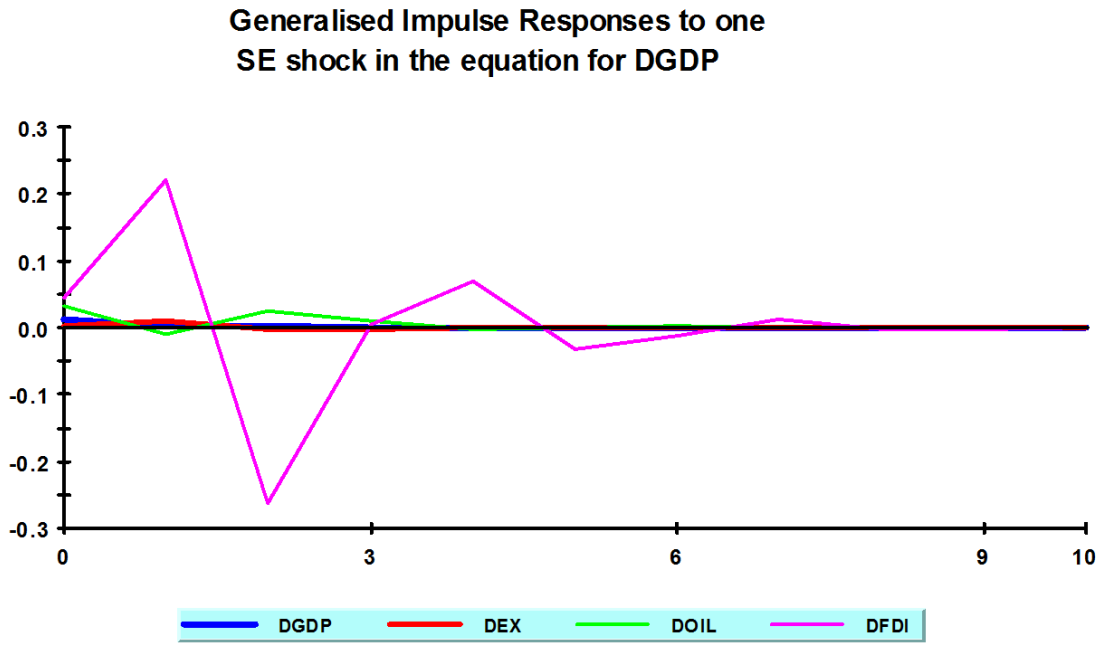
	HORIZON	***LGDP***	***LEX***	***LOIL***	***LFDI***	***TOTAL***	***SELF-DEP***	***RANKING***
LGDP	*13*	*92.61%*	*0.51%*	*6.07%*	*0.81%*	*100.00%*	*92.61%*	*1*
LEX	*13*	*2.27%*	*84.12%*	*13.25%*	*0.36%*	*100.00%*	*84.12%*	*3*
LOIL	*13*	*3.43%*	*6.12%*	*89.96%*	*0.49%*	*100.00%*	*89.96%*	*2*
LFDI	*13*	*3.43%*	*6.12%*	*89.96%*	*0.49%*	*100.00%*	*0.49%*	*4*

Interestingly, Table 5 does not confirm the findings in Table 4. In this respect, economic growth is revealed to be the leader (i.e. exogenous) and followed by oil prices as the 2nd leader. This is contrary to our earlier finding that GDP and FDI are endogenous and as such should be trail oil prices and exchange rates. However, the differences in variance decomposition of the variables are not that significant which except for foreign direct investment which suggest that all the variables are co-dependent and any changes made to any variable would have an effect on the other variables. It is therefore not a surprise that there are many studies with conflicting view as to the nexus between exchange rates, economic growth and oil prices as they are all closely endogenous.

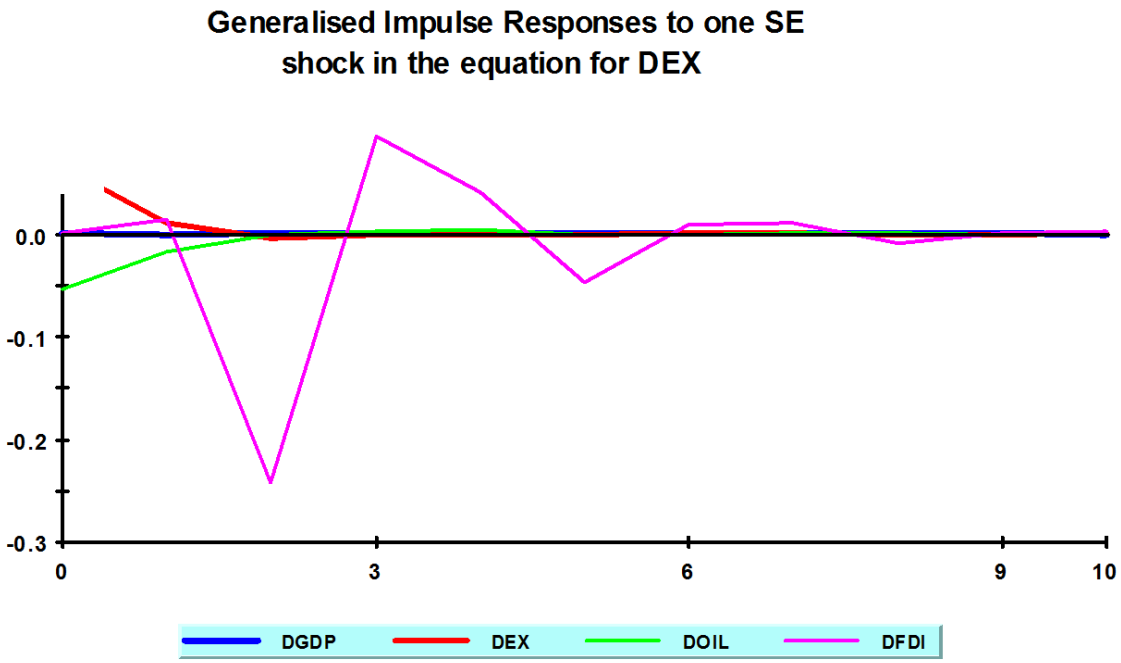
Impulse Response Analysis

Despite the different lag order of the variables as estimated using the AIC for the ARDL regressions, we will employ impulse response (IR) analysis to look at how the shock of one variable affects other variables. For the purposes of this analysis, we will study the graphs of Generalised IR for each variable shocked into the system and see the degree of response and how long it would take for other variables to normalise.

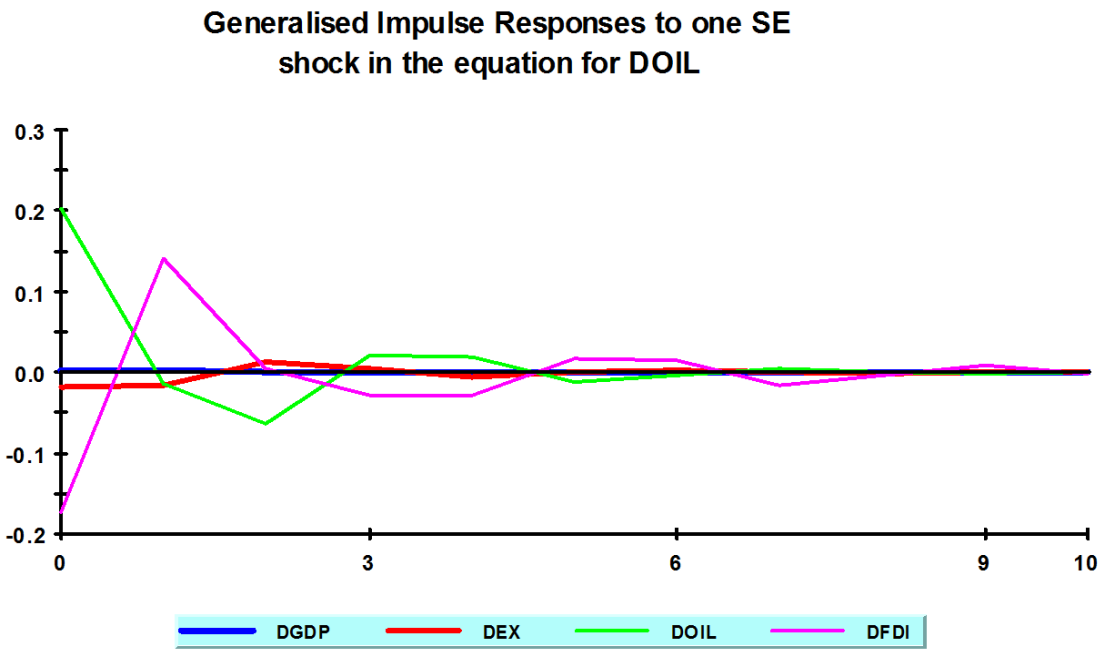
Graph 6.1



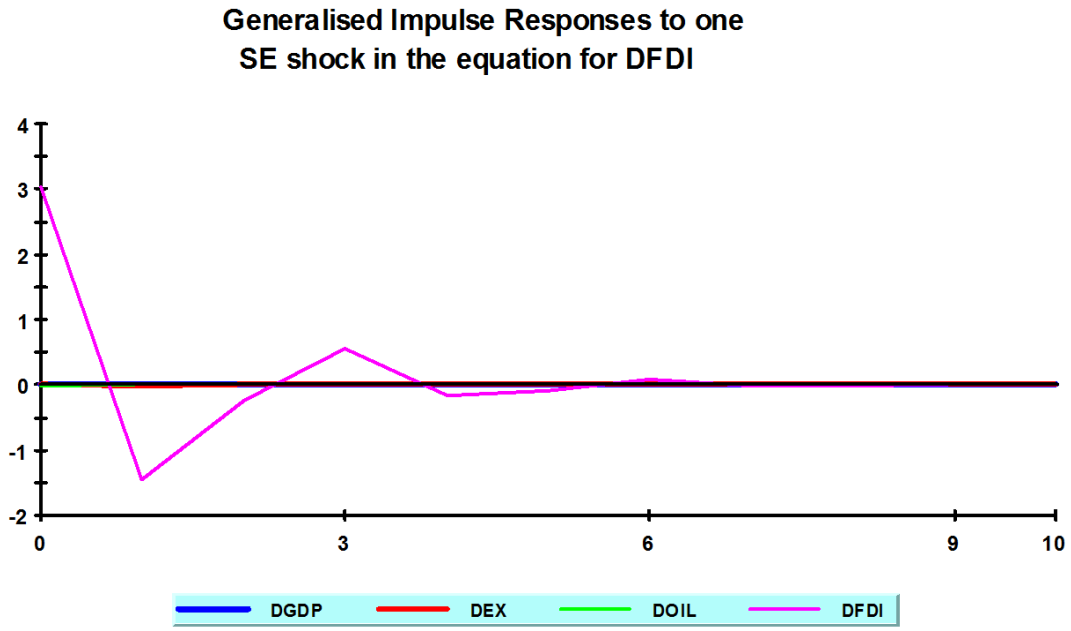
Graph 6.2



Graph 6.3



Graph 6.4



From the above graphs, it is clear to see that the shock of each variable affects the other variables more or less equally with the exception of FDI. Generally, all the variables seem to take about 6years to normalise after a 'shock'. In so far as Graph 6.1, it is interesting to note that the shock of economic greatly affects the FDI in the first five years before slowly normalising towards year six whereas the exchange rate in Graph 6.2 is similar for FDI; however, we notice that it also affects oil prices in the first two year before normalising in year three. From the first two graphs it is clear that both GDP and Exchange rate shocks have a significant impact on FDI. Furthermore, Graph 6.3 seems to show that the shock of oil prices has again a high impact on FDI, but also shows a significant response in exchange rates for the first three years. Lastly, Graph 6.4 shows that the shock of foreign direct investment has very little effect and remains normalised which confirms the FDI is the weakest endogenous variable present.

Conclusion and Policy Implications

This paper examined the relationship between economic growth, oil prices, exchange rates and foreign direct investment using quarterly time series data covering the period of 1987 - 2016 of South Africa. The results suggest that whilst there is co-integration among the variables, causality runs from economic growth, exchange rates and oil prices towards foreign direct investment in the long run.

Policy makers should provide more investment friendly climate for trade and efficient monetary policy since exchange rates and oil prices seem to be key determinants in attracting foreign direct investments. Finally, policy makers should also ensure that adequate measures are in place to protect the local currency against major declines against the US dollar since it will have a negative impact on both exchange rates and foreign direct investment in South Africa.

References

Al-Ezzee, I. (2011). Real Influences of Real ExchangeRate and Oil Price Changes on The Growth of Real GDP: Case of Bahrain. *International Conference on Management and Service Science, 8*, 155-164.

Ben S.Bernake, M. G. (2004). Oil shocks and aggregate macroeconomic Behaviour. The role of monetary policy. *Journal of Money, Credit, and Banking, 36(2),* 287-291.

Division, D. o.-S. (2010). *International Recommendations for the Index of Industrial Production.* New York: United Nations.

Egbe, Onoja (2015). The Impact of Oil Price Volatility on the Real Exchange Rate in Nigeria: An Error Correction Model. *African Research Review: An International Multidisciplinary Journal,* 9(1), 15-22.

Elfeituri, A. E. (2011). Oil price changes and economic growth in oil-exporting countries. *OPEC Review, 11*, 237-250.

Fardous Alom, B. D. (2013). Macroeconomic effects of world oil and food price shocks in Asia and Pacific economies: application of SVAR models. *OPEC Energy Review, 37*, 327-372.

Hamilton, J. D. (1983). Oil and the Macroeconomy since World War II. *The Journal of Political Economy, 91(2),* 228-248.

İbrahim TURHAN, E. H. (2012). Oil Prices and Emerging Market Exchange Rates. *Central Bank of the Republic of Turkey: WORKING PAPER NO: 12/01*, 01-30.

Jung-Kwan Kim, R. A. (2006). Economic activity, foreign exchange rate, and the interest rate during the Asian crisis. *Journal of Policy Modeling*, 28(4), 387-402.

Le viet Trung, T. T. (2011). The impacts of oil prices, real effective exchange rate and inflation on economic activity: novel evidence from Vietnam. *Discussion paper series, RIEB, Kobe University*, 1-29.

Ledyaeva, L. K. (2010). Trade linkages and macroeconomic effects of the price of oil. *Energy economics 32*, 848-856.

Magda Kandil, H. B. (2007). The effects of exchange rate fluctuations on economic activity in Turkey. *Journal of Asian Economics, 18*, 466-489.

Magda Kandil, I. A. (2008). Comparative analysis of exchange rate apprceciation and aggregate economic activity: Theoy and evidence from Middle Eastern countries . *Bulletin of Economic Research 60(1),* 45-96.

Masih, Mansur, Ali El-Elg and Haider Madani (2009). Causality between financial development and economic growth: an application of vector error correction and variance decomposition methods to Saudi Arabia. *Applied Economics, 41*(13), 1691-1699.

Mehmet Balcilar(2017),The Impact of Oil Price on South African GDP Growth: A Bayesian Markov Switching-VAR Analysis, *African Development Review,* 29 (2), 319-336

Nora Yusma, N. W. (2013). Measuring the effects of world oil price change on economic growth and energy demand in Malaysia: A RDL bound testing approach. *International Journal of Trade, Economics and finance 4* , 1-35.

Oluwatomisin M. Ogundipe, P. O. (2014). Oil Price and Exchange Rate Volatility in Nigeria. *IOSR Journal of Economics and Finance* , 5(4), 01-09.

Sánchez, R. J.-R. (2012). Oil price shocks and Japanese macroeconomic developments. *Asian Pacific Economic Literatur, 26*, 69-83.

Tiwari, A. K. (2015). Oil price and exchange rate in Malaysia: a time frequencey Analysis. *Asian Economic and Financial Review, 5(4)*, 661-670.

Wirl, F. (2008). Why do oil prices jump (or fall)? *Energy polic,y 36*, 1029-1043.

Yip Chee, L. H. (2009). The Impacts of oil shocks on Malaysia's GDP growth. *Proceedings of the 5th Asian Mathematical conference, Malaysia*, 1- 8.

Zhang, Y. (2013). The Links between the Price of Oil and the Value of US Dollar. *International Journal of Energy Economics and Policy* ,3(4), 341-351.