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# OIL PRICE CHANGES AND TRADE OPENNESS IN NIGERIA: LINEAR AND NONLINEAR APPROACH

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**Abstract**

*This empirical research examines the relations between trade openness and oil price changes in Nigeria between the period of 1982 to 2014 using linear and nonlinear autoregressive distributed lags models. The ARDL bounds test shows the existence of cointegration, we further estimate the model using NARDL specification and discovered the existence of a long-run relationship among the variable that means they are cointegrated in nonlinearity. In the long run, the study found that when the oil price rises trade openness affected significantly. But, when oil price dropped is not significant. The policymakers should consider the different policy between increases and decreases in oil prices when oil price increases have to monitor the degree of open-up than when oil prices dropped. Ordinarily,*

*the foreign trade in oil producing countries is protected by trade restrictions during low oil price The policy has to take major on the exchange rate policy since depreciation can make the trade more open-up.*

*Keywords: Oil price, Trade openness, Linear, Nonlinearity, Nigeria*

## INTRODUCTION

Trade is the oldest occupation in the world-even in the contemporary world, it plays a major role in sharpening the economic activities by creating jobs and finally leads to growth and development. Energy resources transactions are recorded the most traded commodities in the world the fluctuation in oil prices will explain the trade changes. The global oil price shock in the middle of 2014 has persistently influenced the changes in trade volume between countries, especially a country like Nigeria, which is highly dependent on oil exportation to earn revenue to sponsor other importing finished goods and services from abroad. Dornbusch and Fischer (1980) in a model called trade-oriented suggest that the volume of trade in a nation and its effectiveness in the world market can be influenced by exchange rate determination. The falling of oil price is a serious indication among people, manufacturers and policy makers in Nigeria in particular and the entire world in general. There is no doubt that oil price fluctuation touches many economies especially emerging economies irrespective of oil exporter or importer. There are numerous empirical studies that have been conducted in the literature on both linear and nonlinear impact caused by the fluctuation of oil price on macroeconomics reaction ( Kazi, 1989; Svensson, 1984; Hooker, 2002; Hamilton, 2003; Guo and Kliesen, 2005; Kilian, 2008; Hamilton, 2009; Blanchard and Gal, 2010; Mendoza and Vera, 2010; Hsu, 2012; Chou and Lin, 2013; Kilian and Vigfusson, 2013; Baumeister and Kilian, 2014; Sotoudeh and Worthington, 2014; Allegret et al., 2015). Oil price shocks usually affect the external account balance in an economy through two core categories, trade and finance. The trade part is measuring the changes in the total volume of quantity traded and price of traded goods and services whereas the financial part is measuring the changes in external portfolio positions and assets price (Kilian et al., 2009). For the purpose of this research is concentrated only on the trade side, which is on trade part and explores the mechanisms by which oil price is anticipated to determine trade openness and review the related literature.

The role of exchange rate in affecting trade flows is well recognized in the previous literature that has been conducted to analyze the effects of these two factors on exports, imports and the balance of trade (e.g. Beckerman, 1951; Chinn, 2004; Singh, 2002). The

existence of a theoretical relationship between exchange rate and the trade balance is confirmed by an elasticity model of the balance of trade (Kreuger, 1983). Nominal depreciation (appreciation) of the exchange rate is assumed to change the real exchange rate and thus has a direct effect on the trade balance. A country may devalue her currency to gain international competitiveness and to improve its trade balance (Bahmani-oskooee, 2001). But there are little studies that emphasize the role of oil price changes has a major factor influencing the volume of international trade. This study would try to look at the oil price as a factor to determine the volume of international flow and further to investigate the different impact between the oil price increase and oil price decrease on trade, this will allow us to conclude whether the impact of oil price is symmetric or asymmetric in nature.Nigerian economy is the largest in West Africa region and in Sub-Saharan Africa while second in the whole Africa after South Africa, it is the largest oil producer in Africa, holds the biggest reserves of natural gas in the continent, also among the world's top five exporters of liquefied natural gas (LNG) in the world (OPEC, 2015). Nigeria also has blessed with the potentials for a strong agricultural base, although it has low productivity. The insufficient productivity in the agricultural sector growth is related to lack of applying modern techniques and advancement. If agricultural productivity is boosted and the sector transformed into a better and robust it in a commercial environment, with connections to agro-based activities, it will boost economic growth and provide food security. Crude oil is the mainstream for Nigerian exports to the world markets the production of crude oil reached a capacity of 2.64 million barrels per day in 2005. The major exporters are Europe, Asia, United State of America and others. The crude oil and gas contributed about 95 percent of Nigerian total exportation while the remaining balance was accounted by non-oil exportation.Nigeria devalued its currency in response to oil price falling to discourage importation of foreign products in order to utilize the available foreign currency in a favorable manner. They are anticipating a fruitful result after devaluation, but the reality will be different. Nigeria is one of the 12 members of the Organization of Petroleum Exporting Countries (OPEC) as a cartel, so it has maximum required of production and it cannot be exceeded. Jibrilla (2010) as previously stated, the high dependency on crude oil as a means for exports and downgraded the performance of non-oil sectors more especially agricultural sector will not be benefited from the devaluation. There is a theory proposed by Marshall-Lerner if the $PED_{mx} > 1$ then the devaluation of home currency will improve the trade balance deficit while if the price elasticity of import and export is less than one $PED_{mx} < 1$ then the devaluation of currency will be worsening in the trade balance. A country's relatively less in diversifying economic sector and alternative substitutes for importation should experience worsening trade (Banjoko et al., 2012).

Figure 1 shows the oil price, exchange rate and oil price during the period of our study 1982 to 2014. It can be observed, their reaction in the chart; even though Nigeria is highly dependent on crude oil exportation and import refine petroleum products due to the inefficiency of its domestic refineries to meet the domestic demand. Apart from importing refined petroleum products, Nigeria is highly dependent on the importation of other non-oil products for day to day activities. The majority of the funds generated from oil price are spending back abroad for purchasing foreign products, which may result in a low contribution of oil sectors in the gross domestic products GDP. The oil price is moving more rapidly than total trade, in 1984 when oil price decrease trade started increasing. During 2000 to 2008 oil price increase while trade was not moving down as did in the 1980s, and exchange rate still depreciating and discourage importation. This relationship gives the enough confidence that there is a possibility of asymmetric behavior among the variable. More issues are observed during higher oil price in 2009 trade openness tend to decrease while oil price continues to increase their relationship tend to change more rapidly.

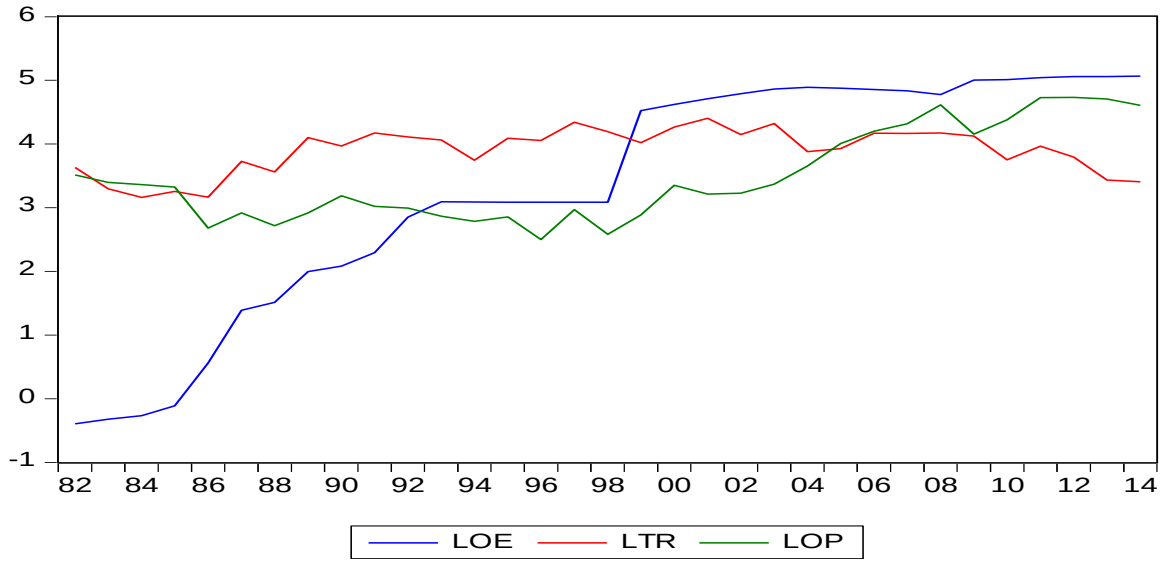



Figure 1 Oil price, exchange rate and trade openness

Source: OPEC Annual Statistical Bulletin, 2017

The direct impact in oil producing countries, when world oil price increase is expected to be positive, as it earned more revenue from oil exportation. The indirect impact is converse, is expected to be negative. Firstly, when world oil price increase means import price in both oil importing and exporting countries increases domestically. Secondly, an exogenous world oil price increase creates a negative supply shock to oil importing countries, causing a low

economic growth and leads them to reduce their oil consumption. So the benefit of the oil producing country is, therefore be different, not huge as from the expectation in the direct impact. In an oil producing country, the effect oil price shock on the trade depends on the magnitude of revenue received from oil export relatively to the price increase in the domestic country's imports (Le and Chang, 2013). The above discussion gives more insight that supports not only oil importing countries are affected during a large increase in oil price, even oil exporting countries are facing challenges in their policy. In oil producing countries, oil revenue lead to economic and financial challenges mostly originated from external shock. Oil price hikes are also promoting uncertainty in policy making because of its volatile nature, specifically, countries that are risk sensitive such as developing countries. Their capital account balance may also be affected harmfully due to a weakening in direct investments and foreign portfolios in the country, or capital flow. However, global oil price increases usually are expected to be helpful in net oil producing countries and harmful in oil importing countries, but the reality condition is more difficult than that. Apart from this argument, oil-producing countries might quiet get benefit from increases in oil price probably to improve their terms of trade, that will ensure more revenue by increasing oil export which can be used for additional consumption and investment (Korhonen and Ledyaeva, 2010). Devaluation or depreciation increases exports by making exports relatively cheaper, and discourage imports by making imports relatively more expensive, thus helping to improve the trade balance. It is argued, however, that there is a short-run phenomenon dubbed the "J-curve" effect on the movement of trade balance, i.e., there will be an initial deterioration before a country's trade balance could eventually improve. The theoretical linkages between the oil market and the currency market are also well established. It has been argued that there is a potential impact of exchange rates on oil price movements, which is based on the law of one price for tradable goods (Blomberg and Harris, 1995).The discussion of the importance of crude oil price as a factor influencing the international balance (Rebucci and Spatafora, 2006). The deficit trade balance for a momentary increase in oil price, moreover, the reaction is somehow for frequent oil price rises (Svensson, 1984). International crude oil price is responsible for larger of the changes in the trade relation for the past twenty-five years. Backus and Crucini (2000); Schubert (2009); Adam et al. (2015) in their empirical analysis find out that during high oil price trade balance tends to decline. Ozlale and Pekkurnaz (2010) show that oil prices affect the trade balance significantly, more effective in the short term than in the long run. Hassan and Zaman (2012) found that the association between oil price and the trade balance is negative and significant. Tiwari et al., (2014) and Khac and Bao (2014) stated oil prices lead to decline trade balance. Bala and Tahir (2016) found that exchange rate and oil price found negatively dependent on trade openness but oil price insignificant.

## RESEARCH METHODOLOGY

The study employed annual statistical secondary data on trade openness, official exchange rate and oil price. Where trade openness is the sum of exports and imports of goods and services measured as a share of gross domestic product, the exchange rate is the official exchange rate calculated Nigerian currency against US dollar, oil price we used Nigerian Bonny light oil price. All the data are obtained from the websites of the World Bank database except Bonny light price from OPEC Annual Statistical Bulletin, 2017. Best on the availability of the data we utilized in this study were between the periods of 1982 to 2014. All variables are expressed in natural logarithm.

The relationship between oil price and trade openness in the literature are usually studied applying various techniques that would arrive at linear cointegration, error correction model and Granger causality. Therefore, those techniques have low power to detect the possibility of nonlinearities in the trade openness dynamics. In recent, Shin et al. (2013); Greenwood-nimmo (2013) advance a well-known ARDL model of Pesaran and Shin (1999) and Pesaran et al. (2001) to nonlinear ARDL cointegration approach (NARDL) has nonlinearity properties to detect asymmetries in both short-run and long-run among the variables. We adopt this methodology for the purpose of this study. Many studies applied ARDL in similar investigations with the trade issue (see Hassan and Zaman, 2012; Khac and Bao, 2014; Fariditavana, 2015. We adopt a model of the long-run relationship between exchange rate and trade estimation in bivariate foam by (Bahmani-oskooee and Alse, 1994).

$$lto_t = \alpha_0 + \beta_1 lex_t + \varepsilon_t \qquad (1)$$

We modify the model by inserting oil price among independent variables to enable to capture the impact of oil price on trade openness in an asymmetric way, is necessary to formulate the long-run equation in line with the nonlinearity approach.

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + \mu_t, \qquad (2)$$

Figure 2 show the partial sum of positive and negative oil price with is necessary to perform the partitioning of the oil price into two different dimensions for the period of 1982 to 2014. This allowed the variable to capture the positive and negative changes and simultaneously test the short run and long run asymmetric changes between the positive and negative partial sum decomposition of the predetermine explanatory variables. It also offers the possibility to quantify the respective responses in the nonlinearities dynamic multiplier dependent variable from positive shock and negative shock of oil price. For a more extensive derivation of the model see Shin et al. (2013).

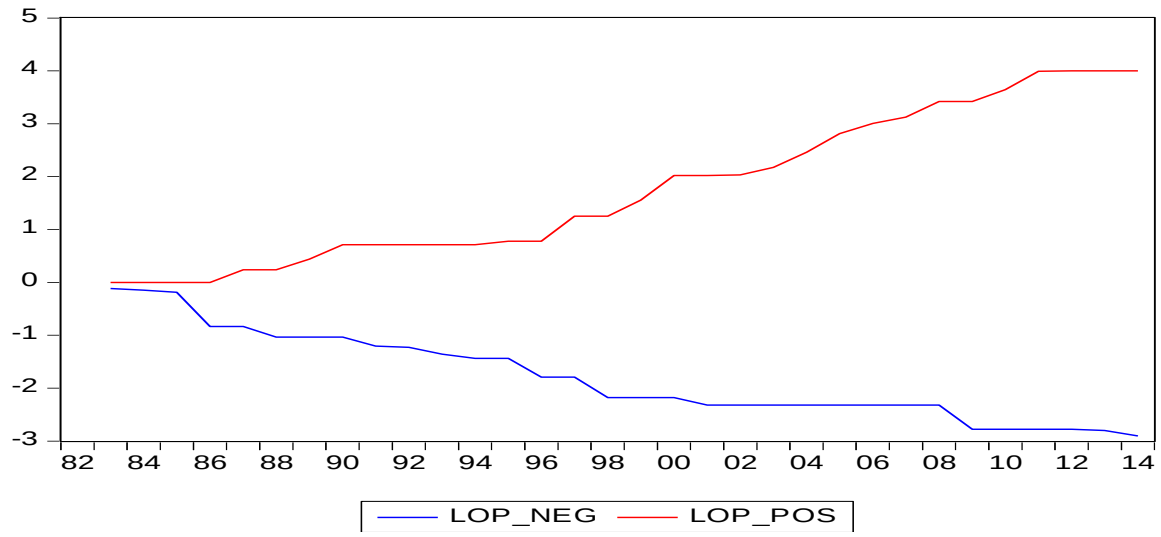



Figure 2 Show the partial sum of positive and negative oil price

Source: OPEC Annual Statistical Bulletin, 2017

Where $y_t$ and $x_t$ are scalar I(1) variables, and $x_t$ is decomposed as $x_t = x_0 + x_t^+ + x_t^-$, where $x_t^+$ and $x_t^-$ are partial sum processes of positive and negative changes in $x_t$

Variable Constructions:

$$lto_t = \alpha_0 + \beta_1 lex_t + \beta_2 lop_t + \varepsilon_t \quad (3)$$

$$lto_t = \alpha_0 + \beta_1 lex_t + \beta_2 lop_t^+ + \beta_3 lop_t^- + \mu_t \quad (4)$$

Where, $lto$ is the log of trade openness,$loe_t$ is the log of exchange rate, $lop_t$is the log of oil price while$lop_t^+ and\ lop_t^-$ are partial sums of positive and negative changes in oil price respectively, and $\alpha = (\alpha_0, \beta_{1,}, \beta_2, \beta_3)$ is a cointegrating vector or a vector of long run parameters to be estimated. $\beta_{1,}$ is expected to be negative depending if the Marshall a Lerner condition hold, while $\beta_{2,}$ is expected to be positive or negative (Le and Chang, 2013).

$$op_t^+ = \sum_{j=1}^{t} \Delta op_j^+ = \sum_{j=1}^{t} \max(\Delta op_j, 0)$$

$$op_t^- = \sum_{j=1}^{t} \Delta op_j^- = \sum_{j=1}^{t} \min(\Delta op_j, 0)$$

This simple approach to modeling asymmetric cointegration based on partial sum decompositions has been applied by Schorderet (2001) in the context of the nonlinear relationship.

The NARDL estimation framework was presented in Shin et al. (2013) follows the Pesaran and Shin (1999) and Pesaran et al. (2001) in ARDL modeling as:

$$\Delta lto_t = \alpha_0 + \beta_1 lto_{t-1} + \beta_2 lex_t + \beta_3 lop_t^+ + \beta_4 lop_t^- + \sum_{i=1}^{p} \pi_i \Delta lto_{t-i} + \sum_{i=1}^{p} \emptyset_i \Delta lto_{t-i} + \sum_{i=0}^{q} p_i \Delta lex_{t-i} + \sum_{i=0}^{q} (\propto_i^+ \Delta lop_{t-i}^+ + \propto_i^- \Delta lop_{t-i}^-) + \mu_t$$

Where, all variables are as defined above, $p$ and $q$ are lag orders and $\beta_3 = -\beta_3/\alpha_0$ and $\beta_4 = -\beta_4/\alpha_0$, the above-mentioned long run impacts of respectively oil price increase and oil price reduction on the trade openness. $\sum_{i=0}^{q}(\propto_i^+$is measures the short-run influences of oil price increases on trade openness. While $\sum_{i=0}^{q}(\propto_i^-$ the short run influences of oil price reduction on trade openness. Hence, in this setting, in addition to the asymmetric long run relation, the asymmetric short-run influences of oil price changes on trade openness are also captured.

## RESULTS AND DISCUSSION

The ARDL cointegration approach has strengths over some methodologies that require a unit root test. It does not necessarily need a stationarity test, although it will not valid be for I(2) variable, as it is beyond and violates the properties of using the Pesaran et al. (2001) bounds testing. We have to abide by the rules of ARDL because it accommodates variables in the series be they stationary at I(0), I(1) or a mixture of both.

### Unit Root Test

We conducted the two prominent unit root tests using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) to test for stationarity. The test shows that trade openness, exchange rate and oil price were stationary at the first-difference that is, suitable for ARDL approach.

Table 1 ADF and PP unit root test

| | Level | | | | F-difference | | | |
|---|---|---|---|---|---|---|---|---|
| | ADF | | PP | | ADF | | PP | |
| Variable | Constant | & trend | Constant | & trend | Constant | & trend | Constant | & trend |
| $lto$ | -1.9026 | 0.6717 | -1.7131 | -1.6077 | -1.1353 | -4.1231b | -7.8093a | -13.081a |
| $lex$ | -2.2308 | -1.0033 | -2.8333 | -0.6650 | -4.7796a | -5.4186a | -4.7796a | -7.4633a |
| $lop$ | -0.4397 | -2.3051 | -0.3387 | -2.3051 | -6.9131a | -7.3831a | -6.8752a | -7.4876a |

Note: & trend is constant with trend SIC is used to select the optimum lag order in ADF and PP test and **a** and **b** denote significance level at 1 percent and 5 percent.

**Optimal lags selection**

Figure 3 Demonstrating criteria of optimal lag lengths selection, the result is automatically displayed different combination models by Akaike Information Criteria (AIC). The optimal lags selected in the ARDL and NARDL models are: one lag for trade openness and no lag for exchange rate and two lags for oil price. While for NARDL maintain one lag for trade openness, no lag for the exchange rate, two lags for positive oil price and no lag for negative oil price respectively.

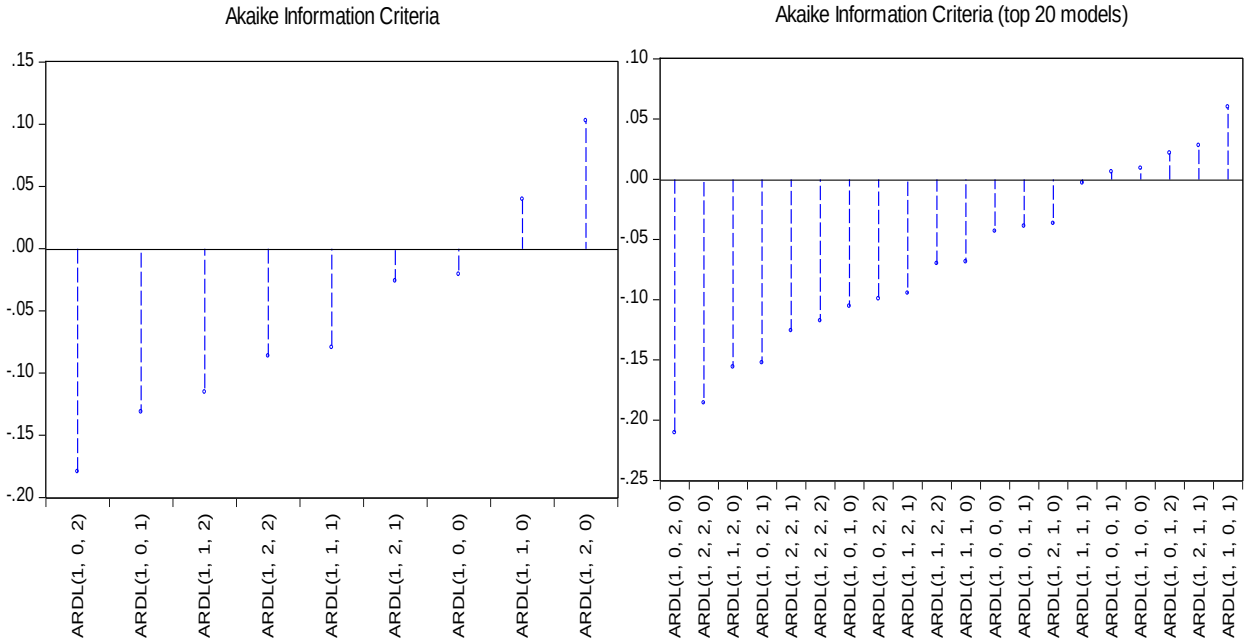



Figure 3 Optimal lags selection for ARDL and NARDL

In order to find out the long-run relationship in the two models (cointegration) among the variables trade openness, exchange rate and oil price.

Table 2 presents the empirical results based on F-statistics calculated from the data in the two models and compared with the tabulated F-statistics value. The unrestricted error correction model was applied to generate the F-statistics value. We can reject the null hypothesis only if the value of calculated F-statistic is greater than the upper bound value at 5 percent level of significance in the table provided below. The study found that both the calculated F-statistics in the two models are above the upper bound in the table below. That indicates that the variables are cointegrated i.e. they are moving in the same direction, there is a long run relationship.

**Cointegration Test**

Table 2 ARDL Linear and Nonlinear Cointegration Test

| Bounds test result | F-statistics | Lag | Level of significance | Unrestricted intercept and no trend | |
|---|---|---|---|---|---|
| $lto_t = f\,(lex_t,\ lop_t)$ | 3.9727 | 2 | 1% | 4.13 | 5.00 |
| | | | 5% | 3.10 | 3.87 |
| | | | 10% | 2.63 | 3.35 |
| $lto_t = f\,(\mathrm{ex}, lop_t^+, lop_t^-)$ | 3.9165 | 2 | 1% | 3.65 | 4.66 |
| | | | 5% | 2.79 | 3.67 |
| | | | 10% | 2.37 | 3.20 |

Note: F-statistics is greater than the upper bound at 5% level, which indicates the existence of long run relationship. Also, lag 2 was selected as the optimal lag length after testing different lags length suggested by Akaike information criterion (AIC).

Following the detection of cointegration relations of the variables in the two models is allowing us to further our estimation by determining the short and the long-run coefficients in the models as reported in table 3 and 4.

The short run coefficients of the oil price and exchange rate in the linear model are mostly insignificant. Moving to the main theme, in the linear model the results reveals that oil price is negatively affected trade openness. While in the nonlinear model reveals that increases in oil price negatively affecting trade openness while the oil price decrease is not. These findings are similar to findings of previous research in nonlinearity, with suggesting the oil price pass-through is incomplete (Delatte and López-Villavicencio, 2012; Ibrahim and Chancharoenchai, 2013; Ibrahim, 2015).

The results show that the exchange rate depreciation increases the amount of the trade openness in Nigeria. Estimated results in the short run show positive and significant impact when oil price increase and when oil price decrease is not significant. Turning to the long run association is revealed that a 1 percent increase in the oil price is related to a reduction in trade openness by 24 percent, while a decrease in oil price is insignificantly related to trade openness.

Table 3 ARDL Short-run estimation results

| Ind. Variables | Linear | | Nonlinear | |
|---|---|---|---|---|
| | Coefficient | P-value | Coefficient | P-value |
| $ect(-1$ | -0.6226a | 0.0003 | -0.6477a | 0.0001 |
| $D(lex)$ | 0.0961 | 0.3689 | 0.1866 | 0.1165 |
| $D(lop)$ | 0.1931 | 0.1601 | - | - |
| $D(lop(-1))$ | 0.2823c | 0.0842 | - | - |
| $D(lop\_pos)$ | - | - | 0.3307 | 0.1449 |
| $D(lop\_pos(-1))$ | - | - | 0.5554b | 0.0378 |
| $D(lop\_neg)$ | - | - | 0.2129 | 0.3805 |
| $R^2$ | 0.7129 | - | 0.7011 | - |
| $B-G$ | 0.1420 | 0.9974 | | 0.8998 |
| $LM$ | | 0.3583 | | 0.0984c |

$\mathrm{B}-\mathrm{G}$ and $\mathrm{LM}$ are Breusch-Pagan-Godfrey Heteroskedasticity test and Breusch-Godfrey Serial Correlation LM test up to the lag order given in the parenthesis respectively and **a** and **b** denote significance level at 1 percent and 5 percent.

Table 4 Long-run estimation results

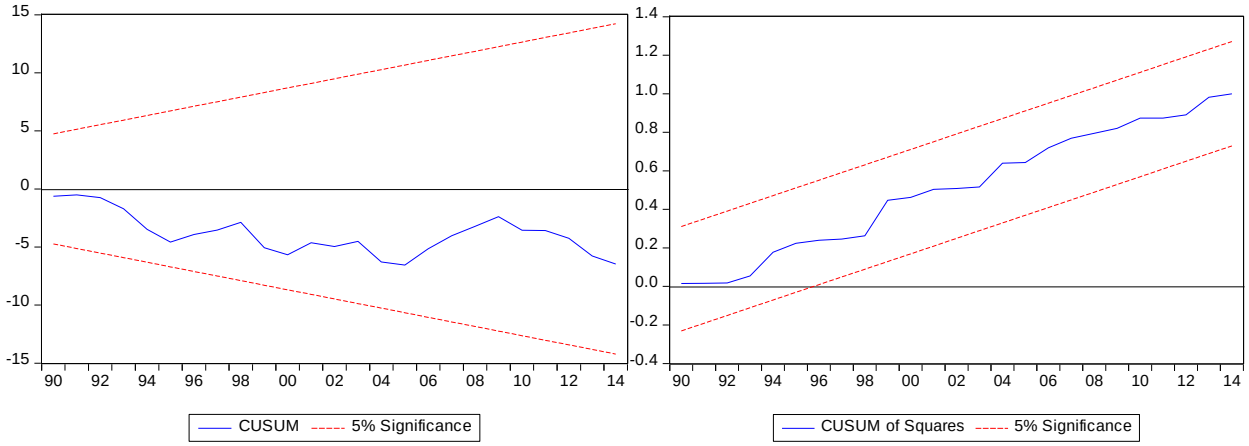
| Ind. Variables | Linear | | Nonlinear | |
|---|---|---|---|---|
| | Coefficient | P-value | Coefficient | P-value |
| $lex$ | 0.1397b | 0.0130 | 0.3510b | 0.0152 |
| $lop$ | -0.3957a | 0.0012 | - | - |
| $lop\_pos$ | - | - | -0.2477b | 0.0353 |
| $lop\_neg$ | - | - | 0.2973 | 0.4157 |
| $c$ | 4.7686a | 0.0000 | 3.4992a | 0.0000 |

**a** and **b** denote significance level at 1 percent and 5 percent.

Consistently, the study used a stability test of CUSUM and CUSUM Square as designated in ARDL framework to check the stability of the models. These results in figure 4 illustrated

that residuals were within the critical bound at 5 percent significance level. This signifies that the ARDL and NARDL estimations are stable, reliable and consistent.

ARDL model




NARDL model

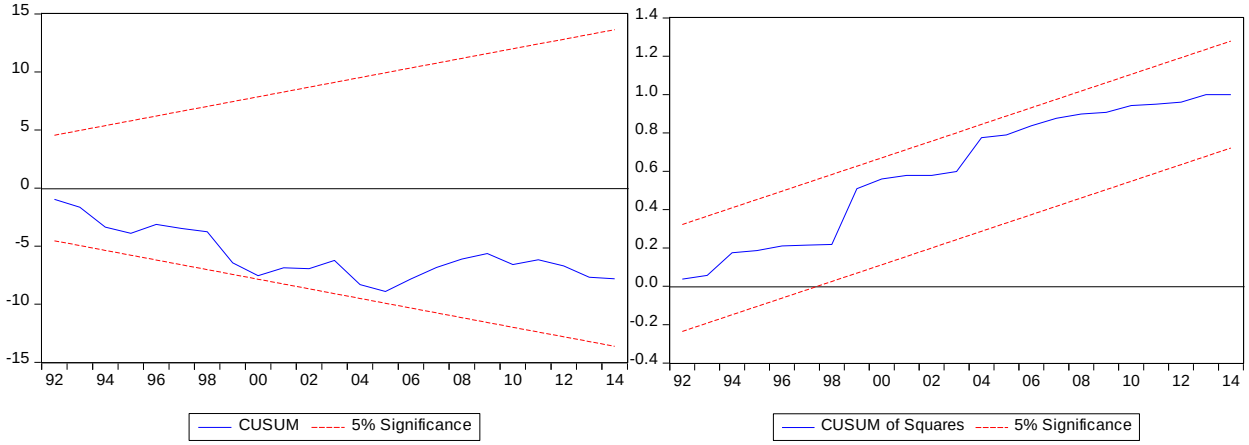



Figure 4 CUSUM and CUSUMSQ

## CONCLUSION

This empirical research examines the relations between trade openness and oil price changes for Nigeria between the period of 1982 to 2014 this study contributes to the literature using linear and nonlinear autoregressive distributed lags models. The bounds test of the ARDL shows the existence of cointegration. Since it has low power to detect asymmetrically, we further estimate the model using NARDL specification and discovered the existence of long-run association among the variable that means they are cointegrated in nonlinearity. In the long run, we found that when oil price increase trade openness affected significantly. But, when oil price dropped is not significant. The import and export have behaved in an asymmetric way, suppose

import to increase during high oil price as income increases and export remain constant has a member of the OPEC cartel as to follow the quota shared. This result is similar to (Adam et al., 2015) found that when oil price increase tends to decrease the Indonesian trade. This research identified the possible impact of government intervention in sharpening asymmetric behavior of trade openness. The policymakers should consider the different policy between increases and decreases in oil prices when oil price increases have to monitor the degree of open-up than when oil prices dropped. Ordinarily, the foreign trade in oil producing countries is protected by trade restrictions during low oil price The policy has to take major on the exchange rate policy since depreciation can make the trade more open-up. This study is limited to Nigerian context only; further studies can explore in other country and testify using different method.

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