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Research article

Asymmetric effect of exchange rate volatility on trade balance in Nigeria

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Abstract: The relationship between real exchange rate volatility and the trade balance has been a contentious issue since the fall of Bretton woods agreement of 1973, owing to the lack of unanimity on the effect. This article provides empirical evidence of the link between the real exchange rate volatility and the trade balance in the light of financial development, confirming the assertion that the effect is significantly dependent on the country's level of financial development. Due to Nigeria's relatively undeveloped financial system, its exchange rate dampens the country's exports. Rather than studying the relationship in isolation, we examine the moderating role of financial development on the link between export and the real exchange rate volatility in this paper. The empirical estimation is based on the Nigeria's data set spanning the years 1980–2019, and it employs threshold autoregressive non-linear co-integration and non-linear ARDL estimation techniques. According to the findings, financial development magnifies the beneficial benefits of the real exchange rate on Nigeria's foreign trade. It also states that the uncertainty in foreign capital flows has a negative impact on Nigeria's international trade. The findings have broad policy implications, implying that in order to diversify and improve the economy's future growth and associated international trade, Nigeria's policymakers should promote adequate financial sector development, as financial shocks are amplified by poorly implemented credit markets.

Keywords: exchange rate volatility; threshold autoregressive; non-linear ARDL

JEL Codes: E58, C22, F14

1. Introduction

Over the years, considerable reductions in transportation costs, tariffs, and non-tariff trade obstacles have aided international trade, just like the stability of the real exchange rate did. However, well-established estimates of bilateral trade costs remain substantial (Balistreri and Hillberry, 2006; Anderson and van Wincoop, 2004). Understanding why projected trade costs remain high is the key to solving numerous trade literature issues, such as a nation's frequent volatility in its real exchange rate or the geographic distance issue (Disdier and Head, 2008). However, the evidences have it that a significant portion of international trade remain unobserved, prompting Head and Mayer (2013) to refer to the unobserved portion of trade costs as "dark costs".

Several researchers investigate the effect of real exchange rate volatility on the volume of international trade, and much has been studied from both an empirical and theoretical standpoint. There is, however, no reached consensus on the impact of real exchange rate risk on trade volume. Although the majority of research anticipate that more exchange rate volatility will reduce international trade, others disagree. While, quite number of researches appear to confirm the premise that real exchange rate volatility decreases trade, a close examination of the findings demonstrate that the main results are more equivocal. This is because most of these results are having insignificant coefficients (Ahmed et al., 2017; Soyres et al., 2018; Tan et al., 2019; Adler et al., 2019; amongst others). Meanwhile, some believe that although exchange rate volatility may have some implications for the international trade balance, the effects are said to be very mild and transitory (Nasir & Jackson, 2019).

The link is still inconclusive, and there is a lot of argument about it, both from the theoretical alongside the empirical perspective. According to the International Monetary Fund (IMF), a lack of a developed financial system will jack up transaction expenses, compounds the issue of trade barrier. In general, financial development appears to be intimately linked to the rise of international trade. Despite its centrality in the corpus of knowledge, however, this problem receives little attention. Few researches, on the other hand, have examined the impact of financial development in the link between real exchange rate volatility and the international trade. Only Caglayan et al. (2013) looked this in depth. Of course, there are certain researches that are relevant. As a result, one of the main goals of this paper is to objectively resolve this contradiction. This research investigates the impact of real exchange rate variations on international trade in the light of financial development. To explore this topic empirically, a time series model is used.

The extensive empirical literature usually follows the Baxter-Stockman model (1989). There were no discernible differences in macroeconomic development between fixed and flexible/floating exchange rate systems. In this paper, we feel it is critical to examine the link between the real exchange rate and the degree of financial development rather than the volatility of the exchange rate in isolation. Previous research has demonstrated that the development of the financial sector promotes long-term growth through improved trade, generates macroeconomic instability, and can play a significant role in financial crises. The amount to which financial development impacts the effect of monetary institutions, such as the exchange rate regime, is an essential issue that must be determined. Our central argument is that when countries are financially undeveloped, the exchange rate regime, or, more commonly, exchange rate volatility, has a detrimental impact on the country's foreign trade. To confirm these claims, we consider production function regressions to which the measure of the real exchange rate is included, as well as the real exchange rate's relationship with financial development in connection to Nigeria's international trade.

The rest of this article is structured as follows: Sub-section 1.1 briefly gives the overview of the Nigerian exchange regime. Section two reviews the relevant literature of the subject matter. Section three describes the nature of the data alongside the empirical methodology. Section four presents the empirical findings. Section five renders discussions in line with the found results. Section six gives conclusion and policy implications.

1.1. Overview of the Nigerian exchange regime

The real exchange rate and its influence on macroeconomic growth continue to pique the interest of a wide range of stakeholders, including policymakers, academics, and development professionals, particularly in developing and purchase-dependent countries such as Nigeria. In these circumstances, policymakers use various exchange rate regimes and rules to reduce imbalance and volatility as much as possible (Velasco, 1999), with the goal of creating an environment favourable to macroeconomic progress and market growth. Since the Bretton Woods Agreement was established in 1947, the Nigerian government has pursued many exchange-rate regimes. Table 1 depicts Nigeria's various exchange-rate regimes and their associated consequences from 1957 to the present.

Table 1. Transitional process of the Nigerian exchange rate regime.

Exchange Rate Regime	Year	Transformations	Results
Fixed	1957 to 1973	*Nigerian Pound *Oil Boom *No devaluation	Nigerian Pound appreciated
Fixed	1974 to 1985	*Introduction of Naira *Currency devaluation *Import licenses and exchange control reform	Naira depreciated
Flexible	1986 to 2014	*Financial liberalization *Bidding and forex auction *CBN Interventions	Naira continues depreciation
Float	2014 to date	*Intentional CBN intervention and control measures *Realignment of the Naira *BDC reforms	Stable inter Bank rate with wider BDC rate

source: Central Bank of Nigeria, Annual Report and Statement of Accounts (2016).

The massive infusion of foreign cash from the 1973 oil boom resulted in the Nigerian Pound appreciation. From 1973 to 1985, another watershed moment in Nigeria's foreign exchange process occurred when the naira replaced the Nigerian pound. The naira was under immense pressure to devalue during this period. That pressure stemmed from the notion that the naira was overvalued in respect to the anchor currency. Following that, it depreciated the naira to a value of N0.66 per US dollar.

Fortunately, it had a barely visible appreciation of 0.2 percent to N0.62/US$1 through 1974, before moderating by 0.1 percent to an average of N0.64/US$1 from 1975 and 1979 due to a reduction in crude oil prices. As export profits increased due to higher oil prices, the naira climbed to N0.55/US$1 in 1980 before falling by 2.9 percent and 14.6 percent to N0.74 and N0.89/US$1 in 1983

and 1985, respectively. Throughout 1986, the Nigerian government established the Structural Adjustment Program to deregulate the economy and remove disruptors that hampered viable growth (SAP). A key aspect of SAP was the CBN's 1986 introduction of a variable exchange rate system (Nnanna, 2002; Adeoye & Atanda, 2012). Various types of flexible exchange rates appeared under SAP, reflecting various changes of the foreign currency market.

Consequently, a decline in oil prices during the late 1990s, along with surplus money in the banking system and a persistent budget deficit, resulted in a 76 percent depreciation of the naira from N21.88/US$1 in 1998 to N92.69/US$ in 1999. Throughout 2002, the naira was devalued to N116.12 per US dollar as a result of the 1997–1999 economic crisis. However, variations in the parallel market price were somewhat controlled by CBN actions from 1999 to 2002. The CBN established the rDAS in 2002 as part of an attempt to equalize the currency rate, and it finally adopted the wDAS in 2005. Having said that, the 2007 global financial crisis, which also coincided with a drop in the value of crude oil, prompted a further depreciation of the naira from N149.58/US$ in 2009 to N158.27/US$ in 2011. The reintroduction of the rDAS by 2012, as part of strategic methods to addressing the financial crisis, resulted to a further depreciation of the naira to N180/US$ by October 2014, which was expected to follow oil-price volatility. Since then, the currency rate has been steadily depreciating. The major source of variation in the Naira exchange rate may be identified as the volatile price of oil in the world market. This would be the obvious result of a unitary economy that is heavily reliant on crude oil income.

2. Literature review

Many theoretical and empirical studies have been conducted on various nations and time periods to examine the influence of exchange rates on the amount of international trade competitiveness. The "absorption theory," which represents how the exchange rate affects both national revenue and foreign commerce, is one of the most well-known methods. According to this theory, depreciation impacts will appear over time rather than all at once (Krueger, 1996). Dornbusch (2000) connects the development of the exchange rate with changes in the interest rate. Meanwhile, in reaction to Serven (1997); Belke and Setzer (2003); Hirschman (1943); Belke and Gros (2001), real options theory and purchasing power parity theory claimed that frequent depreciation in real exchange rates explains waiting and postponement behaviors in connection to investment choices.

Since the introduction of the floating exchange rate system during the 1970s, many studies have been presented to show the relationship between exchange rate fluctuations and international trade. Since then, the introduction of a common currency in Europe has promoted this dispute. The central controversy of the impact of exchange-rate volatility on trade flows rests on how exactly to predict the behavior of traders. Risk-averse traders, for example, react pessimistically to unforeseen changes in exchange rates, resulting in lower overall production and trade flows. Risk-averse traders, for example, operate under a floating exchange system, according to Ethier (1973). He confirmed the claim that exchange-rate volatility has a negative influence on international trade by integrating uncertainty into the foreign exchange rate market. Clark (1973), Baron (1976), Hooper and Kohlhagen (1978), and Gagnon (1993) have all argued that increased volatility reduces trading volume.

Other research, on the other hand, have questioned traders' unfavorable reactions to exchange-rate market uncertainty. The reasoning assumes that traders with a profit motivation will be more conservative and increase their trading volume to compensate for potential future revenue losses caused by exchange rate volatility. Several writers, including Frank (1991), Viaene and de Vries (1992),

Sercu (1992), Dellas and Zilberfarb (1993), and Broll and Eckwert (1994), have proposed that uncertainty might enhance trade flows (1999).

The influence of exchange rates on economic development is investigated by Adeniran et al. (2014). For the analysis, the study used regression analysis of the ordinary least square (OLS). The findings indicated that real exchange rate volatility has a beneficial influence on Nigeria's productivity development, although it is not substantial. Similarly, Bilas et al. (2017) look at the link between financial development and foreign trade in Croatia from the first quarter of 1997 to the final quarter of 2015. The long-run and short-run connections between the series are investigated using the autoregressive distributed lag (ARDL) bounds testing technique to cointegration. The research premise has been accepted, and the link between Croatian financial development and foreign commerce has been developed and validated. Yakubu et al. (2018) investigate the impact of financial development on foreign commerce in Africa, using data from 46 nations from 1980 to 2015. Domestic credit has a beneficial impact on trade, according to the results of the system generalized method of moments.

Aside from the difference between emerging and developed countries, several studies have focused on other issues. Erdem et al. (2010) looked at the link between imports and exports and discovered that the negative impact of exchange rate fluctuations on international commerce was greater on imports than on exports. Alam (2012) discovered that real exchange rate fluctuation has a long-run detrimental impact on imports in Pakistan. Adewuyi and Akpokodje (2013) shown that exchange rate uncertainty has a greater detrimental impact on non-CFA countries than on CFA countries. Exchange rate fluctuations and international commerce have a negative connection, according to Musilla and Al-Zyoud (2012). Jehan and Irshad (2020) investigate experimentally how real exchange rate (RER) misalignment impacts Pakistani economic development. The fully modified ordinary least squares technique reveals that financial growth helps to mitigate the negative effects of real exchange rate misalignment but not completely eradicating it. As a result, it is necessary to investigate the function of financial development in the exchange rate-trade connection. Finally, the overall effect of misalignment on the amount of international trade is evaluated using direct and indirect effects. Our findings will aid in determining the significance of financial development in mitigating the negative impact of RER mismatch on international trade.

3. Methods

The empirical study is based on a regression model in which exports and imports are impacted by a number of factors such as currency volatility, financial development, and financial globalization uncertainty. In order to evaluate the influence of currency-rate volatility on the Nigeria's volume of international trade from the perspective of financial development and persistent volatility in the exchange rate and foreign capital flows, we follow the literature and expand on the model of Bostan and Firtescu (2018). The model mathematical function is specified as:

$$TRD = f(FD, EXR, FGU) \tag{1}$$

where TRD represents Nigeria's international trade, FD represents the financial development, EXR stands for exchange rate volatility measured; FGU denotes the financial globalization uncertainty.

The econometric equation of the model is given as:

$$TRD_t = \beta_0 + \beta_1 FD + \beta_2 EXR + \beta_3 FGU + \beta_4 (FD * EXR) + u_t \quad (2)$$

where u_t represents the error term and $\beta_1 to\ \beta_3$ are the variable estimates of the model. The parameters are in logarithm to enable adjustment for differences in measurements and units.

3.1. Data sources and measurements

Our study used annual time series data for the Nigeria's international trade (real exports per capita), the exchange rate volatility (Real effective exchange rate), the financial globalization uncertainty (lagged one period of foreign direct investment inflows), and financial development (through principal component analysis using five components i.e. market capitalization, domestic credit to the private sector by other financial institutions, lending rate, domestic credit provided to the private sector by the banks and broad money). The aforementioned indices are widely applied in the literature to measure the scrutinized variables (Ahmad et al., 2018; Farouq et al., 2020a, 2020b, 2020c, 2020d; Farouq et al., 2021a, 2021b; Farouq and Sulong, 2020a, 2020b, 2020c; Farouq and Sulong, 2021; Adusei, 2016; Karimo and Ogbonna, 2017; Farouq et al., 2020c; Danlami et al., 2018) from 1980 through 2019, and the deployment of this long period was intentional to capture all the events that had happened across the years. The data are mainly obtained from the World Bank Database (World Bank, 2020). For this research, we deployed the threshold autoregressive non-linear co-integration and non-linear ARDL.

3.2. Brock Dechert and Scheinkman (BDS) test

Brock Dechert and Scheinkman were the first to create the BDS exam (1987). BDS is one of the most powerful time series approaches for detecting serial dependence. The BDS analysis is used to determine the presence of nonlinear dependence in the residual series calculated after the fitness of the Auto Regressive Integrated Moving Average (ARIMA) model has been determined (Chu, 2001). The normal curve follows test statistics asymptotically. The null hypothesis implies that the residuals have an independent distribution, while the alternative hypothesis says that the examples have numerous variations that make their reliance nonlinear. The BDS experiment's core premise is founded on the concept of integral association, which examines the strength with which the sequence reinforces the spatial pattern. The BDS analysis is based solely on indicators of a contemporaneous return, with no interest in its measures, and makes no assumptions regarding the type of returns. A series of significantly fewer or more runs indicates that the study is also not spontaneous (Chu, 2001).

The BDS assumption follows:

$$H_O: f_n = f_1^n \quad (3)$$

$$H_1: f_n \neq f_1^n \quad (4)$$

the null hypothesis is commonly rejected at 5 percent P-value when the $f_n > 1.96$

$$I_t = 1\ if\ |x - y| < \in \quad (5)$$

Similarly, BDS relies on the correlation as:

$$\mathrm{C}(m, \in, T) = \frac{I[(t,s):\|X_t^m - X_s^m\| < \in]}{T^2} \tag{6}$$

where $X_t^m = (x(t).....,x(t-m+1)), \|.\|$ Is the l_∞ norm on R^m, and $I[.]$ indicates the number of elements subject to only modest regularity conditions as $T \to \infty, \mathrm{C}(m, \in, T)$ has limit $\mathrm{C}(m, \in)$ such that if $\{x(t)\}$ is iid, it then follows.

3.3. Unit root

The advanced exponential smooth transition autoregressive (ESTAR) unit root proposed by Kapetanios et al. (2003) and the DF-GLS unit root were utilized in this study. Elliott et al. (2006) created a set of strong unit root tests based on GLS-distended findings in an attempt to address the obvious low-power issue of unit root tests. Elliott, Rothenberg, and Stock (ERS) proposed a simple modification to the ADF test based on GLS-detrending in their article and proved that the proposed test, known as the DF-GLS test, was more successful than the ADF test. KSS's nonlinear unit root testing is based on the fraying of a unit root against the nonlinear and broad fixed exponential STAR (ESTAR) philosophy of the elective principle. Consider the accompanying protocol for ESTAR:

$$\Delta f_t = \rho f_{t-1} + \sigma f_{t-1}\{1 - \exp\{-\varphi(\sigma f_{t-1} - r)^2\} + \omega_t \tag{7}$$

$$\Delta f_t = \pi + \delta f_{t-1}^3 + \sum_{i=1}^{k} a\Delta f_{t-1} + \omega_t, \qquad t = 1,2, \dots \dots \dots . T \tag{8}$$

3.4. Threshold autoregressive model

In this section, we will use Enders and Granger's (1998) threshold cointegration technique to examine the long-run link between exchange rate volatility, financial development, financial globalization uncertainty, and economic growth. This cointegration technique is built on the two phases of the residual-dependent procedures. The first phase equation is specified as:

$$y_{1t} = \alpha_1 + \alpha_2 y_{2t} + h_t \tag{9}$$

$$\Delta h_t = \rho h_{t-1} + z_t \tag{10}$$

$$\Delta h_t = \begin{cases} \rho_1 h_{t-1} + z_t, & if \quad h_{t-1} \geq 0 \\ \rho_2 h_{t-1} + z_t, & if \quad h_{t-1} < 0 \end{cases} \tag{11}$$

$$\Delta h_t = I_t \rho_1 h_{t-1} + (1 - I_t)\rho_2 h_{t-1} + z_t \tag{12}$$

$$\Delta h_t = I_t \rho_1 h_{t-1} + (1 - I_t)\rho_2 h_{t-1} + \sum_{i=1}^{q-1} \emptyset_i h_{t-1} + z_t \tag{13}$$

The most serious issue that arises when evaluating a non-linear model is the possibility of an unclear limit. To identify the optimum edge, strong econometric techniques have been developed. The optimal edge value must be determined such that the fitted model's base RSS can be retrieved from the Chan (1993) graphic. Enders and Granger (1998) measured the intelligence limit benefit using Chan's method. The AIC and BIC selection metrics will be used to choose the appropriate model (best fit model) from the TAR and M-TAR models.

3.5. Asymmetric error correction model

By constructing a non-linear integration using the M-TAR model threshold, we can compute the reactions of exchange rate volatility to changes in the volume of international trade with an asymmetric error correcting term. The correction of asymmetrical mistakes can be represented as follows in this analysis:

$$\Delta LTRD_t = v_1 + v_2 Zplus_{t-1} + v_3 Zminus_{t-1} + \sum_{i=1}^{k} \Omega_i lfd_{t-1} + \sum_{i=1}^{k} \pi_i lfgu_{t-1} + \sum_{i=1}^{k} \mu_i lexr_{t-1} + \sum_{i=1}^{k} \varphi_i lfgu_{t-1} + \sum_{i=1}^{k} \tau_i lexr * fd_{t-1} + z_t \quad (14)$$

3.6. Non-linear autoregressive distributive lag

The NARDL approach is an asymmetrical adaptation of a simple linear ARDL technique for determining the extent of long-term connections. The approach was developed by Pesaran et al. (2001) and expanded by Shin et al. (2009), resulting in partial sum decomposition of nonlinearity. As a result, the method simulates long-term connections as well as sophisticated ways of adjusting in a natural way. The breakdown of the specified variable is included in this approach. Simply expressed, the analysis divides the volatility of the exchange rate into negative and positive sub-parameters. EXR+ and EXR- represents partial positively and negatively changes. It can be measured as:

$$X_t = b^{+} Y_t^{+} + b^{-} Y_t^{-} + u_t \quad (15)$$

where X_t is the f × 1 vector of economic growth, t stands for the period; Y_t is the f × 1 vector of multiple regressors given that $Y_t = Y_t + Y_t^{+} + Y_t^{-}$, standing in place of the natural logarithm of economic growth; μt represent error term; and b^{+} Are the integrated asymmetric parameters of the long run, depicting that exchange rate reacts asymmetrically during increase and decrease periods.

4. Results

Table 2 shows the descriptive statistics along with the correlation matrix. The findings indicate that EXR has the highest volatility among the variables, and the volume of international trade appear to be less volatile than the financial globalization uncertainty and financial development. Notably, all the variables, show considerable variation within the country, which confirms that the data is normally distributed. Besides, the kurtosis and skewness values of the data show potential asymmetry in the distribution. Thus, we pay attention to the asymmetric in the empirical analyses. For the correlation matrix results, considering the correlation values, none of the variables appear to have a multicollinearity issue.

Moreover, the summary of the descriptive statistics of the real exchange rate volatility, financial development, financial globalization uncertainty and the volume of international trade can be seen from the Table 2. The average real exchange rate volatility, financial development, financial globalization uncertainty and the volume of international trade are higher than their corresponding standard deviations. The standard deviation coefficient of variation is not much, no large variability detected within the variables.

Table 2. Descriptive statistics.

	TRD	LEXR	LFD	LFGU
Mean	2.124	13.343	10.237	15.034
Std. Dev.	1.218	11.278	6.302	5.725
Skewness	−2.981	1.912	1.920	2.508
Kurtosis	7.539	5.155	2.612	1.951
	LTRD	LEXR	LFD	LFGU
LTRD	1.000			
LEXR	0.225*	1.000		
	(0.000)			
LFD	0.321*	0.287*	1.000	
	(0.000)	(0.000)		
LFGU	0.094*	0.031*	0.378*	1.000
	(0.000)	(0.000)	(0.000)	

Source: World Bank (2020).

4.1. Diagnostic tests

Table 3. Diagnostic tests.

χ^2_{NT}		χ^2_{SERIAL}	χ^2_{ARCH}
TRD = F (EXR, FD, FGU)	0.610	0.915	1.054
	(0.462)	(0.538)	(0.239)

Source: World Bank (2020).

All the P-values in the three diagnostic tests above are insignificance. Hence, the data is said to be free from serial correlation and heteroscedasticity; also, the normality test shows the data is normally distributed.

4.2. BDS test

The BDS test is used to determine the asymmetry of time series findings. The test was specifically used to residual data series generated by ARIMA models (Dorina and Simina, 2007). Brock, Dechert, and Schneinkman, three renowned economists, inspired the test's name. The test is based on the assumption that the series displays randomness inside the sequence, as opposed to the alternative assumption that the sequence is asymmetric within the model. See also Table 4 for the results of the BDS test. The table shows that at a significance level of 1%, the null hypothesis is rejected in all proportions. This suggests that the data is nonparametric, suggesting that the sequence is asymmetric.

Table 4. BDS linearity test.

Series	D2	D3	D4	D5	D6
LTRD	0.736*	0.305*	0.301*	0.221*	0.826*
LEXR	0.150*	0.042*	0.109*	0.394*	0.903*
LFD	0.804*	0.310*	0.048*	0.809*	0.215*
LFGU	0.406*	0.508*	0.076*	0.501*	0.748*

Source: World Bank (2020).

4.3. Unit root

The results of the conventional unit root tests, DF-GLS, are shown in Table 5, indicating that the unit root null could not be rejected at 5% for all variables tested at a level. However, following first differencing, we were able to reject the null hypothesis of no stationary distribution, thus I (1). It is widely established that the standard linear unit root test has reduced power when non-linear influences reflect the process of series result creation. Traditional unit root testing might produce deceptive findings because to the increased amount of variability and breakage in these datasets (exchange rate volatility). We also used a newly proposed unit root test that integrates nonlinearities into the framework to estimate the nonlinear stationarity of the variables in the sequence. Furthermore, the results of the KSS root unit tests are presented in Table 5, revealing that the KSS test does not reject the null hypothesis for all variables at level, but rather at first difference. As a result of the first difference I (1), our variables become nonlinear stationary.

Table 5. Stationarity test of unit root.

VARIABLES	DF-GLS	KPSS
LTRD	−1.803	−1.315
LEXR	−1.283	−2.920
LFD	−2.812	−3.815
LFGU	−1.130	−3.214
ΔlTRD	−2.273*	−4.215*
ΔlEXR	−3.441*	−5.733*
ΔlFD	−4.321**	−4.013*
ΔlFGU	−3.471**	−5.932*

Source: World Bank (2020).

4.4. Co-integration test

The Threshold Autoregressive (TAR) and Momentum Threshold Autoregressive (MTAR) models are shown in Table 6. We calculate the M-TAR by varying the adjustment speed differential. The HQC vectors represent the TAR, and the M-TAR models have an optimum lag of 2. The BIC and AIC all suggest that the momentum model is best suited to Nigeria. The results of the M-TAR and TAR reveal that we can reject the null hypothesis of $\rho 1 = \rho 2 = 0$ at the 1% significance level. This follows that exchange rate fluctuation, financial development, financial globalization uncertainty, and international trade are cointegrated, the asymmetric. The study evaluates the null hypothesis through normal F-statistics (Enders and Granger, 1998).

The symmetric adjustment could not reject the null hypothesis in both the M-TAR and TAR estimates. The result reveals that in line with the M-TAR and TAR specifications, there is no symmetric in the adjustment between exchange rate fluctuation, financial development, financial globalization uncertainty, and international trade. However, the TAR threshold model rejects both the null hypothesis of no long-run relationship and the corresponding symmetric adjustment at a 1% significance level. This means that the aforementioned variables are cointegrated with a significant asymmetric adjustment. This offers empirical evidence to the presence of an asymmetrical threshold

for the long-run relationship between exchange rate fluctuation, financial development, financial globalization uncertainty, and international trade in Nigeria. As such, these variables are asymmetrically interdependent, making it extremely hard for investors to achieve adequate diversification of portfolios.

Table 6. Cointegration asymmetric results.

	TAR	T−Statistics	Momentum TAR	T−Statistics
ρ^1	−0.822**	2.606	−0.971**	2.842
ρ^2	−0.694**	2.513	−0.544**	2.251
γ^1	0.887*	3.581	0.841**	2.501
γ^2	0.453*	5.941	0.527**	0.198
Tau	0.000		0.000	
F−Joint $\rho^1 = \rho^2 = 0$ $\Phi/_{\phi M}$	4.442**	9.870	4.831*	11.302
F−equal $\rho^1 \neq \rho^2 \neq 0$	0.251*	3.672	0.391*	1.824

Source: World Bank (2020).

Besides that, we observe that the speed of adjustment to the long-term equilibrium appears to be statistically significant going by Table 7. Following that, the model satisfies the convergence criteria. This implies that it will take only 52.4 percent (the coefficient. of $Zminust-1$) speed for the model to reverts to its equilibrium in the case of deviations from the lower regime. While higher regime disequilibrium term, approximately 41.7% (coefficient. of $Zplust-1$) adjustments speed to revert to its long-term equilibrium. Regarding the findings below, we can make a conclusion that the speed of adjustment is quicker in the lower regime.

Table 7. MTAR error correction model.

Dependent variable: LTRDt			
Variables	Coefficients	Standard error	p-value
ΔLTRD	0.541*	0.116	0.000
	[4.640]		
$\Delta LEXR_t$	0.854*	0.143	0.000
	[5.972]		
ΔLFD_t	0.448*	0.109	0.000
	[4.123]		
$\Delta LFGU_t$	0.378*	0.075	0.000
	[5.012]		
	−0.417*	0.117	0.000
$ZPLUS$	[−3.549]		
$ZMINUS$	−0.524*	0.133	0.000
	[−3.945]		

Source: World Bank (2020).

4.5. Estimation

In this section, we present the summary result of the estimation as highlighted in Table 8, where the positive decomposed EXR variable appears to be insignificant, and the corresponding negative EXR variable shows a positive sign with a significant coefficient. Which implies that, one unit decrease in EXR, it will lead to 31 percent decrease in Nigeria's volume of international trade. As expected, financial development and the interaction term variables all shows positive relationship in relation to the volume of international trade, while the moderating term contributing more at 43 percent in the long run. Whereas, the FGU variable turns out to be negatively related to international trade.

Table 8. Short run NARDL.

Variable	Coefficient	Estd.Error	t-Statistics
$LEXR_t^+$	0.231*	0.054	4.278
$LEXR_t^-$	0.354*	0.095	3.726
LFD_t	0.502*	0.134	3.746
$LFGU_t$	−0.285*	0.056	5.089
$LInt_t$	0.248*	0.054	4.593
ECM	-0.536*	0.098	5.469
Asymmetry $\boldsymbol{W\_SR}$ Stat	7.250[2.234]*		
R-Squared	0.557		
Adjusted R-Squared	0.473		

Long Run NARDL

Variable	Coefficient	Estd.Error	t-Statistics
$LEXR_t^+$	−0.146	0.954	0.153
$LEXR_t^-$	0.345*	0.049	7.041
LFD_t	0.452*	0.085	5.318
$LFGU_t$	−0.249*	0.056	4.446
$LInt_t$	0.458*	0.064	7.156
Asymmetry $\boldsymbol{W\_LR}$ Stat	9.052[2.541]*		

Source: World Bank (2020).

5. Discussion

Following the NARDL estimation result in Table 8, the long-run result depicts both the positive and the negative decomposition of the variable of interest (real exchange rate). For the positive decomposed variable of the real exchange rate, it shows an insignificant coefficient in relation to the volume of Nigeria's international trade. This signifies that no significant relationship exists between the increase in the real exchange rate and the corresponding volume of international trade in Nigeria. This is contrary to the general assertion that as one's country's exchange rate appreciates, its productivity growth usually reduces, and subsequently decreases its volume of exports, and this is simply because the increase in the price of such currency will now make its goods expensive in the global market, which in turn decreases its competitive advantage in the world market. More so, the

country's import is thereby encouraged in relation to the corresponding export. But this is not the case in the Nigerian context, as Nigeria is nearly a mono-cultural economy, such that the substantial proportion of its export is from a single product (i.e crude oil), thus, the accompanying disadvantage of the exchange rate appreciation is not reflected on the country's growth, because the economy is still yet to attain the needed active diversification required to make changes on the export opportunities. This result supports the findings of Adeniran et al. (2014) among others.

On the other hand, the second decomposed variable of real exchange rate reveals that the depreciation of the Nigeria's exchange rate is accompanied by a complementing decrease in the volume of Nigeria's international trade. This is also contrary to what is usually obtainable in the developed world, such as the study of Nasir and Simpson (2018) who have it that exchange rate depreciation can lead to improvements in the balance of trade due to an increase in exports or decrease in imports. Table 8 shows that one unit decrease in exchange rate brings about a 34 percent decrease in the Nigeria's volume of international trade. And the possible explanation to this is linked to the real options theory and the purchasing power parity theory, following the justification of Serven (1997); Belke and Setzer (2003); Hirschman (1943); Belke and Gros (2001), who reveals that exchange rate continuous devaluation explains waiting and postponement behaviors in relation to investment decisions. Therefore, an increase in devaluation in the exchange rate may discourage firms from increasing investment and creating employment, which will subsequently affect the productivity growth of the economy and thus, dampen the exports.

Meanwhile, the financial development in relation to the volume of international trade result indicates that a one-unit increase in FD will increase the volume of trade by 45 percent, the finding supports the wide range of literature (Yakubu et al., 2018; Bilas et al., 2017). Similarly, in the case of financial globalization uncertainty, the result reveals that a one-unit increase in the FGU will also bring a negative change in the Nigeria's volume of international trade by 24 percent. Notably, financial globalization uncertainty implies shocks in foreign capital flows. Therefore, a feasible explanation to this result is that a shortage in the foreign capital flows to the Nigerian economy will have an adverse effect on its volume of international trade, and this is considering its highly dependence on the foreign finances towards the local investments.

Lastly, it is worthy of note that our interaction term shows a statistically significant and positive result, which indicates that the effect of the real exchange rate in relation to the Nigeria's volume of international trade increases with the presence of financial development. This implies that the relationship between the exchange rate and the volume of international trade is strengthened if accompanied by financial development. As such, a one-unit increase in the exchange rate will result in a corresponding increase in the volume of international trade following the interactive role of financial development by 45 percent. We, therefore, conclude that financial development assists in mitigating the adverse effect of exchange rate misalignment. This finding reveals that as the financial development increases, the adverse effect of the exchange rate on the country's international trade reduces, which means that while financial development is attained, many hedging or covering instruments would be developed to combat exchange rate volatility. We, therefore, recommend that Nigeria still needs to enhance the performance, structure, and efficiency of the financial sector so as to reap from the benefit. This is in line with Jehan and Irshad (2020).

6. Conclusions

This paper presents an empirical evidence regarding the relationship between the real exchange rate volatility, financial development, financial globalization uncertainty, and Nigeria's international trade. We first carried out a co-integration test to validate the presence of long-run asymmetric relationship among the variables, after which we conducted a test to ascertain the nonlinear relationship between the real exchange rate volatility and the volume of trade, where we found the positive decomposed variable of the exchange rate to be insignificant in relation to the volume of international trade. On the other hand, the negative decomposed variable of the real exchange rate recorded a negative and significant result with the volume of international trade. We further found the evidence of an asymmetric relationship between the real exchange rate volatility and the volume of international trade as also found in the past studies such as Nasir et al. (2021); Mohsen and Nasir (2020). Meanwhile, through the interacting role of financial development, the exchange rate became positively related to international trade. In the case of financial globalization uncertainty, the relationship appeared to be negative.

Nevertheless, from our empirical analysis, it has been highlighted that the exchange rate in the presence of an efficient financial system is positively related to the Nigeria's international trade. Therefore, we recommend that policymakers should pay more attention to policies that would promote the efficient and functional financial system in order to become resilient in the event of foreign capital shortage, as well as encourage local production and active diversification, thus, export promotion to a sustainable surplus balance of trade. In addition, there should be a conducive business-friendly environment, sufficient security, infrastructural facilities, and effective fiscal and monetary policies to attract foreign investors in Nigeria.

7. Limitation of the study

Like all other time series studies on macroeconomic variables, this research has its own limitation as current study is only limited to context of developing country like Nigeria. Future research might consider comparing the results of developing countries such as Nigeria, India, South-Africa and Sri Lanka through implementing NARDL in order to get more diversified perspective of positive and Negative effect of real exchange rate volatility on the volume of international trade in the developing countries.

Conflicts of interest

The authors declare no conflict of interest.

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