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Analyzing the Asymmetric Effect of Exchange Rate on InternationalTrade Performance: The Role of Oil Price in Nigeria

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Abstract: The relationship between trade balance and exchange rate has been thoroughly studied over time, and the discussion has remained popular among academics and decision-makers. This discourse, however, is far from settled, particularly in light of the newly proposed nonlinear theory of how exchange rates affect trade balance. This study thus broadens this dialogue on the relationship between the trade balance and exchange rate by taking into account the unique features of the economy under investigation, using the nonlinear ARDL model. Using secondary data, this method was used to demonstrate that currency depreciation's potential for boosting trade performance can be enhanced further by changes in oil prices.

Keyword: Trade Performance; Exchange Rate; nonlinear ARDL; Asymmetric; Oil price;Nigeria

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1. Introduction

The exchange rate-trade balance relationship has remained at the centre of international economics debates around the world. This may be related to the fact that the exchange rate determines a country's trade balance, which affects the overall economy. Changes in the exchange rate are likely to impact policy decisions, affect import and export volumes, and upset the trade balance and balance of payments. Changes in exchange rates, on the one hand, provide an opportunity for local stakeholders to invest in foreign currencies for high returns, but on the other hand, they tend to cause local currencies to fall, causing the country's economy to suffer. It is unclear, however, whether the extent to which exchange rate changes affect trade balance can be generalized for appreciation versus depreciation. For example, Zubair et al. (2014) suggested that exchange rate appreciation has the potential to affect imports positively and exports negatively, while the prediction is the other way around for exchange rate depreciations. Thus, there have been increasing efforts in international economics literature, particularly in recent times, to validate such asymmetric effects of exchange rate on trade performance (see, for example, Razak & Masih., 2018; Bhat & Bhat, 2021; Bao & Lee, 2021; Sambo et al., 2021; Keho, 2021b; Barkat et al., 2022). That said, largely unexplored and of great importance in this study is the question of whether such asymmetric dynamics of the exchange rate and its impact on trade performance are sensitive to the peculiarities of the investigated economy.

For example, the asymmetric dynamic of the exchange rate in a typical net oil-exporting nation such as

Nigeria, whose economy relies heavily on the commodity's dollar profits to support its spending, cannot be considered isolated from movements in oil prices in the international market. For instance, the fact that the official Naira-Dollar exchange rate increased from N168/US$ in January 2015 to N306.4/US$ as of March 2017 amid a recession was largely blamed on a drop in oil prices. Putting it in a more practical term, the value of the naira has dwindled from N360/US$ in 2019 to about N580/US$ or thereabouts in 2022. Although the latter unprecedented depreciation of the Nigerian currency has been attributed largely to the global lockdown caused by the COVID-19 pandemic, some argue that it is primarily due to the episode of a record drop in international oil prices that coincided with the COV-19 outbreak. To that end, the more pressing question, and one that is central to this paper, is whether the asymmetric dynamic of exchange rates and the extent to which it affects trade performance are sensitive to an economy's peculiarities.

Motivated by the Nigerian economy's oil export peculiarities, this study revisits the literature on the exchange-trade performance nexus to account for the role of oil prices, hypothesizing that it matters in the asymmetric dynamic of the exchange rate and its impact on trade performance. As earlier mentioned, quite a number of empirical studies have investigated the asymmetric impact of exchange rates on trade performance. However, the only notable exception, particularly in the context of the Nigerian economy, is the study by Sambo et al. (2021), yet this present study, to the best of our knowledge, is the first to extend the debate to include the role of oil prices as a measure of the peculiarity of an oil exporting economy and hypothesize that it matters in the nexus.

In addition to this introductory section, the rest of this study is structured as follows: Section 2 examines the subject's relevant literature from both theoretical and empirical perspectives. Section 3 presents the methodology and discusses the data. Section 4 presents and analyses the results, while Section 5 concludes the study.

2. Literature Review

There have been growing theoretical and empirical studies investigating the impact of exchange rates on trade performance. From the viewpoint of the Marshall-Lerner condition, for example, a country's trade balance is assumed to be favourably influenced by currency depreciation when the absolute export demand elasticity plus the import counterpart is greater than one (see Bahmani et al., 2013). Based on this theoretical stance, much of the existing empirical research has assumed a linear relationship between the exchange rate and the trade balance. However, findings from the existing studies built on this linear assumption have been largely mixed. On the one hand, studies have found that exchange rate depreciations has a significant and positive impact on trade balance (Bahmani-Oskooee, 2001; Boyd et al, 2001; Lal& Lowinger, 2002; Musila & Newark, 2003; Yol & Baharumshah, 2007; Igue & Ogunleye, 2014; Ogbonna, 2016; An-ning et al., 2017; Yazgan & Ozturk, 2019; Keho, 2021a). On the other hand, Onafowora (2003), Adeniyi et al. (2003), and Genemo (2017), among others, found that depreciation instead worsens the trade balance. Amidst these two extremes are studies that fail to establish any significant relationship between exchange rate and trade balance (Loto, 2011; Shawa & Shen, 2013; Akpansung & Babalola, 2013; Hatemi-J & Irand-oust, 2015; Meniago & Eita, 2017; Kamugisha & Assoua, 2020).

Given the obvious discrepancies in the existing literature's findings, particularly regarding the direction and significance of the exchange rate's impact on trade balance, this raises concerns about the accuracy of the assumption of linearity in the exchange rate and trade balance relationship. As a result, quite a bit of empirical research has since sprung up with the opposing view that the relationship between exchange rate and trade performance is nonlinear. Resting on the nonlinear autoregressive distributed lag (NARDL) model developed by Shin et al. (2014), the probability of the nonlinear (asymmetric) effects of exchange rates on trade balance is usually captured by decomposing changes in exchange rate movements into currency depreciation and appreciation. Bahmani-Oskooee and Fariditavana (2015, 2016), Nusair (2017), as well as Iyke and Ho (2017), are some of the studies whose findings have over time confirmed that asymmetries matter in the exchange rate–trade balance nexus.

On their investigation of how bilateral exchange rates, together with vehicle currency exchange rate, asymmetrically impact Vietnam's bilateral trade balance with respect to EU-27 countries and the UK, Bao and Le (2021) using NARDL modelling technique show that the asymmetric impact of real effective exchange rate is evident both in the short run and long run. In another development, Bhat and Bhat (2021) using the case of India applies an asymmetric model and despite reporting no evidence of J-curve, they finds that currency appreciation deteriorates trade balance while currency depreciation improves it. In the quest to show new light on the nonlinear relationship between real exchange rate and trade balance in Cote d'Ivoire, Keho (2021b) reveal that the effects of changes in real exchange rate are asymmetric in both time horizons. More specifically, the study results show that real exchange rate appreciations deteriorate the trade balance while real depreciations improve it. The study further show that the effect of large depreciations is higher when compared with large appreciations.

In the case of Barkat et al. (2022), they examined the asymmetric impact of the nominal effective exchange rate (NEER) on the trade balance in GCC countries. Using nonlinear pooled mean group (PMG) estimator, their finding reveal the presence of a J-curve shape where an increase in NEER (currency depreciation) deteriorates the trade balance in the short run and improves it in the long run. The study also show that the trade balance's response to NEER positive changes is greater compared to negative changes. This, among other things, tends to confirm the hypothesis that asymmetries matters in the nexus between exchange rate and trade balance. This position has continued to find support in the findings of a number of studies particularly in recent time (see Bahmani-Oskooee & Baek, 2018; Bahmani-Oskooee et al., 2018a,b; Ari et al., 2019;Bahmani-Oskooee& Nasir 2019;Fariditavana, & Nouira, 2020).

Deciphered from the foregoing is the fact that there has been some level of consensus that asymmetries matter in the relationship between exchange rate and trade balance. That said, there appears to be a dearth of this strand of literature in the context of the Nigerian economy, with Sambo et al. (2021) being the only notable exception. More importantly, little or no effort has been made to comprehend the extent to which the asymmetric impact of exchange rates on trade balance is sensitive to the peculiarities of the studied economy. To bridge this important gap, this present study, motivated by the oil export peculiarities of the Nigerian economy, goes beyond the question of whether asymmetries matter in the exchange rate–trade balance relationship todetermine whether the dynamics of such an asymmetric are sensitive to changes in oil prices.

3. Methodology and Data

3.1 The model

Nigeria's international trade can be categorised based on its trade imbalance because the country's exports are mostly primary products and raw materials, but its imports are primarily capital goods, industrial goods, luxury items, and so on. To that end, the trade balance is usually measured as exports minus visible imports. As a result, the trade-balance-exchange-rate relationship is often based on the assumption that neither imports nor exports are perfect substitutes for domestic commodities. Furthermore, the economy is separated into two types of products: domestic and international, with domestic consumers requiring a mix of home and foreign things. As a result, trade balance (TB) can be expressed as a function of foreign income (FY), domestic income (DY), trade openness (TOP), and exchange rate (ER), which is our variable of interest in this study. Thus, the functional form of a trade balance model in the context of the Nigerian economy is shown in equation (1).

$$TB = f(FY, DY, TOP, ER) \quad (1)$$

Equation (2) further expresses the variables in their natural logarithmic form, thereby re- representing their functional representation in equation (1) in an estimable form.

$$\log TB_t = \delta_0 + \beta_1 \log FY_t + \beta_2 \log DY_t + \beta_3 \log TOP_t + \beta_4 \log ER_t + \varepsilon_t \qquad (2)$$

On the assumption that the relationship between the exchange rate and the trade balance is nonlinear, equation (2) is rewritten in a nonlinear form as shown below. .

$$\log TB_t = \delta_0 + \beta_1 \log FY_t + \beta_2 \log DY_t + \beta_3 \log TOP + \beta_4^+ \log ER_t^+ + \beta_5^- \log ER_t^- + \varepsilon_t \qquad (3)$$

One of the main contributions of this study to literature is to account for the peculiarities of the investigated economy. To achieve this, we extend the model in equation (3) to include changes in oil prices, which in this study capture the peculiarity of Nigeria as an oil-exporting economy.

$$\log TB_t = \delta_0 + \beta_1 \log FY_t + \beta_2 \log DY_t + \beta_3 \log TOP + \beta_4^+ \log ER_t^+ + \beta_5^- \log ER_t^- + \beta_6 OP_t + \varepsilon_t \qquad (4)$$

The nonlinear trade balance models in equations (3) and (4) are the focus of this study, with the former capturing the hypothesis that the exchange rate and trade balance relationship is nonlinear (asymmetric) and the latter accommodating the assertion that the extent to which such asymmetry matters in the relationship may be sensitive to the peculiarities of the studied economy. In both cases, however, the nonlinear (asymmetric) feature of the exchange rate is captured by partitioning the exchange rate into positive (exchange rate depreciation) and negative (exchange rate appreciation).

3.2 The Econometric Method

To capture the asymmetric dynamics of exchange rate effects on trade balance, we follow the common approach in the literature and favour the nonlinear ARDL (NARDL) approach developed by Shin et al. (2014), which allows for the separation of exchange rate depreciation and appreciation and evaluates their respective effects on trade balance. Starting with the trade balance model without the role of the peculiarity of the investigated economy, equations (5) are the NARDL version of the trade balance models in equations (3).

$$\Delta tb_t = \phi + \alpha_1 tb_{t-1} + \alpha_2 fy_{t-1} + \alpha_3 dy_{t-1} + \alpha_4 top_{t-1} + \alpha_5 er_{t-1}^+ + \alpha_6 er_{t-1}^- + \sum_{j=1}^{p} \beta_{1j} \Delta tb_{t-j} + \sum_{i=0}^{q1} \beta_{2i} \Delta fy_{t-i} + \sum_{i=0}^{q2} \beta_{3i} \Delta dy_{t-i} + \sum_{i=0}^{q3} \beta_{4i} \Delta top_{t-i} + \sum_{i=0}^{q4} \beta_{5i} \Delta er_{t-i}^+ + \sum_{i=0}^{q5} \beta_{6i} \Delta er_{t-i}^- + \varepsilon_t \qquad (5)$$

All of the variables are still defined as before, but they are written in lower case to show that they were captured in their natural logarithm term. The long run parameters of the intercept and slope coefficients are calculated as follows: $\frac{\phi}{\alpha_1}, \frac{\alpha_2}{\alpha_1}, \frac{\alpha_3}{\alpha_1}, \frac{\alpha_4}{\alpha_1}, \frac{\alpha_5}{\alpha_1}$ and $\frac{\alpha_6}{\alpha_1}$, while the short run estimates are obtained as $\beta_{1j}, \beta_{2i}, \beta_{3i}, \beta_{4i}, \beta_{5i}$ and β_{6i}. Moving forward, presented in equation (6) is the NARDL version of the trade balance model, which includes the peculiarities of the studied economy.

$$\Delta tb_t = \phi + \alpha_1 tb_{t-1} + \alpha_2 fy_{t-1} + \alpha_3 dy_{t-1} + \alpha_4 top_{t-1} + \alpha_5 er_{t-1}^+ + \alpha_6 er_{t-1}^- + \alpha_7 op_{t-1} + \sum_{j=1}^{p} \beta_{1j} \Delta tb_{t-j} + \sum_{i=0}^{q1} \beta_{2i} \Delta fy_{t-i} + \sum_{i=0}^{q2} \beta_{3i} \Delta dy_{t-i} + \sum_{i=0}^{q3} \beta_{4i} \Delta top_{t-i} + \sum_{i=0}^{q4} \beta_{5i} \Delta er_{t-i}^+ + \sum_{i=0}^{q5} \beta_{6i} \Delta er_{t-i}^- + \sum_{i=0}^{q7} \beta_{8i} \Delta op_{t-i} + \varepsilon_t \qquad (6)$$

The procedure for obtaining long-run and short-run parameters in equation (6) is the same as in equation (5). However, because the variables in the first differences can accept more than one lag, it is necessary to determine the best lag combination for the ARDL. The Schwartz Information Criterion is used to determine the ideal lag length (SIC) in both equations (5) and (6), respectively. The lag combination with the lowest value of the specified criterion among the contending lag orders is the ideal lag. The model is therefore tested for long-run correlations using the recommended ARDL model. Since the upper and lower bounds are involved, this cointegration testing strategy is also known as "bounds testing." There is cointegration if the estimated F-statistic is higher than the upper bound and not present if it is lower than the lower bound.

$$\Delta tb_t = \phi + \psi ECT_{t-1} + \sum_{j=1}^{p} \beta_{1j} \Delta tb_{t-j} + \sum_{i=0}^{q1} \beta_{2i} \Delta fy_{t-i} + \sum_{i=0}^{q2} \beta_{3i} \Delta dy_{t-i} + \sum_{i=0}^{q3} \beta_{4i} \Delta top_{t-i} + \sum_{i=0}^{q4} \beta_{5i} \Delta er^{+}_{t-i} + \sum_{i=0}^{q5} \beta_{6i} \Delta er^{-}_{t-i} + \varepsilon_t \quad (7)$$

$$\Delta tb_t = \phi + \psi ECT_{t-1} + \sum_{j=1}^{p} \beta_{1j} \Delta tb_{t-j} + \sum_{i=0}^{q1} \beta_{2i} \Delta fy_{t-i} + \sum_{i=0}^{q2} \beta_{3i} \Delta dy_{t-i} + \sum_{i=0}^{q3} \beta_{4i} \Delta top_{t-i} + \sum_{i=0}^{q4} \beta_{5i} \Delta er^{+}_{t-i} + \sum_{i=0}^{q5} \beta_{6i} \Delta er^{-}_{t-i} + \sum_{i=0}^{q7} \beta_{8i} \Delta op_{t-i} + \varepsilon_t \quad (8)$$

Equations (7) and (8) are the error correction variants of the NARDL models in equations (5) and (6), where the ECT_{t-1} is the error correction term while the coefficient ψ represent the speed of adjustment to equilibrium level in the respective models.

3.3 Data description and source

In this study, the key variables of interest are the trade balance (TB) and exchange rate (ER). The former is a proxy for trade performance measured as the log of exports less the log of imports of visible goods, and the latter is measured as the log of the country's national currency (the naira) relative to the US dollar. Other variables of interest considered in the study are domestic income (DY), foreign income (FY), and trade openness (TOP). The DY is measured as the log of Nigeria's real GDP; the FY, on the other hand, is measured as the log of world real GDP less the log of Nigeria's real GDP, while TOP is measured as the sum of exports and imports as a ratio of GDP. All the variables have an annual frequency spanning 1990 to 2021, and they were sourced mainly from the Central Bank of Nigeria (CBN) online database and the WTI online database.

4. Result Presentation

4.1 Preliminary analysis

The preliminary results presented in Table 1 include summary statistics and unit root testing results for the individual variables under consideration. With respect to the summary statistics, quite an interesting finding is the fact that the mean value is positive for the trade balance (TB). In other words, between 1990 and 2021, the country appears to have maintained an average annual trade surplus of 1.12. In terms of the exchange rate, which is another key variable of interest in this study, the mean statistic indicates that, on average, N133 is required in exchange for one unit of the dollar (i.e., $1). More so, the standard deviation statistic, which measures the dispersion from the mean level, reveals the exchange rate as the most volatile of all the variables under consideration. However, while the Kurtosis statistic is mainly platykurtic for all the variables, the Skewness statistic, on the other hand, is mixed across the different variables under consideration but positive for both TB and ER, respectively. Although the Jarque-Bera (J-B) test usually takes into consideration the skewness and Kurtosis statistics, we find the null hypothesis of normality evident in all the variables.

Table 1: Preliminary Results

Variable/ Statistic	Descriptive statistics					ADF test		
	Mean	*Std. Dev.*	*Skewness*	*Kurtosis*	*J-B test*	**Level**	**First_Df**	**I(d)**
TB_t	1.12	1.43	0.10	1.57	2.78	-1.585[a]	-5.318[b]***	I(1)
DY_t	5.56	0.48	0.01	1.37	3.55	-2.026[a]	-2.722[a]*	I(1)
FY_t	10.96	0.27	-0.06	1.73	2.16	-2.323[a]	-4.721[a]***	I(1)
TOP_t	37.17	8.28	-0.01	2.66	0.16	-3.202[a]**	-	I(0)
ER_t	133.46	97.40	0.51	2.35	1.93	-5.075[a]***	-	I(0)
OP_t	49.90	31.67	0.62	2.17	2.99	-1.887[a]	-4.921[a]***	I(1)

Source: The asterisks ***, **, & *implies statistical significances at 1%, 5% and 10%, , respectively. The term Std. Dev. denotes standard deviation while ADF represents Augmented Dickey-Fuller unit root test. The subscripts a & b implies that the ADF test was performed with model with constant only or with constant and trends while the I(d) is the order of integration.

When analysing time series, the result of unit root testing is frequently the most crucial pre- analysis result for determining the best estimation technique(s) from the multiple possibilities available in the literature. Thus, a further look at the table shows that the null hypothesis of unit root holds in TB, DY, FY, and OP but is rejected in the cases of TOP and ER. On the whole, the order of integration hovers around I(0) and I(1), thus suggesting the order of integration is mixed for the variables. This, among other things, strengthens our preference for an econometric technique that allows for the combination of variables with different orders of integration in a single framework. Thus, the empirical estimates obtained from the estimated NARDL (1, 1) models are presented and discussed in the following immediate section, where Model_1 defined a nonlinear trade-balance regression without accounting for the peculiarities of the investigated economy, whereas Model_2 included the peculiarities of the Nigerian economy via changes inoil prices.

4.2 Empirical finding and discussion

The short- and long-run elasticities of the coefficients on the link between trade balance and exchange rate as calculated by NARDL models are shown in Table 2. Although the table contained other trade balance factors such as DY, FY, and TOP, the elasticities of the coefficients on nonlinear exchange rates are critical in the context of this study. However, we begin our discussion of results with the bounds testing results, which indicate that there is potential long-run cointegration between trade balance and exchange rates, as well as other variables, in both the NARDL model with and without oil price. Confirming the consistence of such cointegration in the nexus between trade balance and exchange rates are coefficients on the error correction term (ECT) reported each in Model_1 and Model_2. For instance, irrespective of whether we account for the peculiarity of the Nigerian economy or not, the coefficients on the ECT are correctly signed and statistically significant at 1% level of significance both in Model_1 and Model_2, respectively. What this portends is that the potential for long-run cointegration in the relationship between exchange rate and trade balance is robust across the alternative nonlinear trade-balance regressions considered.

Table 2: NARDL estimates on the asymmetric effect of exchange rate on trade performance

Long Run Equation	Model_1		Model_2	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**
DY_t	6.7140**	2.8996	2.6443**	0.4850
FY_t	4.5451***	1.9413	4.8293*	2.9264
TOP_t	0.0576**	0.0243	0.0169	0.0227
ER^+_t	1.7786***	0.5625	2.3623**	0.5855
ER^+_t	-0.1062	1.2594	5.5416	8.6949

OP_t			1.2992**	0.7994
Short Run Equation				
ΔTB_{t-1}	-0.7444***	0.1788	-0.9437***	0.2036
ΔDY_t	4.9979*	2.7188	2.4744**	0.4577
ΔFY_t	3.1818**	1.5613	4.3331*	1.9780
ΔTOP_t	0.0429**	0.0197	0.0160	0.0212
ΔER^{+}_{t}	1.3240***	0.4402	2.2908**	0.4953
ΔER^{+}_{t}	-0.0790	7.6376	4.3074	5.1077
ΔOP_t			5.6542**	2.0604
ECT_{t-1}	-0.7444***	0.1303	-0.9437***	0.1406

Bounds Testing Cointegration Results

Level of Significance	Model_1			Model_2		
	F-statistic	I(0)	I(1)	F-statistic	I(0)	I(1)
10%		3.16	4.41		1.95	3.06
5%	4.46*	3.82	5.25	3.62**	2.22	3.39
1%		5.35	7.24		2.79	4.10

Diagnostic and Post-Estimation Results

	Model_1	Model_2
Adjusted R^2:	0.51	0.59
F-statistics:	16.459***	44.996***
Autocorrelation test (Q-Statistic):	4.488	3.675
Autocorrelation test (Q^2-Statistic):	8.866**	2.851

Note: The value in parenthesis represent the probability values for the various post estimation tests performed, while
***, ** and * denote 1%, 5% and 10% level of significance.

However, while the coefficients on exchange rate depreciation and appreciation are positive and negative in the long run and short run dynamics, respectively, it is instructive that the statistical significance of their impact on trade balance was only evident in the case of exchange rate depreciation ($ER^{\square}_{t}$). Our finding so far, particularly when there is no provision for the peculiarity of the Nigerian economy, seems to be suggesting that the assumption of nonlinearities in the effect of the exchange rate is manifested in terms of the differences in the direction of the impacts. While acknowledging the significance of the impact only applies to exchange rate appreciation, which is consistent with the findings of a number of previous studies (for example, Igue&Ogunleye, 2014; Ogbonna, 2016; An-ning et al., 2017; Yazgan&Ozturk, 2019; Keho, 2021a), yet an interesting finding in the context of this study is the fact that the magnitude of the significant impact appears to be higher in the long run compared to what is obtainable in the short run.

From the foregoing, it can be inferred that the extent to which currency depreciation is likely to improve trade performance might be larger in the long run in terms of magnitude compared to the short run. More importantly, we find the potential of currency depreciation for enhancing trade performance significantly more pronounced when the estimated nonlinear trade balance regression is extended to include changes in oil prices. For instance, in a model without oil prices, a 1% increase in currency depreciation improves the trade balance by 1.8% and 1.3% in the long run and short run, respectively. Whereas when the oil price is included in the model, the magnitude of the impacts is 2.4% and 23% in the short run and long run, respectively. This therefore supports our hypothesis and contribution to the literature that the extent to which asymmetries matter in the trade balance and exchange rate relationship might be sensitive to the peculiarities of the investigated economy.

5. Conclusions

There is no denying that the trade balance and exchange rate relationship have been extensively investigated over the years, and the debate has continued to garner attention among academics and policymakers. However, the debate is far from over, especially in light of the emerging hypothesis that the impact of exchange rates on trade balance is nonlinear. In addition to contributing to this latter strand of literature on the trade balance–exchange rate nexus, this present study further extends the literature to include the peculiarities of the investigated economy. Using the nonlinear ARDL model developed by Shin et al. (2014), this study shows empirically that the extent to which currency depreciation is likely to improve trade performance might be larger in the long run in terms of magnitude compared to the short run. More importantly, the magnitude of the impact of currency depreciation on enhancing trade performance seems significantly larger when the estimated nonlinear trade balance regression model is extended to accommodate the peculiarities of the investigated economy. The innovation and findings of this study, particularly with respect to changes in oil prices as a measure of the peculiarity of the Nigerian economy, offer policymakers in oil exporting economies evidence- based insight on the importance of oil prices and the improving impact of exchange ratedepreciation on trade performance.

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