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The Impact of Oil Price Volatility on the Real Exchange Rate in Nigeria: An Error Correction Model

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Abstract

In this paper, we empirically investigated the link between real exchange rates and real oil prices in Nigeria. We studied to find out whether the real exchange rate is positively related to the real oil prices as predicted by the models in previous research. We also investigated whether real oil prices can predict long-run movements in real exchange rates. The Error Correction Method (ECM) of analysis was used in the investigation.

Introduction

A development in the global challenge to policy makers across countries is the increasing spate of fluctuations in oil prices. Over the period 1980-2008, the price of crude oil had fluctuated significantly, with mean, minimum and maximum values of $32.31 (bbl), $12.72(bbl), and $140(bbl) respectively. The above statistics, in addition to a standard deviation of 17.08 over the sample period show that the prices of crude have always been characterized with severe instability. Monthly fluctuations have in fact been more severe than these annual trends with the price of crude oil reaching $140(bbl) in July 2008.

Volatile oil prices may have a number of adverse effects on an economy. Some of these directly affect the economy as a whole some affect the government and hence the economy through the governments reactions and some affect individuals firms and consumers directly. Such instability in the prices of crude oil is bound to cause macroeconomic distortions especially in net oil importing countries like Nigeria. Such effects may include among other things, the depreciation (or appreciation) of the domestic currency.

The exchange rate is arguably the most difficult macroeconomic variable to model empirically. The role of exchange rate and its effects on macroeconomic performance has continued to generate interest among economists. Many economists argue that exchange rates stability facilities production activities and economic growth. They are also of the view that misalignment in real exchange rate could distort production activities and consequently hinder exports growth and generate macroeconomic instability. Exchange rate policy guides investors on the best way they can strike a balance between their partners and investing at home or abroad. Instability and/or fluctuations in exchange rate hurt producers and investors alike because it affects their projected (planned) revenue and costs, including profits margin. For instance, businesses (based on the exchange rate) set out the amount to be committed into acquiring raw materials and equipment/machines from abroad. In the same manner, they estimate their future stream or incomes. Instability in the exchange rate may distort the realization of such estimates. For example exchange rate depreciation results in high cost of importing raw materials and capital goods. This in turn raises the cost of production and reduces the profits of the firms importing these items. In order to cushion the effects of high cost of production, they (firms) would pass it onto the consumers in form of higher prices. Besides production will decline and unemployment will rise. Couple with these is the reduction in exports, accumulation of trade deficits and deterioration of balance of payment as well as decline in the welfare of the people. Many papers have previously suggested that oil prices may have an important influence on exchange rates. The suggestion, however, that oil prices might be sufficient to explain all long run movements in real exchange rates appears to be new. Structural time-series work on the determinants of real exchange rate fluctuations indicates that real shocks or permanent components play a major and significant role in explaining real exchange rate fluctuations.

Objectives of the study

The potential importance of oil prices for exchange rate movements have been noted by Krugman (1983), Nikbakht (2009). These studies particularly, focused on oil price volatility on the oil importing country and not that of a net exporter of crude oil. Chen and Chen (2007) for example derived a real exchange rate equation in which they concluded that if the home country is more dependent on imported oil, a real oil price rises may increase the prices of tradable goods in the home country by a greater proportion than in the foreign country, and thereby cause a real depreciation of the home currency. Yet the impact of oil price volatility on real exchange in an oil exporting country, such as Nigeria, could actually follow a different path.

Literature review

A great deal of attention has been given to the relationship between oil prices fluctuations and economic activity since the early 1970s. Empirical studies show that these oil price shocks were immediately followed by worldwide recessions and periods of inflation spurred considerable research. By looking at the channel of transmission of oil price shocks to the larger economy, many researchers have argued that fluctuations of oil prices are linked to macroeconomic performance.

This theoretical relationship between macroeconomics and oil price movements has been widely applied and tested using various econometric techniques dealing largely with the economies of the United State and other OECD countries. Nevertheless, the analysis of the impact of oil price volatility on macroeconomic variables is complicated by other key events and changing economic environments during the period in which the price fluctuations occurred.

However, not much work has been done on the relationship between oil price volatility and the exchange of currencies especially in LCDs. Nikbakht (2009) studied the long-linkage between real oil price and real exchange rate in OPEC members and investigated the long run relationship between them by using a monthly panel of seven countries of OPEC members from 2000:01 to 2007:12. First he tested whether or not exchange rates are co-integrated with real oil prices. The country-by-country results rejects the co-integration between oil prices and exchange rates, but stationary and co-integration tests for pooled series showed the high power of panel analysis for unit root and co-integration between exchange rates and oil prices. It was shown that real oil prices may have been the dominant source of real exchange rate movements. Finally, results showed that, there is a long run and positive linkage between real oil prices and real exchange rates. It was therefore suggested that since the real exchange rate of OPEC members depends on oil price movements severely, economists and governments of these countries should consider this powerful relationship and oil shocks in their economic planning and decision making.

Lastrapes (1992) by using the Blanchard and Quah (1989) decomposition, find that much of the variance of both real and nominal exchange rates from a number of countries over both short and long horizons is due to real shocks. The conclusions from the structural time-series literature therefore seem to be robust to both decomposition methods and currencies. This has led some to suggest that unidentified real factors may be causing persistent shifts in real equilibrium exchange rates.

Clarida and Gali (1994) use the Blanchard-Quah identification strategy to estimate the share of exchange rate variability that is due to different shocks by using quarterly US, Canada, US-Germany, US-Japan and US-UK real exchange rate data from 1974:Q3 to 1992:Q4. They found that real shocks can account for more than 50% of the variance of real exchange rate changes over all time horizons.

Different sources of real shocks have been investigated in Zhou (1995) among many sources of real disturbances, such as oil prices, fiscal policy, and productivity shocks; it has been shown that oil price fluctuations play a major role in explaining real exchange rate movement. Moreover, Chaudhuri and Daniel (1998) investigated 16 OECD countries and find that the non-stationary behaviour of US dollar real exchange rates is due to the non-stationary behaviour of real oil prices. Similar results were obtained by Amano and Norden (1998a, b) by using data on real effective exchange rates for Germany. In Japan, and the US, they found out that the real oil price is the most important factor determining real exchange rates in the long run. Camarero and Tamarit (2002) use panel co-integration techniques to investigate the relationship between real oil prices and the Spanish Peseta's real exchange rate.

Yousefi and Wirjanto (2004) adopted a novel empirical approach to the crude oil price formation for the purpose of understanding the price reactions of OPEC member countries to changes in the exchange rate of the US dollar against other major currencies and prices of other members. The results are broadly consistent with the view of the absence of a unified OPEC determined price in the international crude market literature. In addition, the results also highlight cross-regional dimensions of the crude oil market.

Chen and Chen (2007) investigated the long-run relationship between real oil prices and real exchange rates by using a monthly panel of G7 countries. They found that real oil prices may have been the dominant source of real exchange rate movements and that there is a link between real oil prices and real exchange rates. They then examined the ability of real oil prices to forecast future real exchange returns. Finally, they found that panel predictive regression estimates suggest that real oil prices have significant forecasting power.

In the case of Nigeria, Olomola and Adejumo (2010) examined the effect of oil price shock on output, inflation, the real exchange rate and the money supply in Nigeria using quarterly data from 1970 to 2003. The VAR method was employed to analyze the data. The findings were contrary to previous empirical findings in other countries; oil price shock does not affect output and inflation in Nigeria. However, they did find that oil price shocks do significantly influence the real exchange rates.

The implication is that a high real oil price may give rise to wealth effect that appreciates the real exchange rate. This may squeeze the tradable sector, giving rise to the ‘Dutch Disease’

Methodology and model specification

This study employed co-integration and error correction approach to estimate the relationship between exchange rate and real oil prices. This is to study the short run dynamics and long run properties of the relationship. The basic model to be used follows the conclusion by Nikkbakht (2009) that oil price alone is enough to predict the long run behaviour of real exchange rate. The ECM is specified as:

$$\mathbf{\Delta Inrer_1 = \alpha_0 + \alpha_1 \Delta rpoil_{t-1} + \alpha_2 \Delta hop_1 + \alpha_3 \Delta tdb + \alpha_4 \Delta res + \beta_1 rer_{t-1} + \delta ectt_{-1} + \pounds_1}$$

Where

rer = real exchange rate
rpoil = real oil price
bop = balance of payments
tdb = trade balance
res = foreign exchange reserves
ect = error correction term
£ = error term

lexc
Real exchange rate is calculated as:

where P_{us} = price index of the US

cpi = Nigeria’s domestic price index

ner = nominal exchange rate

From the estimated result, the short run relationship between oil price and real exchange rate will be derived. Moreover the effect of oil price fluctuation on long run real exchange real will be examined. In this way, it will be verified if oil price is a sufficient predictor of real exchange rate in the long run.

Empirical analysis

The dynamics of oil price volatility and real exchange rate in Nigeria is captured in an error correction model. However, due to time dependence of most times series data, unit roots test for each of the variables is carried out in order to verify the stationarity or other wise of each of the variables. Indeed, the unit root test is performed in order to ascertain whether first differencing of each series would produce stationarity. This is because such series that are integrated of order one often possess long-run properties. It is the short run dynamics of this relationship that is captured in an error correction methodology. Table 1 shows the result of the ADF unit root test carried out on all the variables. For each variable, generates the time series is determined.

Table 1: Unit Root Test for variables (in First Difference)

Variables	ADF	ADF Test Statistic	95% Critical ADF value	Remark
DLRER	1	-6.279	-2.887	Stationary
DLRPOIL	1	-8.254	-2.887	Stationary
DBOP	2	-7.675	-2.887	Stationary
DTDB	2	-8.506	-2.887	Stationary
DLRES	1	-10.122	-2.887	Stationary

The unit root tests on all variables are carried out using the ADF test mechanism. The results show that all the variables are stationary at first difference. This is because each of their ADF values are greater than the 95% critical value. Thus, after differencing the variables once each of them became stationary, thus, there is unit root in each of the variables since they are all integrated of order one i.e. 1(1)

From the outcome of the unit root test, the test of co-integration among the variable can be carried out. This is done based on the proposition by |Engle and Granger (1987) that time series integrated of the same order will possess similar long-run properties. In order words, a linear combination of the variables produces co-integration among them.

The co-integration test is done using Engle and Granger two step procedures; first, we estimate an OLS model with real exchange rate as dependent variables and all the four independent variables as regressors. Secondly, the residuals obtained from the model are tested for unit root. If the residual is stationary i.e. 1(1) then we accept the hypothesis of co-integration in the series. The co-integration test results is represented in table 2 below

Table 2: Co integration Test

ADF lag	ADF Test Statistic	95% Critical ADF value	Remark
1	-4.328	-4.541	Stationary

Table 3: Error Correction Representation

Variables	Coefficient	I-RL
dLRER (-1)	0.165	1.669
dLRPOIL	0.120	1.148
dBOP	-0.57E-7	-0.654
dTOP	-0.591E-7	0.964
dLRES	0.018	0.806
dINPT	-0.144	-0.765
eCM(-1)	-0,077	-2.314

R^2 = 0.98 R^2 = 0.38

F (6,107) = 1.91 DW-Statistic = 2.0

The goodness of fit of the model result shown above is rather inefficient. Firstly, the R-squared result indicates that only about 9.8 percent of the short run systematic variation in real exchange rate is explained by the independent variables and the ecm. This shows that the pattern of movement in real exchange rate has not been effectively captured by the specified ecm representation. The overall fir of the model is also impressive, with an F-statistics value of 1.91. The F-statistic fails the significance test at the 5 percent level of insignificance. Based on this outcome, we cannot accept a significant dynamic relationship between real exchange rate and the independent variables combined

A cursory look at each of the coefficient of the explanatory variables reveals that only the coefficient of RES does not have the expected apriori sign. The other entire coefficient has the expected apriori signs. However, none of the coefficient is significantly different from zero. This goes to show that in the short run, none of these variables plays any significant role in predicting the real exchange rate. The DW-statistic reveals absence of autocorrelation in the model.

The outcome of the analysis points us to one issue. Namely that a dynamic short run behaviour of exchange rate cannot be measured by the volatility of oil prices and the other factors highlighted in the model. This finding is in line with the outcome of Baxter (1994) that "univairate analysis where he found that real exchange rate does not follow a (short run) random walk; rather most of their movements are due to changes in permanent components.

The error term is negative and passes the significance test at the 5 percent level. However, the coefficient of the error term is very low and it shows that adjustment to long run equilibrium is slow. Only about 8 percent of the adjustment to equilibrium is completed within the first quarter.

Conclusion

In this study, we have set out to examine the dynamic relationship between oil price volatility and the real exchange rate in Nigeria. This analysis was motivated by the fact that the Nigerian economy depends heavily on crude oil and volatility in its prices has and still, significantly affected major economic variables using quarterly data for the period 1981 Q1 to 2009 Q4. The study however, reveals that though most of the movements in real exchange rate is due to changes in the permanent components, dynamic short run impact of oil price volatility on exchange rate does not hold. This may be due to the fact that transactions on crude oil are not primarily carried out using the naira and so the fluctuation in prices may not be easily transmitted to the naira exchange rate in the short run.

The lesson here is that permanent adjustment in exchange rate of the naira should be the main issue of concern when oil prices are fluctuating. Moreover, adequate measures should be put in place to de-link long run movements of the naira exchange rate from oil price changes. This is because oil prices are highly volatile and very unsettled. If current vagaries in the prices of oil categorically affects long run exchange rate, then long run stability of the external sector is not assured.

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