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The Determinants of Nigeria's Forest Products Trade Balance

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ABSTRACT

This paper examines the cointegration relationship between forest products trade balance and its determinants in Nigeria using the autoregressive distributed lag (ARDL) bounds testing approach. The results revealed that the variables were cointegrated. In the long run, domestic and foreign incomes have significant negative and positive impacts on the trade balance, respectively, whereas exchange rate has an insignificant impact on trade balance. In the short run, both domestic and foreign income have significant negative impacts on the trade balance. In addition, the coefficient of exchange rate also shows significant negative impact, which supports one of the assumptions of J-curve hypothesis and Marshall-Lerner condition. J-curve existence was tested, and it was revealed that it does not exist in the case of Nigeria's trading in forest products. The results of variable decompositions and generalized impulse response tests further confirmed the earlier findings. Hence, Nigeria may have to adopt policies that are income related or growth driven to improve its forest products' trade balance. This is because of the significant role of income variables in influencing changes in the trade balance revealed through the study.

JEL Classification: F14, F18

Keywords: Trade balance, forest products, short-run, long-run, ARDL

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INTRODUCTION

The response of trade balance to its determinants, particularly exchange rate, has long been a debated issue in the literature on international economics. Theoretically, nominal appreciation or depreciation of exchange rate is assumed to change the real exchange rate and hence has a direct effect on the balance of trade (Himarios, 1989; Bahamani-Oskooee, 2001). Earlier studies conducted to resolve this debate resulted in the development of elasticity approach to trade balance (Robinson, 1947; Meltzer, 1948). This approach predicts that, in the long run, depreciation would result in improvement of the balance of trade if the export and import elasticity value is greater than one; i.e., the Marshal-Lerner condition holds. Junz and Rhomberg (1973) later indicated that, after the devaluation of a nation's currency, balance of trade should be expected to follow a J-curve shape in the short run.

A number of studies have revealed weak evidence of linking exchange rate variations to trade balance (Rahman and Mustafa, 1996; Rahman *et al.*, 1997). Other empirical evidence suggests that variations in exchange rate have an effect on the balance of trade in some countries. But still the impact of the variations in exchange rate on trade balance is ambiguous (i.e. unclear). Therefore, the general results suggest mixed evidence.
An increasing trend in the world's trading of forest products has helped to accelerate economic growth and at the same alleviate poverty in different countries, particularly emerging ones. However, it has been proven that trading of forest products out of poverty has resulted in further relegation in some countries. To avoid this, mechanisms must be put in place to make sure that trading of forest products is carried out based on sustainable forest use and in a legal manner. Above all, good governance is highly required to formulate and implement sustainable forest management policies which will ensure sustainability in the production and trading of forest products.

Nigeria's forest products industry plays a vital role by making significant contribution to the economy as one of the developed industries or sectors of the national economy. Export of wood products accounted for more than 70% of the forest industry's contribution to the nation's Gross Domestic Products (Aribisala, 1993). The forest resources served as an engine of economic growth and propelled economic activities as far back as 1792 when pit sawing operation commenced, followed by the establishment of a power saw mill in the Delta area in 1902 (Aribisala, 1993). According to this study, this development resulted in an increase in wood production for domestic industrial uses and exports. Since then, the export of wood has raised significantly with the high demand for sawn wood, log, plywood and veneer.

The majority of the studies on forest products trade focused on determining the impact of exchange rate changes on the forest products trade volume and price (Sarka, 1996; Sun and Zhang, 2003; Bolkesjo and Buongiormo, 2006). Until recently, a study by Baek (2007) investigated the J-curve effect in US-Canada bilateral trade in forest products.
In this context, little or no attention has been paid to assess the impact of the changes in the exchange rate on Nigeria's forest products trade balance despite the importance of the sector. Therefore, this research paper aims to empirically test the impact of exchange rate as well as the other determinants of trade balance on Nigeria's forest products trade balance based on the J-curve hypothesis of international trade.

The paper is organized sequentially in seven sections, which include introduction, theoretical framework, empirical literature review, methodology, results, conclusions and policy recommendations. The introduction section gives an overview of the subject matter. The theoretical framework section describes the theory upon which the analysis rests. The empirical literature section discusses the past literature written in the area. The methodology section discusses the techniques used for estimation and analysis. The results section presents and discusses the findings of the study. The conclusion section concludes based on the results obtained. Lastly, the policy recommendation section suggests that policies be adopted based on the overall findings of the study.

THEORETICAL FRAMEWORK

This section explains the base line theory upon which the study relies. The theoretical framework provides the already-established principles and ideas about the impact of the trade balance's determinants. Accordingly, the study employed J-curve hypothesis to analyse the relationship between Nigeria's forest products trade balance and its determinants.

The J-curve Effect Hypothesis

The Marshall-Lerner condition suggests that currency depreciation is likely to improve a nation's trade balance if the elasticity of imports and exports in absolute terms is greater than one; i.e., elastic ($PED_{mx}>1$). A basic problem in measuring world price elasticities, however, is that there tends to be a time lag between changes in exchange rate and their ultimate effect on real trade. One popular description of the time path of trade flows is called the J-curve effect. This hypothesis suggests that, in the very short run, currency depreciation will lead to a worsening of a nation's trade balance. But as time passes, the trade balance is likely to be improved. This is because it takes time for new information about the price effects of depreciation to be disseminated throughout the economy and for economic units to adjust their behaviour accordingly.

The time path of the response of trade flows to a currency's depreciation can be described in terms of the J-curve effect, so called because the trade balance continues to get worse for a while after depreciation (sliding down the hook of the J) and then gets better (moving up the stem of the J). This effect occurs because the initial effect of depreciation is an increase in import expenditure. That is, the home-currency price of imports has risen, but the volume is unchanged, owing to prior commitments. As time passes, the quantity adjustment effect becomes relevant. That is, import volume is depressed, whereas exports become more attractive to foreign buyers.

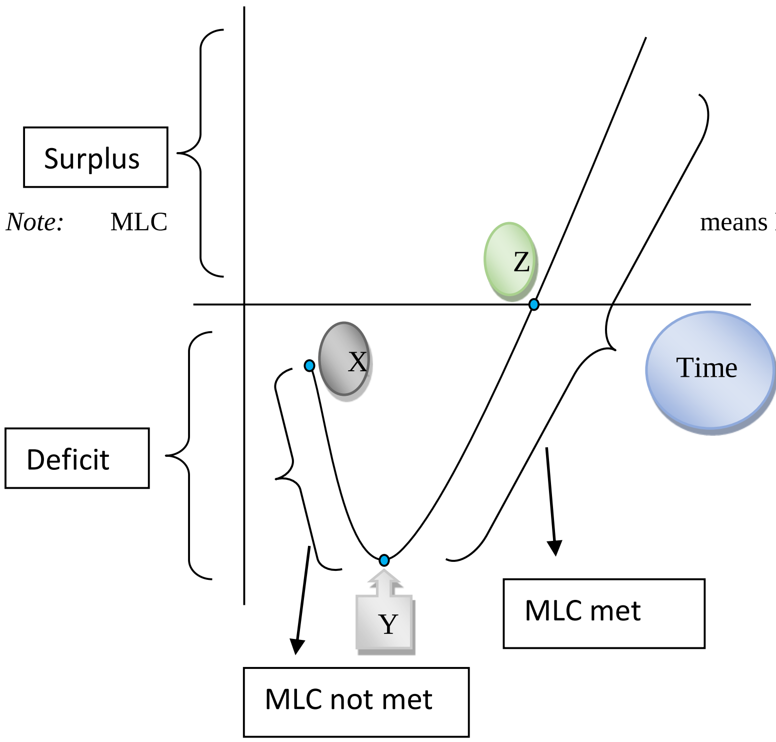


Figure 1 J- curve Hypothesis' diagram

Note: MLC means Marshall-Lerner condition

The J-curve (Figure 1) shows the effect of devaluation of a currency on the net export (exports minus imports). When the devaluation takes place at time ***t***, the net export falls from X to Y, since the level of import is unchanged, but the currency is worthless. As time goes on, the net export will gradually change, since consumers buy less imported goods, and other countries buy more goods from the country due to the lower real price. At Z, the net export is at the break-even point, and as time goes by, the net export finds equilibrium.

The Derivation of Trade Balance Equation in a Reduced Form

The trade balance forms part of a country's balance of payment (BOP), and it sums up the imports and export. It is defined as the net trade value measured in domestic currency. The derivation of the trade balance equation is going to be carried out based on the traditional two-country model by Rose and Yellen (1989), adopted by Rose (1990) and recently applied by Baek (2007).

$$DD_m = DD_m(Y, P_m) \tag{1}$$

The quantity demanded for import in a domestic country, DD_m, depends on domestic income, Y, and relative price of imports, P_m.

$$DD_m^* = DD_m^*(Y^*, P_m^*) \tag{2}$$

The quantity demanded abroad for country's export, DD_m^*, also depends on a foreign country's income, Y^*, and has a negative relationship with a country's relative price for imports, P_m^*.

$$SS_x = SS_x(P_x) \tag{3}$$

The exports' supply from home country, SS_x, is positively related to a country's relative price of export (i.e., the ratio of domestic currency price of export to the home price level), P_x.

$$SS_x^* = SS_x^*(P_x^*) \tag{4}$$

SS_x^*, the quantity supplied of exports from the foreign country, is dependent on the foreign currency's price of exports divided by foreign price level, which gives P_x^*.

Therefore, the domestic relative imported goods' price can be expressed as:

$$P_m = \frac{EP_x^*}{P} = \left(\frac{EP^*}{P}\right)\left(\frac{P_x^*}{P^*}\right) \equiv QP_x^* \tag{5}$$

At the same time, the relative price of imports in the foreign country is expressed as:

$$P_m^* = \frac{P_x}{Q} \tag{6}$$

At equilibrium:

$$DD_m = SS_x^* \tag{7}$$

and

$$DD_m^* = S_x \tag{8}$$

Therefore, the net value-export value minus import value is expressed as the trade balance (TB):

$$TB = P_x DD_m^* - QP_x^* D_m \tag{9}$$

If we re-write equation (9) in a reduced form, we have:

$$TB = TB(Q, Y, Y^*) \qquad (10)$$

where *TB* is trade balance, *Q* represents exchange rate, *Y* is domestic income, and Y^* is foreign income.

For the purpose of this paper, we change some notations to suit our enquiry. *Q* becomes *EXR*, *Y* becomes Y^{NIG}, and Y^* becomes Y^W.

$$TB = TB(Y^{NIG}, Y^W, EXR) \qquad (11)$$

Equation (11) is the empirical model for this paper.

EMPIRICAL LITERATURE REVIEW

The impact of depreciation and appreciation in the exchange rate on the balance of trade depends on the determinants of the elasticities of demand and supply of exports and import. In the short run, the elasticities are smaller in absolute value which entails inelastic supply and demand, while, in the long run, the elasticities are more elastic, and hence balance of trade may deteriorate more in the short run than in the long run (Bahman-Oskooee, 2004). Owing to currency devaluation, in the beginning, the trade balance deteriorates, since prices and volume of trade could not be changed. This scenario assumes that exports and imports are invoiced in domestic and foreign currency, respectively. The pass-through price of both the domestic and foreign producers to the consumer and the demand and supply elasticities of exports and imports both determine the effect of exchange on trade balance (Hsing, 2005).

The Marshall-Lerner condition is considered to be a necessary and sufficient condition for improvement of the balance of trade after depreciation of a nation's currency (Bahman-Oskooee, 2004). This study further suggests that, for currency depreciation to impact the balance of trade significantly, the summation of the import and export demand's elasticities must be more than unity. However, the Marshall-Lerner applies to the long run, since exporters and importers could have adequate time to respond to changes in the exchange rate.

Most of the studies on the J-curve effect revealed mixed outcomes. While some results are in line with the J-curve hypothesis, others contradicted it. Gupta-Kapoo and Ramakrishnan (1999) adopted the error correction model coupled with the impulse response function to test for the J-curve effect on Japan's trade balance using quarterly samples from 1975 to 1994. They found that the J-curve exists in the case of Japanese trade balance. Similarly, a study which employed a reduced-form equation to determine the impact of permanent shock on the trade balance revealed that some evidence of the J-curve effect exists in Croatia's trade balance (Tihomir, 2004).

Bahmani-Oskooee (1999) investigated the long-run relationship between Iranian trade balance and the black market value of the Iranian rial by using cointegration analysis. He found that, in oil-producing nations such as Iran, owing to rent-seeking chances, depreciation of the country's rial in the black market could have an adverse effect on the nation's trade balance.

Similarly, Pattichis (2012) examined the effects of exchange rate depreciation on US-UK trade in services based on disaggregate data in the short and long run. The paper employed an ARDL bounds-testing approach and categorized the services into three internationally traded services- travel, passenger fares and other transportation services. The results indicated that the real exchange rate had a significant effect on trade in services in at least one of the time periods, and some evidence of J-curve was also found.

Bahmani-Oskooee and Kantipong (2001) used bilateral data to test for the J-curve phenomenon in Thailand's trading with its largest trading partners, which include Germany, Japan, Singapore, the U.K. and the U.S. The study employed quarterly data (1973:1-1997:4) and found that the J-curve exists in trading with the U.S. and Japan. Carter and Pick (1989) investigated the existence of a J-curve on the U.S. balance of trade in agricultural products and found a J-curve pattern in the trade balance. The findings further revealed that the deterioration in the balance of trade lasted for 9 months after the 10% devaluation of the U.S. dollar.

Baek (2007) examined the dynamic effect of bilateral U.S.-Canada exchange rate variations on forest products trading. By using an ARDL modelling approach, the study found little evidence of the J-curve effect in some forest products after adopting disaggregated data over the period of 1989 to 2005.

Bahmani-Oskooee et al. (2013) studied the response of trade balances of 106 industries to currency depreciation using annual data. By applying the cointegration method of analysis, the study revealed that 19 industries indicated evidence of a J-curve. Many other studies revealed evidence of the J-curve effect in countries' trade balance and sectorial trade balance (Koray and McMillin, 1999; Leonard and Stockman, 2001; Singh, 2002; Lal Lowinger, 2002; Akbostanci, 2004; Narayan, 2004; Stucka, 2003; Hacker and Hatemi-J, 2004).

On the other hand, some set of literatures disproved the J-curve effect's existence. Haynes and Stone (1982) assessed the impact of terms of trade after deterioration. The study employed data from the sample period between 1947 and 1974 and found that no improvement was observed in trade balance after deterioration.

Miles (1979) examined the impact of devaluation on trade balance and discovered that it does not improve the trade balance but improves the balance of payments using data from 14 countries (1956-1972). Similarly, Brada et al. (1997) discovered the nonexistence of a cointegration relationship between balance of trade, real exchange rate and domestic and foreign incomes during the 1970s.

Wilson and Tat (2001) analysed the relationship between real exchange rate and trade balance for bilateral trade in merchandise goods between Singapore and the U.S. using quarterly data between 1970 to 1996 based on the reduced-form model. The findings show that the real exchange rate has no significant impact on the bilateral trade balance for Singapore-U.S., thereby confirming the previous findings related to a weak relationship.

In a similar vein, Bahmani-Oskooee et al. (2003) re-examined India's balance of trade as a follow up on previous research that did not find any significant evidence. The study adopted disaggregated data to check for J-curve existence in India's trading with its partners. The findings indicate no J-curve effect; however, it was revealed that long real devaluation of India's currency has a significant effect on improving the balance of trade. A study conducted on Singapore to assess the impact of real exchange rate depreciation on trade balance revealed that the J-curve phenomenon does not exist and is invalid in the case of Singapore (Kua and Wilson, 2000).

Ferda (2007) studied the aggregate and disaggregate impact of the dynamics of Turkish bilateral trade with its 9 trading partners using cointegration analysis, generalized impulse response analysis and stability test. The empirical findings of the study revealed the non-existence of J-curve at the disaggregate levels. Nevertheless, Marshall-Lerner condition holds after using aggregated data. The stability test of trade balance models produced mixed results.

Wang et al. (2012) tested short-run J-curve hypothesis and long-run trade balance effect of exchange rate between China and its 18 major trading partners using panel data set between 2005 and 2009. Applying the panel cointegration test, the fully modified OLS test and panel error correction model to examine the relationship and the effects in both the short run and the long run, it was revealed that inverted J-curve phenomenon exists in China's trading with its partners. The findings further indicated that real depreciation of the country's currency has a decreasing long-run effect on China's trading with its partners.

Umoru and Eboreime (2013) investigated the J-curve hypothesis in Nigeria's trade of oil with the rest of the world using 40-year observations. The study which employed ARDL bounds testing approach to cointegration revealed that the J-curve effect could not be validated in Nigeria's oil trading. Other studies which could not find J-curve effect and could not establish any significant effect of the real exchange rate on the different countries are numerous (see Rose and Yellen, 1989; Rose, 1990; Koch and Rosensweig, 1990; Felmingham, 1998; Wilson and Tat, 2001).

Having reviewed and discussed the outcome of various past works of literature on the impact of exchange rate on trade balance as well as the research on J-curve effect and trade balance, this study will add to the body of literature by determining the real impact of exchange rate depreciation on Nigeria's trade of forest products with other countries of the world. The J-curve effect will also be analysed in this research to see whether or not it exists.

METHODOLOGY

Data Description

The series used in this study are balance of trade expressed as *X/M ratio* (TB_t), official exchange rate (ER_t), world income in the form of GDP (Y^W) and Nigeria's income in form of GDP (Y^{NIG}). The series are annual data collected for the period of 1970 – 2010 from the World Bank's official website and Food and Agricultural Organization's database. It is important to point out here that, to get the trade balance *(TB)*, the ratio of export to import (X/M) was taken. This is in order to be consistent with previous literature. Furthermore, the ratio of export to import has been adopted because of its non-sensitivity to the unit of measurement, and it can also be easily interpreted as the real or nominal trade balance (Bahmani-Oskooee, 1991; Duasa, 2007). As stated earlier in the introduction, the overall aim of this paper is to assess the impact of trade balance determinants on Nigeria's forest products trade with the rest of the world. Nonetheless, since all of the variables are converted into natural logarithms, the estimated coefficients can be interpreted as elasticities.

Statistical Analysis

The study aims to use the econometric method of data analysis to analyse the impact of trade balance determinants on Nigeria's trade in forest products both in the short-run and long-run period as well as check for the existence of a J-curve. The method is an autoregressive distributed lag approach to cointegration (ARDL). The ARDL approach has been chosen in order to check for the long-run cointegration relationship among the variables and also derive the error correction version (ECMs) of the ARDL to analyse the short-run dynamics.

However, there are other methods of testing for cointegration, such as the Juselius Johansen (1990) cointegration and conventional Johansen (1998) cointegration tests. The methodology has been selected because of its numerous advantages over other similar approaches that could be used to achieve the same objective. Unlike the conventional cointegration method, which estimates the long-run relationship within the context of a system of equations, the ARDL method uses only one single reduced form of equation (Pesaran and shin, 1999). Also, the ARDL method does not necessarily require pre-testing of variables for unit root, and as such, it can be used regardless of the order of integration of the variables; whether they are all $I(0)$ *or* $I(1)$ or mixed. More so, with ARDL, it is not impossible for different variables to have a different lag, which is quite impossible with the standard cointegration test. Similarly, with ARDL, both short-run and long-run results could be simultaneously obtained (Emran et al., 2007; Chindo et al., 2015). Finally, the ARDL model could be applied to small sample data ranging from 30 to 80 observations in which the set of tabulated critical bound values have been developed by Narayan (2004) and Narayan (2005).

Model Derivation and Specification

To build our ARDL model, we start from the balance of trade model for forest products on the basis of theoretical framework developed by Rose and Yellen (1989). From Equation (11), we have the following:

$$TB = TB(Y^{NIG}, Y^{W}, EXR) \qquad (11)$$

Transforming the function into econometric model and taking the natural log the variables, we have:

$$\ln TB_t = \beta_0 + \beta_1 \ln Y_t^{NIG} + \beta_2 \ln Y_t^{W} + \beta_3 \ln EXR_t + \upsilon_t \qquad (12)$$

where $lnTB_t$ is the Nigeria's trade balance with the rest of the world expressed as trade surplus (X/M) for the aggregate forest products, t represents the years covered by the study, Y_t^{NIG} is Nigeria's real income, Y_t^{W} is the income of the world, EXR_t is the official exchange rate and U_t represents the error term.

Regarding the coefficients' sign in Equation (12), we expect that $\beta_1 < 0$, $\beta_2 > 0$ and $\beta_3 > 0$, since depreciation in Nigeria's currency should increase exports and at the same time decrease imports based on the theoretical provision, hence improving the balance of trade.
The approach of ARDL involves the estimation of the error correction model version of the ARDL model for variables' estimation in the estimation process (Pesaran *et al.*, 2001). Therefore, from Equation (12), the specified ARDL model becomes:

$$\Delta lnTB_t = \beta_1 + \sum_{i=1}^{c} \lambda_i \Delta lnTB_{t-i} + \sum_{i=0}^{c} \partial_i \Delta \ln Y_{t-i}^{NIG} + \sum_{i=0}^{c} \theta_i \Delta \ln Y_{t-i}^{W} + \sum_{i=0}^{c} \pi_i \Delta \ln EXR_{t-i} + \rho_1 \ln TB_{t-1}$$
$$+ \rho_2 \ln Y_{t-1}^{NIG} + \rho_3 \ln Y_{t-1}^{W} + \rho_4 \ln EXR_{t-1} + U_t \qquad (13)$$

In line with Equation (13), two hypotheses to be tested were stated:

$H_0 : \rho_1 = \rho_2 = \rho_3 = \rho_4 = 0$ (No cointegration)
$H_a : \rho_1 \neq \rho_2 \neq \rho_3 \neq \rho_4 \neq 0$ (cointegration exists)

where Δ stands for the difference operator, and disturbance term U_t is assumed to be serially uncorrelated. The parameters with summation signs ($\sum$) represent the short-run dynamics between the balance of trade and its determinants; i.e., the J - curve effect. Also, the terms with ρ's as coefficients in the second part of the equation represent the long-run parameters, which are to be jointly tested for the long-run relationship (cointegration).

The null hypothesis (H_0) would be tested against the alternative (H_a) using F-test, which has a non-standard distribution depending on whether the variables in the specified model are purely *I(0)* or *I(1)* or mixed; the number of regressors (*k*) in the model; and whether the model has or hasn't intercepted and/or trended. Considering the small sample size nature of this study, which is 40 observations, the critical bounds values tabulated by Narayan (2005), which are based on a small sample size (between 30 to 80), will be used. In the table, there are two sets of critical values generated, which are *I(0)* known as the lower bound and *I(1)* known as the upper bound. When the F- statistics' value exceeds the value of the upper bound, we can safely conclude that cointegration exists regardless of the order of integration of the variables. When it falls below the lower bound, we fail to reject the null hypothesis, and when it falls between the two bounds, conclusion cannot be made; i.e., they are inconclusive.

However, if a cointegration relationship exists among the variables, a long-run model would be estimated as specified:

$$lnTB_t = \beta_1 + \sum_{i=1}^{c} \lambda_{1i} lnTB_{t-i} + \sum_{i=0}^{c} \partial_{1i} \ln Y_{t-i}^{NIG} + \sum_{i=0}^{c} \theta_{1i} \ln Y_{t-i}^{W} + \sum_{i=0}^{c} \pi_{1i} \ln EXR_{t-i} + \varepsilon_t \quad (14)$$

The choice of lag orders of the ARDL model would be mainly based on the Schwarz Bayesian criterion (SBC) or Akaike information criterion (AIC) before proceeding to estimate the selected model using the ordinary least squares method (OLS).

The short-run model can be constructed by specifying the ECM model in this form:

$$\Delta lnTB_t = \beta_2 + \sum_{i=1}^{c} \lambda_{2i} \Delta lnTB_{t-i} + \sum_{i=0}^{c} \partial_{2i} \Delta \ln Y_{t-i}^{NIG} + \sum_{i=0}^{c} \theta_{2i} \Delta \ln Y_{t-i}^{W} + \sum_{i=0}^{c} \pi_{2i} \Delta \ln EXR_{t-i}$$
$$+\gamma ECM_{t-i} + \mu_t \quad (15)$$

where, ECM_{t-i} represents the error correction term which can be expressed as:

$$ECM_t = lnTB_t - \beta_1 - \sum_{i=1}^{c} \lambda_{1i} lnTB_{t-i} - \sum_{i=0}^{c} \partial_{1i} \ln Y_{t-i}^{NIG} - \sum_{i=0}^{c} \theta_{1i} \ln Y_{t-i}^{W} - \sum_{i=0}^{c} \pi_{1i} \ln EXR_{t-i} \quad (16)$$

The short-run's coefficients to be obtained from Equation (16) are coefficients of the short-run dynamics of the model's convergence to equilibrium in the long run, and γ in Equation (15) denotes the speed of the adjustment process.

EMPIRICAL RESULTS

Unit Root test

Prior to testing the long-run relationship among the variables, we employed ADF, PP and KPSS unit root tests to ascertain the order of integration of the variables. The ARDL modelling approach to cointegration requires that all variables must be between the order of zero and the order of one (i.e., I(0) to I(1)). Though it is not a necessary condition before testing for cointegration, it is important, as any presence of I(2) variable(s) among the variables may render ARDL invalid or not applicable in this context. The results of ADF, PP and KPSS tests are presented in Tables 1 and 2.

Table 1 Unit root test results (constant without trend)

Variables	Level			First Difference		
	ADF Test statistics	PP Test statistics	KPSS Test statistics	ADF Test statistics	PP Test statistics	KPSS Test statistics
lnTB	-1.5512 (0.497)	-1.9026 (0.327)	0.2108	-4.4935*** (0.000)	-4.4465*** (0.001)	0.1525
lnY^{NIG}	-1.5361 (0.505)	-1.7420 (0.403)	0.2450	-6.3029*** (0.000)	-6.2871*** (0.000)	0.1764
lnY^{W}	-1.9707 (0.298)	-3.2039** (0.027)	0.7961***	-5.6051*** (0.000)	-4.7538*** (0.000)	0.4134*
lnEX	0.0304 (0.955)	-0.0790 (0.944)	0.7429***	-5.1021*** (0.000)	-5.0929*** (0.000)	0.1848

Notes: *** denotes 1% level of significance, ** denotes 5% level of significance and * denotes 10% level of significance. Parentheses are the *p*-values. For KPSS; 0.7390, 0.4630 and 0.3470 are the t-critical values at 1%, 5% and 10% significance level respectively. All KPSS test statistics values below the critical value indicate stationarity, while those above this value indicate nonstationarity (i.e. unit root). This is because; the null hypothesis states that the variable is stationary unlike ADF's and PP's null hypothesis where it states that the variable is nonstationary.

Table 2 Unit root test results (constant with trend)

Variables	Level			First Difference		
	ADF Test statistics	PP Test statistics	KPSS Test statistics	ADF Test statistics	PP Test statistics	KPSS Test statistics
lnTB	-1.8117 (0.680)	-2.0679 (0.547)	0.1020	-4.4176*** (0.005)	-4.3677*** (0.006)	0.1319*
lnY^{NIG}	-1.5814 (0.782)	-1.8284 (0.672)	0.1176	-6.2518*** (0.000)	-6.2378*** (0.000)	0.1785**
lnY^{W}	-4.1657** (0.011)	-2.5460 (0.305)	0.1999**	-5.0283*** (0.001)	-5.8936*** (0.000)	0.1184
lnEX	-2.0606 (0.551)	-2.1765 (0.489)	0.1114	-5.0510*** (0.001)	-5.0433*** (0.001)	0.1556**

Notes: *** denotes 1% level of significance, ** denotes 5% level of significance and * denotes 10% level of significance. Parentheses are the *p*-values. For KPSS; 0.7390, 0.4630 and 0.3470 are the t-critical values at 1%, 5% and 10% significance level respectively. All KPSS test statistics values below the critical value indicate stationarity, while those above this value indicate nonstationarity (i.e. unit root). This is because; the null hypothesis states that the variable is stationary unlike ADF's and PP's null hypothesis where it states that the variable is nonstationary.

Using the ADF and PP tests, the unit root test results (Tables 1 and 2) generally reveal that all the variables have different order of integrations (mixture of I(0) and I(1)), but when first differenced, all of the variables become stationary. On the other hand, using a KPSS test, the results contradict ADF and PP's results. It displays the mixture of I(0) and I(1). However, since no variable(s) is I(2) among the variables, then we can proceed to the next step of the estimation process. The next step, which involves the descriptive statistics presented in Table 3, indicates that all the variables satisfy the requirement for normal distribution.

Table 3 Descriptive Statistics

	$lnTB$	lnY^{NIG}	$lnEX$	lnY^{W}
Mean	-2.479	5.963	2.012	38.391
Standard Error	0.223	0.089	0.348	0.057
Median	-2.030	5.819	2.084	38.427
Standard Deviation	1.430	0.570	2.229	0.364
Sample Variance	2.044	0.325	4.967	0.132
Kurtosis	0.011	-0.365	-1.688	-1.148
Skewness	-0.971	0.395	0.102	-0.109
Range	4.828	2.452	5.616	1.226
Minimum	-5.634	4.774	-0.604	37.730
Maximum	-0.806	7.226	5.013	38.956
Sum	101.658	244.468	82.476	1574.051
Observations	41	41	41	41

Cointegration Test Results

Table 4 shows the results of cointegration test based on the ARDL bounds testing approach. The F-statistics obtained from the variable addition test in microfit is 10.063 at the optimal lag, which exceeds the upper bound of the critical values obtained from Narayan (2005) Table and hence cointegrated at 1%, 5% and10% significance level under unrestricted intercept and no trend. The bounds are 5.018-6.610 at the 1% significance level, 3.548-4.803 at the 5% significance level and 2.933-4.020 at the 10% significance level. The decision rule here is that, when F-statistics exceed the upper bound, cointegration exists. When F-statistics fall below the lower bound, there is no cointegration, and lastly, when it falls between the upper and the lower bounds, it is inconclusive. However, in our own case, the F-statistic exceeds the upper bounds at all three levels of significance (1%, 5% and 10%), which indicates strong cointegration among the variables in the model (see Table 4).

Table 4 The Cointegration test results based on ARDL bounds testing approach

Model	F-stat.	Lag	Significance Level	Critical Bounds' values: Unrestricted intercept & no trend		Critical Bounds' values: Restricted intercept & no trend	
				$I(0)$	$I(1)$	$I(0)$	$I(1)$
			1%	5.018	6.610	4.310	5.544
$F(lnTB\|lnY^{NIG},lnY^{W},lnEX)$	10.063	4					
			5%	3.548	4.803	3.100	4.088
			10%	2.933	4.020	2.592	3.454
n = 40							

Notes: The F-statistics critical bounds' values for testing cointegration relationship at 1%, 5% and 10% are (5.018, 6.610), (3.548, 4.803) and (2.933, 4.020), respectively. These critical values are obtained from Narayan Table, Case III by Narayan (2005).

Long run ARDL Model Results

The summary of the long-run coefficients are presented in Table 5. Both the domestic and foreign income coefficients conform to the theoretical expectation. The coefficient of domestic income has a significant negative relationship with trade balance, while the foreign income's coefficient has a significant positive relationship with the trade balance. These two results are consistent with the Keynesian view, which postulates that an increase in domestic income leads to higher demand for import and hence negatively affects the nation's trade balance. On the other hand, an increase in foreign income leads to higher demand for the country's export abroad, which subsequently improves the nation's trade balance. These results are consistent with Umoru and Eboreime (2013), Petrovic and Gligoric (2010) and Bahmani-Oskooee (2001) in their respective studies. However, the results contradict the results obtained by Sulaiman and Abdul-Rahim (2014), Baek (2007) and Duasa (2007). The contradiction may have resulted from the trade balance ratio they adopted; e.g., the M/X ratio as opposed to the X/M ratio adopted in this study. Furthermore, the coefficient of the exchange rate indicates a negative and insignificant impact on the trade balance. This means that, in the long run, the exchange rate does not have a significant influence on Nigeria's forest products trade balance. This supports the findings of Liew *et al*. (2003), in which the exchange rate has been found to be insignificant in initiating changes in trade balance in the case of Singapore, Thailand, and Malaysia.

Table 5 The estimated long run coefficients of Nigeria's forest products trade balance based on ARDL Model (1, 0, 0, 1)

	Dependent variable: $lnTB_t$	
Regressors	Coefficients	T-ratio [*p*-value]
lnY^{NIG}	-2.8948***	-3.8149 [0.001]
lnY^{W}	13.1108**	2.2650 [0.031]
lnEX	-1.3689	-1.6762 [0.104]
Constant	-484.910**	-2.2357 [0.033]

Notes: ***, ** and * denote level of significance at 1%, 5% and 10%, respectively. Parentheses are the *p-values*.

Short run ARDL model Results

The summary coefficients in the short run are presented in Table 6. The coefficient of domestic income is negative and significant in affecting the trade balance, which is consistent with the theory, whereas the foreign income's coefficient has been found to be negative and significant. This reveals that, unlike in the long run, foreign income in the short-run impacts negatively Nigeria's forest products trade balance. This result contradicts the findings by Umoru and

Eboreime (2013), who found that foreign income in the short run has a positive impact on Nigeria's oil sector trade balance. However, the result is similar to the one obtained by Baek (2007), who conducted research on US-Canada forest products trade and discovered that foreign income has a negative relationship with the U.S.'s trade balance of forest products. This study was similar to the findings of Sulaiman and Abdul-Rahim (2014) in the case of Thailand's trade of forest products. Regarding the coefficient of exchange rate, it indicates that there exists a significant negative relationship between Nigeria's forest products trade balance and the exchange rate in the short run. This means that any attempt to depreciate Nigeria's currency (naira) in order to improve the forest products trade balance may lead to its deterioration in the short run. The result concords with the findings of Kyophilavong *et al.* (2013), who investigated the existence of a J-curve in the case of Laos. Their findings reveal that the exchange rate has a strong negative impact on trade balance in the short run. The error correction term has a negative value, which is less than one in absolute terms and is significant at the 1% level. This conforms to the earlier expectation and confirms the earlier cointegration relationship found among the variables in the model. More so, it shows that the speed at which the disequilibrium will be corrected in the system annually is 34.5%. The goodness fit of the short-run model could also be seen in the R-sqaured's value (51%), F-statistics (8.19***) and DW-statistics (1.9568). All of these parameters proved that the short-run model is a good fit and could produce efficient estimates.

Table 6 The estimated short run coefficients obtained from error correction model based on ARDL (1, 0, 0, 1) selected based on Schwarz Bayesian Criterion

	Dependent variable: $\Delta lnTB_t$	
Regressors	Coefficients	T-ratio [*p*-value]
ΔlnY^{NIG}	-1.0008***	-4.4508 [0.000]
ΔlnY^{W}	-12.173*	-2.0080 [0.053]
$\Delta lnEX$	-0.4732**	-2.3555 [0.025]
Constant	-167.643***	-3.4173 [0.002]
ECT(-1)	-0.3457***	-3.5940 [0.001]
R-sqaured	0.5140	
Adjusted R-squared	0.4357	
F-stat.	8.1994***[0.000]	
DW-statistics	1.9568	
AIC	-27.7525	
SBC	-32.5852	

Notes: ***, ** and * denote level of significance at 1%, 5% and 10%, respectively. Parentheses are the *p-values*.

J-curve Effect Test Results

To test for the J-curve existence, it is required that the sign of the first coefficient of the current lag of exchange rate variable to be negative and significant in the short run. While the subsequent lag of the exchange rate to be positive and significant. However, if this condition is met, then the J-curve can be said to exist in this case. In the case of this study (Table 7), the sign of the current lag of the exchange rate is negative and significant, which is consistent with the initial requirement for the J-curve's existence. The subsequent lag is positive and insignificant. Though the subsequent lag is insignificant, we could say that there exists weak evidence of the J-curve phenomenon. But on a general note, the J-curve effect does not fully exist in the case of Nigeria's trading in forest products. The finding is in agreement with the results reported by Baek (2007) on the U.S.-Canada forest products trade, Umoru and Eboreime (2013) on Nigeria's oil trade with the rest of the world and Sulaiman and Abdul-Rahim (2014) on Thailand's trade in forest products. This indicates that Nigeria's currency devaluation will worsen forest product trade balance significantly in the short run, and later, the positive recovery will have an insignificant impact on the trade balance.

Table 7 The J-curve effect's test

Trade balance	ΔEX_t	ΔEX_{t-1}	ΔEX_{t-2}	ΔEX_{t-3}	ΔEX_{t-4}	ECT_{t-1}
Coefficients	-0.5866*	0.3671	-0.2151	-0.3108	-0.1353	-1.068***
[p-value]	[0.094]	[0.936]	[0.560]	[0.390]	[0.667]	[0.000]

Notes: ***, ** and * denote level of significance at 1%, 5% and 10%, respectively. Parentheses are the *p-values*.

Diagnostic Test Results

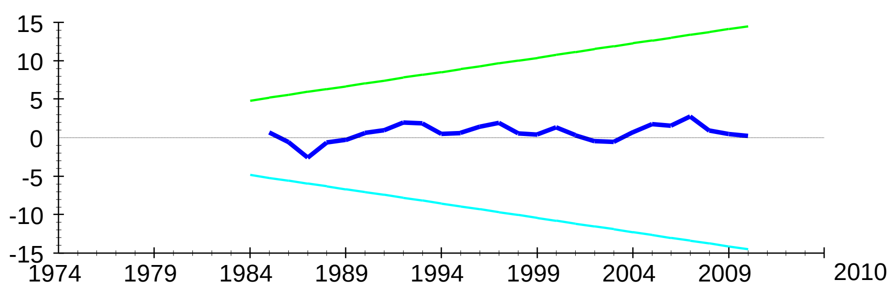
The results of the diagnostic tests have shown that the model has passed all of the tests for serial correlation, functional form, normality and heteroscedasticity (Table 8). The null hypotheses of all four diagnostic tests mentioned earlier are no autocorrelation, no functional form problem, normally distributed and homoscedastic, respectively. Both the LM version and F-version test probabilities reveal insignificance for all tests. This means that we could fail to reject all of the null hypotheses. The results proved the model to have met the classical linear regression assumptions.

Table 8 Diagnostic tests results

Diagnostic Tests				
Test Statistics	LM Version	Test stat.	F Version	F-stat.
Serial Correlation	*CHSQ(1)*	0.0101 [0.920]	F(1, 30)	0.0082 [0.928]
Functional Form	*CHSQ(1)*	0.0993 [0.753]	F(1, 30)	0.0807 [0.778]
Normality	*CHSQ(2)*	3.4896 [0.175]	NA	NA
Heteroscedasticity	*CHSQ(1)*	1.4262 [0.232]	F(1, 35)	1.4032 [0.244]

Notes: ***, ** and * denote level of significance at 1%, 5% and 10%, respectively. Parentheses are the *p-values*.

The plot of the cumulative sum of recursive residuals (Figure 2) and the plot of the cumulative sum of squares of recursive residuals (Figure 3) are used to determine the stability of the model along the sample periods. Both of the figures have indicated that the model is stable along the sample observations, as the blue line lies in between the two critical bounds at the 5% level of significance.



The straight lines represent critical bounds at 5% significance level

Figure 2 Plot of Cumulative Sum of Recursive Residuals

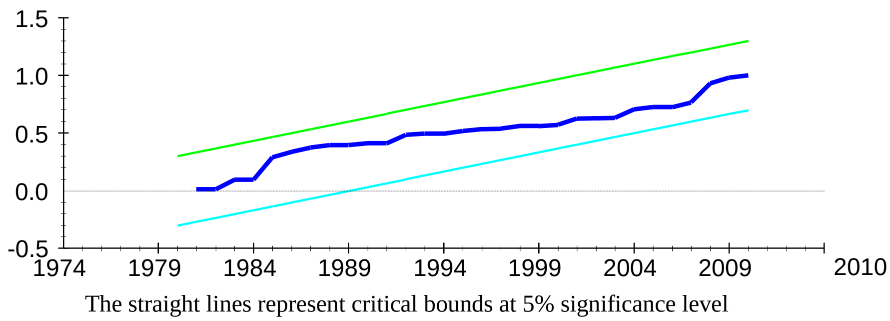


Figure 3 Plot of Cumulative Sum of Squares of Recursive Residuals

Variance Decompositions Results

In order to assess how much of the predicted error variance for any variable in the system is described by innovations in each explanatory variables over the periods of time, the study employed a variance decompositions approach (Table 9). Normally, own series' shocks describe a major portion of the error variance, even though the shock also has an effect on other variables in the system. Taking 10 periods (time horizon), the results (see Table 9) demonstrated that Nigeria's forest products trade balance is explained by domestic income (37.64%), world income (15.73%) and exchange rate (8.17%), whereas the rest (38.45%) is explained by its own innovative shock. The results show that the amount of forecast variance of balance of trade determined by innovation in exchange rate (*lnEX*) is meagre when compared to the percentages explained by innovations in other variables. Right from period one to period 10, the percentage of forecast variance of forest product trade balance explained by innovations in domestic income (lnY^{NIG}) and world income (lnY^{W}) have been on the increase significantly, and the increase in the percentage explained by innovation in exchange rate (*lnEX*) is insignificant. This substantiates our earlier findings that trade balance is significantly explained by domestic income and world income, while exchange rate has an insignificant role in determining variation in trade balance in the long run.

Further results reveal that the contribution of innovations in trade balance, world income and exchange rate to explain the variation in domestic income is 34.94%, 17.98% and 0.43% in ten years' time, respectively, while the rest is determined by own innovations. Furthermore, the contribution of innovations in trade balance, domestic income and exchange rate to determine changes in world income is 0.94%, 9.7% and 3.9%, respectively, whereas the remaining percentage (85.39%) is influenced by its own innovations. Lastly, the contribution of innovations in trade balance, domestic income and world income to explain variation in exchange rate is 19.40%, 20.4% and 2.72% respectively. The rest is determined by its own innovations.

Table 9 The estimate of Variance decompositions approach

Percentage of forecast variance explained by innovations in:				
Period	*lnTB*	*ln*Y^{NIG}	*ln*Y^{W}	*lnEX*
(i) Variance Decompositions of lnTB				
1	100.0000	0.000000	0.000000	0.000000
2	94.33300	4.328547	1.217166	0.121291
3	88.34383	10.89979	0.667533	0.088847
4	76.78412	20.69352	2.029408	0.492960
5	64.10978	27.41737	7.017347	1.455507
6	53.07324	31.88015	11.57062	3.475983
7	45.89680	34.35332	14.29615	5.453736
8	41.55823	36.05154	15.33842	7.051817
9	39.41377	37.04515	15.66890	7.872173
10	38.45040	37.64285	15.73474	8.172007
(ii) Variance Decompositions of lnY^{NIG}				
1	15.99125	84.00875	0.000000	0.000000
2	23.90200	74.01814	1.866447	0.213414
3	26.41437	63.19462	10.18651	0.204499
4	32.13840	53.32807	14.04663	0.486893
5	36.06105	48.84797	14.45645	0.634535
6	38.56819	46.56675	14.14695	0.718107
7	38.60782	46.24374	14.46297	0.685476
8	37.58910	46.25733	15.55383	0.599738
9	36.13202	46.47859	16.88379	0.505609
10	34.94292	46.63410	17.98338	0.439598
(iii) Variance Decompositions of lnY^{W}				
1	0.023149	6.190953	93.78590	0.000000
2	0.060881	12.90816	86.64686	0.384105
3	0.588946	16.41463	82.70696	0.289464
4	0.812555	16.96837	81.63197	0.587109
5	0.723276	15.64719	82.57905	1.050487
6	0.853859	13.49315	84.03377	1.619221
7	1.056390	11.64997	84.98937	2.304271
8	1.096811	10.59131	85.28097	3.030903
9	1.025066	10.05444	85.31956	3.600927
10	0.942880	9.749563	85.39553	3.912025
(iv) Variance Decompositions of lnEX				
1	0.673913	8.146335	0.316259	90.86349
2	2.637236	9.043278	2.191192	86.12829
3	5.825938	11.58429	1.567133	81.02264
4	9.831701	13.68957	1.123353	75.35538
5	13.16797	15.51641	1.049437	70.26618
6	15.93015	16.74060	1.319372	66.00988
7	17.77248	17.74600	1.690491	62.79103
8	18.87696	18.67481	2.044708	60.40352
9	19.32602	19.60030	2.380856	58.69283
10	19.40680	20.42520	2.728691	57.43931

Generalized Impulse Response Results

As earlier stated, one of the aims of this study is to determine how the series responds when there occurs a shock in other variables beyond the selected period. To accomplish this task, the study adopted a generalized impulse response function method using vector autoregressive (VAR) to analyse the response of a variable to a shock in another variable. This method (generalized impulse response function) has been developed by Pesaran and Shin (1998) to provide an alternative method for analyzing shocks and response among the variables. The method has been chosen owing to its advantages over other methods such as Cholesty factorization. For example, it does not require the ordering of variables, as it is insensitive to that. This is because the ordering is determined by the VAR system. Unlike the Cholesky method, which is highly sensitive to the ordering of the variables in a VAR, the results of the generalized impulse response (Figure 4) revealed that forest products trade balance responds significantly to shocks in domestic income from year 1 up to year 10 in a negative way. This result reiterates our earlier finding that domestic income significantly influences the trade balance negatively. It is also in accordance with the Keynesian view of income-trade balance relationship, which postulates an increase in the domestic income increased demand for import and hence deteriorates the trade balance. Also, the trade balance responds positively and significantly to shocks in the world income from year 2 to year 3 and subsequently starts dying down to the negative direction in the subsequent years. It indicates that, after 3 years, the earlier positive impact of the world income found by this study may become a negative impact in subsequent years. Finally, trade balance responses to shock in the exchange rate is insignificant from year 1 to year 3, as it is around zero; thereafter, it will start responding positively. This also reaffirms our earlier finding that the exchange rate has an insignificant impact on the trade balance in the long run.

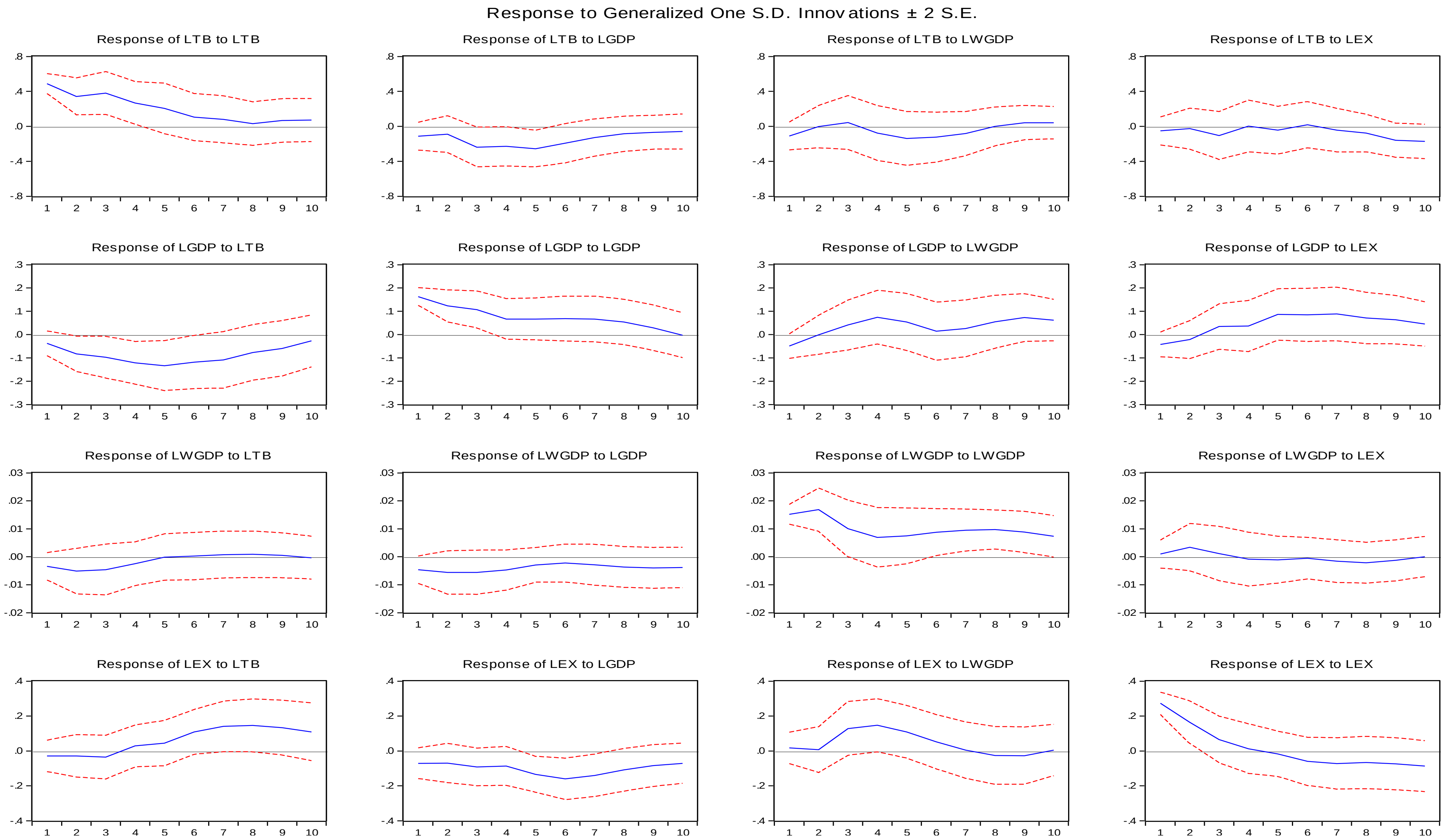


Figure 4 Generalized impulse Response functions

CONCLUSION

The general conclusion that could be made from this study is that Nigeria's forest products trade balance is significantly determined by domestic income and world income in the long run. While in the short run, the trade balance is significantly influenced by domestic income, world income and exchange rate. However, the relationship between exchange rate and trade is negative in this case, which means that any attempt to devaluate Nigeria's naira (currency) to improve the trade balance may have deteriorating effects in the short run. Although we found a negative impact of the exchange rate on trade balance in the short run, the existence of the J-curve effect could not be established, as the conditions for its existence could not be satisfied. This may not be unconnected with the frequent intervention by the government through the central bank of Nigeria (CBN) to control and regulate the exchange rate over the years. For example, Nigeria's exchange rate arrangements have evolved from a fixed regime in the 1960s to a system of a pegged regime in the 1970s to 1980s and to the many different floating exchange rate regimes in 1986, coupled with the introduction of structural adjustment program; i.e., SAP (Dada and Oyeranti, 2012). The failure of the different flexible exchange rate regimes led to the introduction of Dutch auction system (DAS) in July 2002 to achieve three targets, among which is achieving a realistic exchange rate for naira. All of these interventions may have accounted for the theoretical inconsistency of our findings related to the J-curve effect existence. Both the variance decomposition and generalized impulse response revealed that the exchange rate has little impact on Nigeria's forest product trade balance.

Nonetheless, one of the limitations to this study is that aggregate data have been employed. While applying aggregated data, much information about the trading countries may not be provided. For example, it may be possible while a country's currency is depreciated against some countries, it could be still higher against others. In this scenario, the direction of the trade balance may be weakened or destabilized. Future researches are needed to assess the J-curve effect using disaggregate or bilateral data, if any.

Finally, for Nigeria to improve its forest products trade balance, it may have to adopt policies that are income or growth related. This is because of the significant role of income variables in influencing changes in the trade balance revealed by this study.

Policy Implication and Recommendation

The policy implication of this study could be deduced from the behaviour of all the trade balance determinants towards influencing changes in Nigeria's forest products trade balance, both in the short run and long run. For instance, exchange rate exhibits a negative and significant impact on trade balance in the short run and is still negative but insignificant in the long run. This means that the adoption of policies such as devaluation, as suggested by the J-curve hypothesis to improve country's trade balance, will not yield good results on Nigeria's forest products trade balance. Devaluation of Nigeria's naira (currency) will lead to significant deterioration of the country's forest products trade balance in the short run. While in the long run, the policy will have an insignificant impact on the trade balance. In contrast, the domestic and foreign income yielded a significant negative and positive impact on trade balance in the long run, respectively, whilst in the short run, both the incomes revealed a significant negative impact. This demonstrates that policies on income could better be used in correcting trade balance deficit.

Lastly, to make policy recommendations, we suggest that policy makers should concentrate on growth-driven policies to boost forest product trade balance in the case of Nigeria. As it has been empirically tested, these variables (income variables) could significantly influence the trade balance. Hence, correction of any difficulty in Nigeria's forest products trade balance should be carried out through policies on income or growth.

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