

Dynamic relationship of exchange rates and crude oil prices in South Africa: Are there asymmetries?

Hamisu Sadi Ali[a*], Umar Mukhtar[b & c], Bulama Abiso Tijani[b& d], Abdullahi Muhammad Auwal[b&c]

[a]Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, 43400 Serdang, Selangor-Malaysia.

[b]Department of Agribusiness & Information Systems, Faculty of Agriculture, Universiti Putra Malaysia, 43400 Serdang, Selangor-Malaysia.

[c]Department of Agricultural Economics and Extension, Faculty of Agriculture, Federal University Dutse, P.M.B. 7156, off Ibrahim Aliyu Bye-Pass, Jigawa State-Nigeria.

[d]Department of Agricultural technology, Ramat Polytechnic, P.M.B 1070, Maiduguri Borno State, Nigeria

*Corresponding author's E-mail: hamisusadi@gmail.com

Abstract

We estimated the relationship between the exchange rates and crude oil prices for the period of 1960 to 2013. Based on Engle-Granger we found that the variables are cointegrated means there exist long-run relationship. However, when we move on to TAR and MTAR models the findings are opposite as there is no element of cointegration and the speed of adjustment is symmetric. This shows that based on TAR and MTAR models the effects of exchange rates on crude oil prices is insignificant. The policy relevance is that South African authority need to monitor its exchange rates persistently related to other currencies more especially American dollar because it determined the crude oil prices that might have greater influences on other macroeconomic variables.

Keywords: Exchange rates, Oil prices, Asymmetry, South Africa, Error correction model.

Introduction

The relevance of crude oil in the global economy can never be ignored considering its significance as a source of earnings to some countries and as a source of energy that roll various economic activities in the world. The link that exists between crude oil prices and exchange rates was since studied by various authors because the relationship between the two macroeconomic variables is important more especially to oil importing country like South Africa. Crude oil price is determined by the organization of petroleum exporting countries (OPEC) based on quota assign to various members of the economic cartel. Traditionally, the currency that is used to determine the global price of the crude oil is American dollar ($), the present values of dollar in relation to South African Rand may affect the consumption as well as the usability of the products in South African economy that might have either positive or negative effects on the overall economy. The purpose of the paper is to examine the effects of exchange rates on crude oil prices for the period under investigation. The paper is motivated by the fact that South Africa is among the fastest growing and leading economies in African sub-continent, therefore import high volume of crude oil for its consumption and uses US dollar as the trade currency. The volume of the product imported will therefore be determined by the ratio of South African Rand in relation to American dollar that ultimately affect almost overall economy as the prices of crude has significant influence on various macroeconomic variables.

An overview of South African Economy

[1]The democratic transition that took place in South Africa in 1994 changed the economic landscape of the country, before the independence there is internal and financial sanctions of apartheid government which led to poor performance of the economy. However, after Second World War such constraints was removed and the economy started taking shape for prosperity and upward performance. The economy recoded growth rate of 3.3% averagely over the period of 1994 to 2012 in real terms. An amazing development of 1.4% average growth recorded during the period of 1980 to 1993. In real terms the country experienced 5% average growth between

[1] Statistics on South African economy can be accessible through http://beta2.statssa.gov.za/?page_id=735&id=1

2004 to 2007, while it decline to less than 3% between 2008 to 2012 which might be connected with the effects of global financial crisis of 2008.

Literature Review

The influence of oil price instability on other macroeconomic variables gave researchers in the field of economics and finance more courage to study its relationship with other macroeconomic variables. Theoretically, it shows that when the prices of the crude oil rise it affected the output negatively hence increase the cost of production inputs (see for example Brown and Yücel, 1999). This behaviour will also increase demand for money which might spur the level of interest and thereby hamper economic growth (Brown and Yücel, 2002). Increase in oil prices could also raises the prices level that might create price wages twists. The level of investment, consumption and stock markets prices could also be influenced adversely due to increase in the oil price and this reduces disposable income and increase production cost, if this behaviour remains unchecked the level of employment will be low as a result of high costs of production. Various empirical researches were conducted on the nexus between oil price and other macroeconomic variables including crude oil prices. The relationship between oil price and other price indexes was examined by Mansor and Kanokwan (2014) using both symmetric and asymmetric cointegration approaches. The finding shows that the dynamic of oil price have more effect on energy price inflation, followed by transportation and communication inflation, and finally the non-raw food price inflation. This suggests that the influence of oil price inflation on other price indexes depends on the type of the commodity as it has more effects on some commodities when compared to others. Using quarterly data for the time period of 1970 to 2011 of crude price and exchange rates in Philippine, Chen et al., (2013) applied threshold auto regressive (TAR) model and the model reveals that the two variables are non-stationary in the long run. However, when momentum autoregressive (MTAR) is applied the variables were asymmetrically cointegrated. This means it is not always the adjustment is linear it depends on the economic situation and the nature of the economic variables.

Nazlioglu and Soytas (2011) examine the relationship between oil prices exchange rates and other agricultural prices in Turkey. They used monthly data of January, 1994 to March, 2010 and applied both Toda Yamamoto causality and impulse response function. The results shows that the prices of agricultural products are not affected by the oil prices and exchange rates shocks, and the long-run relations shows that the fluctuations of oil prices and exchange rates instability are not transmitted to the prices of agricultural products in Turkey. The effects of oil price on feed grain prices in China for the time frame of January, 2000 to October 2007 was documented by Zhang and Reed (2008). The results show that the crude oil price does not have any effects on feed grain prices. Greenidge and DaCosta (2009) conducted their study on the factors that influence inflation for short-run and long-run periods among four Caribbean countries (Barbados, Jamaica, Guyana and Trinidad and Tobago) and concluded that oil price changes affects the level of inflation substantially in both short run and long run periods. Lizardo and Mollick (2010) in their paper on oil price fluctuations and US dollar exchange rates using US dollar against major global currencies for the period of 1970 to 2008. Their finding reconfirmed that oil prices affects exchange rates dynamics in the long-run. When oil prices increases the value of US dollar in relation to oil exporters currencies such as Russia, Canada, and Mexico depreciate. However, same behaviour leads to depreciation of oil importers currencies relative to US dollar e.g. Japan.

Chen and Chen (2007) used monthly data from 1972 to 2005 and examine the long-run relationship between real oil prices and exchange rates across G7 economies. Their findings show that real oil prices influence exchange in the long-run. The result also indicated that real oil prices forecast the future value of exchange rates, which means it affects its movement for the entire countries under study. Lardic and Mignon (2008) also investigate the nexus between oil price and economic activities as measured by GDP. Their findings shows that normal cointegration was excluded, however asymmetric cointegration exist between oil price and GDP in the US, G7, and Euro area economies. In their study Amano and Norden (1998) on the nexus between oil price and real effective exchange rates in the US concluded that there exist stable link between shocks of oil price and US real effective exchange rates for the post-Bretton Woods period. Their results therefore shows that oil prices might have been the leading source of real exchange rate persistent shocks and that the prices of energy may have essential effects on the forthcoming movement of exchange rates.

Data, methodology and Empirical Results

Data for the study was sourced from two relevant data sources which are Western Texas intermediate (WTI)[1] for crude oil and Data stream international for exchange rates and consumer price index. Monthly data for the period

[1] For data on crude oil prices check: http://research.stlouisfed.org/fred2/series/MCOILWTICO

of January, 1960 to December, 2013 is used. We calculated real oil price by multiplying the global crude oil price with South Africa's local currency in relation to US dollar at given period divided by the its consumer price index (CPI). Real exchange rate is obtained by taking South Africa's currency per US dollar and multiplied with United State CPI. Both variables were expressed in natural log for normalization purposes.

Model Specification

$$LER_t = \beta_0 + \beta_1 LOP_t + \mu_t \quad (1)$$

LER is signifies the log of exchange rate and LOP is the log of oil prices, β_0 is the intercept and β_1 is the slope of the coefficient that explains the relationship between exchange rate and crude oil prices and μ_t is the error term that may be serially correlated (Enders and Siklos, 2001). Since we are dealing with the time series data the first is to check whether our variables are stationary or not using the traditional Augmented-Dickey Fuller (ADF) and Phillip Perron (PP) unit root tests. After confirming the stationarity of our variables we then proceed by testing the residuals to see they are cointegrated as introduced by Engle and Granger (1987) technique.

Table 1: ADF and PP unit root tests for Exchange rates and Oil prices

Variables	ADF at level	ADF First Difference	PP at level	PP First Difference
LER_t	-1.921 (0.322)	-24.134 (0.000)*	-2.120 (0.236)	-24.112 (0.000)*
LOP_t	-1.462 (0.552)	-22.090 (0.000)*	-1.153 (0.695)	-21.979 (0.000)*

NB: The ADF and PP test equations include both constant and trend terms. The Schwarz information criterion (SIC) is used to select the optimal lag order in the ADF test equation. The values in brackets are corresponding p-values. * Denote significance level at 1%, ** at 5%, and *** at 10% respectively.

Based on the result in table 1 both null hypothesis cannot be rejected at level for both variables, but when we take first difference it is rejected at 5% level of significance which shows variables are integrated at I(1), that means they are stationary after taking first difference.

The estimation of the residual is shown below as suggested by Engle-Granger:

$$\Delta\mu_t = \rho\mu_{t-1} \sum_{i=1}^{q} \delta_1 \Delta X_{t-1} + v_t \quad (2)$$

The long-run estimated result is shown below:

$$LER_t = 1.46 + 0.74 LOP_t$$

(0.021)** (0.017) **

$$R^2 = 0.79, \ D.W = 0.02 \quad (3)$$

Values in brackets are t-statistics, we will now regress residual using ADF at level with no trend and intercept in order to get Engle-Granger value

$$\Delta\mu_t = 0.031\mu_{t-1}$$

(-2.135)

$$R^2 = 0.062, \ D.W. = 2.000 \quad (4)$$

Based on the t-statistics valued (-2.135) null hypothesis is rejected at 5% which signifies that residual is stationary at level, impliedly indicating the long-run relationship between the variables. Since we established the cointegrating relationship among the variable the next is to test whether the speed of adjustment is symmetric or asymmetric with regard to adjustment when deviated from the equilibrium. In order to test for asymmetric cointegration we employed Enders and Granger (1998) and Enders and Siklos (2001) terminologies. We will now estimate equation (2) which rely on ρ and λ, equation (2) will be altered as:

$$\Delta\mu_t = I_t\rho_1\mu_{t-1} + (1 - I_t)\rho_2\mu_{t-1} + \sum_{i-1}^{p-1} \gamma_i\Delta\mu_{t-1} + \varepsilon_t \quad (5)$$

Heaviside indicator (τ) is used to determine above and below threshold where by:

$$T_t = \begin{cases} 1 \text{ if } \mu_{t-1} \geq \tau \\ 0 \text{ if } \mu_{t-1} < \tau \end{cases} \quad (6a)$$

$$M_t = \begin{cases} 1 \text{ if } \Delta\mu_{t-1} \geq \tau \\ 0 \text{ if } \Delta\mu_{t-1} < \tau \end{cases} \quad (6b)$$

When we combine equation 5 and 6a we got Threshold Auto Regressive (TAR) model, and equation 5 and 6b refers to Momentum Threshold Auto Regressive (M-TAR) model. Based the models if μ_{t-1} is above the threshold the coefficient for the adjustment is $\rho 1\mu_{t-1}$, whereas if the μ_{t-1} is below the threshold the adjustment coefficient is $\rho 2\mu_{t-1}$. Null hypothesis of no cointegration (Enders and Siklos, 2001) will be tested in order to find out whether the variables are asymmetrically cointegrated, and then we use the values of F-equality and F-Joint to determine speed of adjustments after deviating from the equilibrium.

Table 2: Engle –Granger, TAR and M-TAR cointegration for Exchange rates and Crude Oil prices

	Engle-Granger	TAR	TAR Consistent	MTAR	MTAR Consistent
ρ_1^{a}	-2.492 (-1.941)	-0.018 (-1.998)	-0.017 (-1.981)	-0.011 (-1.105)	-0.036 (-2.897)
ρ_2^{a}	N/A	-0.013 (-1.292)	-0.005 (-0.595)	-0.020 (-2.156)	-0.003 (-0.460)
Φ	N/A	0.1343	0.861 [7.044]**	0.495	5.177 [8.353]**
$\rho_1 = \rho_2$	N/A	2.757	2.111 [7.362]	2.939	4.284 [7.889]**
τ		0	-0.391	0	0.027

N.B: t-statistics and critical values are given in round and squared brackets respectively. Monte Carlo simulation is used to obtain critical value at 5% significance level.

Engle-Granger above test indicated that variables are cointegrated as null hypothesis of no cointegration is rejected at 5% level of significance. Both upper and lower threshold for the two models exhibit element of convergence as indicated by the negative signs as well the significant values as well as their respective F-equality and F-Joint. Based on the two models of TAR and MTAR we cannot reject null hypothesis as both F-equality and F-Joint are not significant hence null hypothesis of no cointegration ($\rho_1 = \rho_2 = 0$) cannot be rejected. The explanation remains that variables were cointegrated, but the speed of adjustment is symmetry.

Error correction model (Symmetric)

ECT_{t-1} signify linear error correction term which determine the short-run dynamic nexus between exchange rates and oil prices, it shows the extent to which the variables adjusted to equilibrium when deviated from the steady state.

$$\Delta LER_t = \theta_0 + \sum_{i=1}^{\rho} \alpha_{1i} \Delta LER_{t-i} + \sum_{i=1}^{\rho} \beta_{1i} \Delta LOP_{t-i} + \eta_1 ECM1_{t-1} + \mu_{1t} \quad (7)$$

$$\Delta LOP_t = \theta_1 + \sum_{i=1}^{\rho} \alpha_{2i} \Delta LOP_{t-i} + \sum_{i=1}^{\rho} \beta_{2i} \Delta LER_{t-i} + \eta_2 ECM2_{t-1} + \mu_{2t} \quad (8)$$

Based on the above VECM Δ indicates the first difference, θ_0 θ_1, α_1 α_2, β_1 β_2, are the model parameters while η_1 η_2 are the speed of adjustment coefficients which are assumed to be negative and statistically significant. The estimated VECM result is shown below:

Table 3: Symmetric error correction modelling (ECM)

$$\Delta LER_t = 0.000 + 0.090\Delta LER_{t-1} - 0.046\Delta LOP_t - 0.018ECT_{t-1} + \mu_t$$

(0.589) (0.039) (0.023) (0.011)

The error correction term above is negative sign and significant (-0.018(0.011)) at 5% significant level which indicates the existence of short-run cointegration among the variables. The results therefore suggests that when variables deviated by 1% from the equilibrium it takes about 1.8% to converge to steady state, which means in South Africa whenever crude oil price increases by 1% the exchange rates will rise up by 0.09% which confirms that speed of adjustment is symmetry.

Conclusion

The present paper examines the effect of exchange rates on crude oil prices in South Africa using monthly data from 1960-2014 sourced from Data stream International and Western Texas intermediate. The findings reveals that exchange rates and crude oil prices are cointegrated in South Africa, however, when applied TAR and MTAR both shows no element of cointegration and the speed of adjustment is symmetry, which means the influence of exchange rates on crude oil prices is not persistent considering the nature of the oil prices that is controlled by the cartel (OPEC). Since exchange rates influence oil prices in the long-run the monetary authority has to put more efforts to stabilize the value of Rand in relation to American dollar, because if Rand goes ahead of $USD it will lead to oil price hikes in the country hence lead to more inflation and affect the economy's competitiveness.

References

Amano, R. A., & Van Norden, S. (1998). Oil prices and the rise and fall of the US real exchange rate. Journal of international Money and finance, 17(2), 299-316.

Balke, N. S., & Fomby, T. B. (1997). Threshold cointegration: International economic review, 627-645

Brown, S., & Yücel, M. K. (2002). Energy prices and aggregate economic activity: an interpretative survey. The Quarterly Review of Economics and Finance, 42(2), 193-208.

Brown, S. P., & Yuecal, M. K. (1999). Oil prices and U.S aggregate economic activity: a question of neutrality. Economic and financial review-federal reserve bank of Dallas, 16-23.

Chen, S. S., & Chen, H. C. (2007). Oil prices and real exchange rates. Energy Economics, 29(3), 390-404.

Chen, J. E., Lee, C. Y., & Goh, L. T. (2013). Exchange rate and oil price: asymmetric adjustment. Applied Economics Letters, 20(10), 987-990

Croushore, D. D., Abel, A. B., & Bernanke, B. S. (2001). Macroeconomics. Addison-Wesley.

Enders, W., Siklos, P., 2001. Cointegration and threshold adjustment. Journal of Business and Economic Statistics 19, 166–176.

Engle, R.F., and Granger, C.W.J. (1987). Cointegration and Error correction: Representation, Estimation, and Testing. Econometrica, 55(2), 251-276

Ewing, B. T., Payne, J. E., Thompson, M. A., & Al-Zoubi, O. M. (2006). Government expenditures and revenues: evidence from asymmetric modeling. Southern Economic Journal, 190-200.

Granger, C.W.J. (1988). Some recent developments in a concept of causality, Journal of Econometrics, 39, pp. 199-211.

Greenidge, K., & DaCosta, D. (2009). Determinants of inflation in selected Caribbean countries. Business Finance and Economics in Emerging Economies, 4(2).

Ibrahim, M. H., & Chancharoenchai, K. (2014). How inflationary are oil price hikes? A disaggregated look at Thailand using symmetric and asymmetric cointegration models. Journal of the Asia Pacific Economy, 19(3), 409-422

Jones, D. W., & Leiby, P. N. (1996). The macroeconomic impacts of oil price shocks: a review of the literature and issues. Oak Ridge National Laboratory.

Jones, D. W., Leiby, P. N., & Paik, I. K. (2004). Oil price shocks and the macro-economy: what has been learned since 1996? The Energy Journal, 1-32.

Lardic, S., & Mignon, V. (2008). Oil prices and economic activity: An asymmetric cointegration approach. Energy Economics, 30(3), 847-855.

Lizardo, R. A., & Mollick, A. V. (2010). Oil price fluctuations and US dollar exchange rates. Energy Economics, 32(2), 399-408.

Narayan, P. K. (2007). Are Nominal Exchange Rates and Price Levels Co-Integrated? New Evidence from Threshold Autoregressive and Momentum-Threshold Autoregressive Models*. Economic Record, 83(260), 74-85.

Nazlioglu, S., & Soytas, U. (2011). World oil prices and agricultural commodity prices: evidence from an emerging market. Energy Economics, 33(3), 488-496.

Shen, C. H., Chen, C. F., & Chen, L. H. (2007). An empirical study of the asymmetric cointegration relationships among the Chinese stock markets. Applied Economics, 39(11), 1433-1445.

Utkulu, U., Seymen, D., & Arı, A. (2004, June). Export supply and trade reform: The Turkish evidence. International Conference on Policy Modelling, Paris June.

Yau, H. Y., & Nieh, C. C. (2009). Testing for cointegration with threshold effect between stock prices and exchange rates in Japan and Taiwan. Japan and the World Economy, 21(3), 292-300.

Zhang, Q., & Reed, M. (2008, February). Examining the impact of the world crude oil price on China's agricultural commodity prices: the case of corn, soybean, and pork. In Proceedings of the Southern Agricultural Economics Association Annual Meetings, Dallas, TX.