Jibrilla Aliyu & Mohammed Tijjani, *Cogent Economics & Finance* (2015), 3: 1045213
http://dx.doi.org/10.1080/23322039.2015.1045213

cogent economics & finance

GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

Asymmetric cointegration between exchange rate and trade balance in Nigeria

Alhaji Jibrilla Aliyu[1]* and Shehu Mohammed Tijjani[2]

Received: 23 October 2014
Accepted: 14 April 2015
Published: 13 May 2015

*Corresponding author: Alhaji Jibrilla Aliyu, Faculty of Arts, Social and Management Sciences, Department of Economics, Adamawa State University, PMB 25, Mubi, Adamawa, Nigeria
E-mail: aliyumaiha@gmail.com

Reviewing editor:
Caroline Elliott, Huddersfield University, UK

Additional information is available at the end of the article

Abstract: This paper empirically examines the long-run pass through of the official exchange rates into trade balance in Nigeria by means of threshold cointegration and asymmetric error correction modeling. The study provides evidence for non-linear cointegration between our variables of interest. The estimated asymmetric error correction models provide new evidence for slower transmission of exchange rate depreciations into the country's trade balance, which in turn appears to offer partial support for the Dutch disease hypothesis. This finding suggests that policy-makers cannot hope to use currency devaluation to improve the trade balance. It is recommended that policy-makers focus attention on diversification of the economy away from dependence on crude oil exports into productive manufacturing and non-oil exports, which will be vital in making the economy more competitive.

Subjects: Economics and Development; Finance; Sustainable Development

Keywords: exchange rate; trade balance; Dutch disease hypothesis; threshold autoregression; asymmetric adjustment; causality autoregressive; causality

JEL classifications: F4; F410; C220

1. Introduction

The interrelationships between exchange rates and trade balance have been extensively studied by international and financial economists. Trade balance, usually interpreted as the difference between

Alhaji Jibrilla Aliyu

ABOUT THE AUTHOR

Alhaji Jibrilla Aliyu is an academic staff in the Department of Economics, Adamawa State University, Mubi, Nigeria. Currently, he is a doctorate candidate in the Department of Economics at the University Putra Malaysia, and is being trained academically in international and ecological economics. His research areas of interest include monetary economics and institutional factors that influence sustainable development.

PUBLIC INTEREST STATEMENT

Exchange rate changes are considered vital in shaping a country's competitiveness in the global economy. In particular, one of the basic propositions of trade theory is that devaluation of domestic currency will restrain imports and stimulates exports, which is expected to lead to improvement in the trade balance. However, taking the case of a developing country such as Nigeria that heavily depends on oil exports, devaluation may not necessarily lead to improvement in the country's trade balance. This study, using threshold cointegration and asymmetric error correction models provides evidence that justify this argument. Thus, the paper challenges the current production structure of the Nigerian economy, and calls on policy-makers to device right choices that can minimize the country's overdependence on natural resources, particularly oil. Policies that will ensure productive human and physical capital are particularly desirable to make the economy more competitive.

exports and imports, reacts to changes in exchange rate. This is consistent with trade-oriented model suggested by Dornbusch and Fischer (1980) which postulates that the volume of a nation's trade balance and its competitiveness in the international market can be influenced by exchange rate fluctuations. This however has a consequential effect on the real performance of an economy (Zhao, 2010). The academic debates on the exchange rate pass through have also recently received considerable attention. This academic discussion has far-reaching implications on the nation's trade balance (Campa & Goldberg, 2005).

International economic theory has predicted that devaluation of domestic currency may have a positive effect on economic progress of a nation through a decrease in the relative price of domestically produced goods (see, for instance, Alexander, 1952). This may have a favourable effect on a country's trade balance, provided that the so-called Marshall–Learner condition holds.[1] The ability of a fall in the exchange rate to contain a balance of trade deficit, would, however, depend on the structure of a country's production, which in turn may significantly influence the adjustment process and the exchange rates pass through into trade balance.

A low exchange rate pass through means that the domestic currency devaluation may lead to lower expansionary effect on the domestic production. As a consequence, the country's exports may fall short of increasing international demand that may follow decrease in the relative price of domestically produced substitutes. For example, Guittian (1976) and Dornbusch (1988) in Kandil, Berument, and Dincer (2007) have noted that, although, exchange rate devaluation may likely increase the international competitiveness of the domestic economy and consequently improve the trade balance, its success in achieving this goal would depend on the ability of the home economy to meet up with the surge in demand for domestically produced goods that will follow the devaluation. Of particular concern is the potential effect exchange rate devaluation may have on a trade account balance of a small open economy like Nigeria that heavily depends on oil exports.

The transmission of exchange rates in Nigeria to the trade balance partly hinges on the extent to which the country's production structure respond to changes in the value of the domestic currency. If the equilibrium balance of trade is to be maintained, the changes in the exchange rate should completely *pass through* to trade balance with relatively minimum time lag. However, considering the historical marginal performance of the non-oil sectors of the Nigerian economy since the discovery of the crude oil in the early 70s (Atsegbua, 2012; Babatunde, 2015; Berry, 1984; Igue & Ogunleye, 2014; Jibrilla, 2010), changes in the exchange rate may not be completely passed through to trade balance.

To understand why the pass through of the exchange rates into the country's trade balance may not be complete, suppose, for example, that in response to a fall in the international oil prices, Nigeria devalued Naira (Nigerian currency) to maintain an equilibrium balance of payments. The expectation being that the positive effect of such devaluation will counteract the negative influence of falling international oil prices. However, such an expectation could not be met, first, because Nigeria is a member of the Organisation of Petroleum Exporting Countries (OPEC), it cannot increase its production level due to quota and, second, as already pointed out, the overdependence of the country on the oil exports, which relegated the performance of other sectors (Jibrilla, 2010) could not guarantee equilibrium between domestic supply of output and the surge in demand for such output that follows exchange rate devaluation. Thus, it seems safe to argue that the pass through from the exchange rates to the international trade balance in the country may be incomplete within a relatively short period.

The average monthly data on official exchange rates and trade balance of Nigeria can be seen from Figures 1 and 2, respectively. It seems that these variables on average do not show similar trends. The fact that these data did not follow a similar trend appears to suggest that exposure of

Figure 1. Official US dollar - Nigerian naira exchange rates, January 1999–December, 2013.

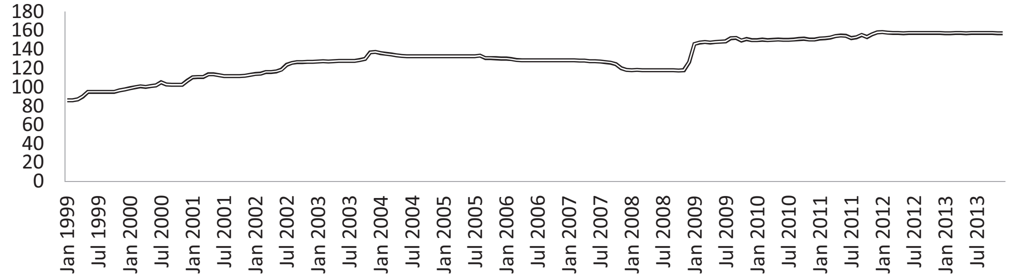
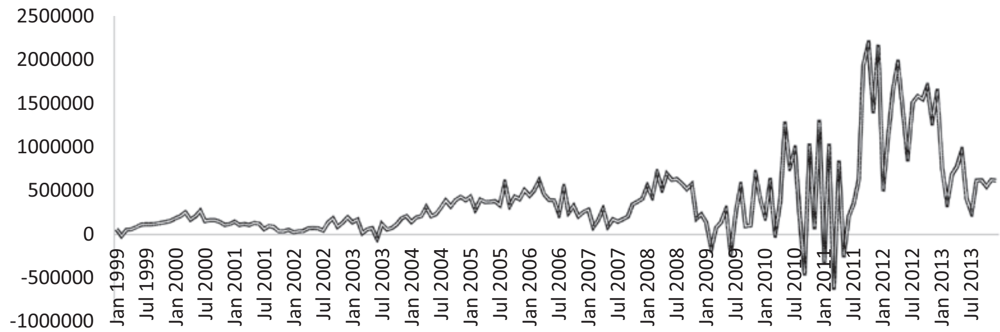


Figure 2. Trade balance in domestic currency, January 1999–December, 2013.

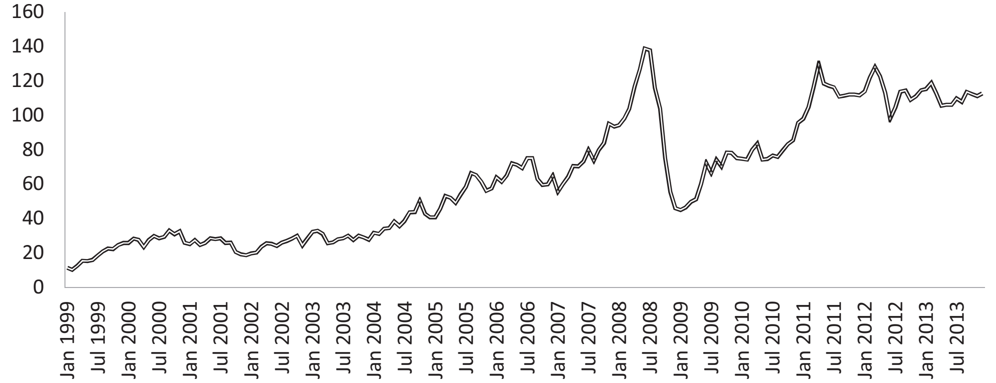


the trade balance to exchange rate changes could not be the same over appreciations and depreciations cycles. This also tended to indicate that the exchange rate pass through could not be complete over the cycles.[2]

Although, it is often assumed in the literature that the adjustment process between changes in exchange rate and a nation's trade account balance follow the same speed, it has been observed that the pass through of exchange rate changes could be incomplete due to possible inelasticities of import and export prices (see Bahmani-Oskooee & Ratha, 2004). This observation may have important implication for a resource-dependent economy like Nigeria.

Perhaps the most notable consequence of overdependence on crude oil exports is the negative influence it may have on the import-competing commodities. Because of the country's relatively less diversified production structure and alternative substitutes for imports (Banjoko, Iwuji, & Bagshaw, 2012), the speed at which the trade balance adjusts to exchange rate changes towards the long-run equilibrium can vary. For example, the over dependence of the country on oil exports implies that non-oil sectors plays less significant role in the country's trade balance,[3] as such the adjustment process of trade balance due to devaluation of the domestic currency that might follow falling oil prices may differ from

Figure 3. Crude oil price in US dollars, January 1999–December, 2013.



when there is currency appreciation, perhaps, for example, following rising oil prices and hence the improvement of revenue from oil exports (compare, for example, the trends of Figures 2 and 3).

This asymmetric behaviour in trade balance–exchange rates nexus is particularly possible if imports are rigid downwards and import substitutes are rigid upwards following exchange rate changes. To explain, given the meagre contribution of the non-oil sector to the total exports in Nigeria, trade imbalance may adjust downward slower (trade deficit may improve slowly), since imports could not be easily substituted, while the currency devaluation could already have a negative effect on the oil revenue. In contrast, an exchange rate appreciation, which could also have a positive effect on the oil revenues, may lead to faster upward adjustment of the trade imbalance (faster improvement of the imbalance). In this case, a currency depreciation may have a negative impact on the current account balance and also the Marshall–Learner condition may not hold since the "deterioration" of a country's current account will have a negative effect on its international reserve holding (see e.g. Chao, Chen, Hu, Huang, & Wang, 2014; Ito, 2009). As such, a non-symmetric pass through of exchange rates is hypothesized.

Besides, it is a well-established fact that financial and macroeconomic variables tend to exhibit asymmetric behaviour across the business cycles (Enders & Granger, 1998; Tsai, Lee, & Chiang, 2012). For example, an emerging body of economic studies found evidence of asymmetric adjustments in many macroeconomic relationships (see e.g. Chen, Finney, & Lai, 2005; Enders & Chumrusphonlert, 2004; Ibrahim & Chancharoenchai, 2014; Payne & Waters, 2008) among others. The recent evidences (Bussiere, 2013; Duasa, 2009 among others) on the asymmetric adjustment of international trade variables due to changes in exchange rate provide additional reasons to examine the possible asymmetric adjustment of the trade balance to exchange rate changes.

This article, therefore, aims to add to the literature by empirically re-examining the exchange rate pass through in Nigeria, particularly on the adjustment of the trade balance in response to changes in the exchange rates. Specifically, this article examines whether the trade balance adjust in the same speed for both exchange rate devaluations and appreciations as commonly assumed or the adjustment process when there are devaluations differ from when there are appreciations.

While elsewhere few studies have empirically examined the asymmetric relationship between exchange rates and trade volumes—for example, Shimizu and Sato (2015) for Japan, Hasanov (2013) for Azerbaijan as well as between exchange rates and trade balance—for example, Duasa (2009) for the case of Malaysia among others—yet, this issue remains largely unexplained in the Nigerian context.

The key contributions of this research to the existing monetary policy transmission mechanism literature are twofold. First, evaluating the behaviour of the trade balance in response to changes in the exchange rate, and whether the Marshall–Lerner conditions hold strengthens the contributions of this study to the country's macroeconomic sustainability. This is particularly important for policy-makers considering that the economy is heavily dependent on crude oil exports as the main source of foreign exchange (see e.g. Adedeji, 2001; Atsegbua, 2012; Berry, 1984).

Second, as noted by Enders and Granger (1998) and Tsai et al. (2012) among others, financial and macroeconomic variables display asymmetric adjustment paths. Following Enders and Siklos (2001), our work is modelled to evaluate the possible asymmetric behaviour of exchange rate pass through into trade balance in the context of adjustment process using the threshold autoregression (TAR) and/or momentum threshold autoregression (MTAR). This is an essential departure from previous models as our extension implies that the behaviour of equilibrium trade balance especially in resource-rich country may not be determined entirely by the behaviour of changes in exchange rate policies. We believe that the findings from this study will have valuable implication for policy-makers in the country, particularly from the perspective of the increasing competitiveness of the economy so as to benefit more from the country's integration into the global economy and employment generation, respectively.

The rest of the paper is organized as follows: the Section 2 discusses the theoretical motivation and related literature; Section 3 reviews the relevant empirical literature; Section 4 describes the data and methodology; Section 5 presents and discusses the empirical findings and; finally, Section 6 concludes.

2. Theoretical motivation and related literature

The theoretical relation between trade balance and exchange rate can be viewed from the perspective of "elasticity approach or the model of imperfect substitutes" (that is, imported goods and the domestic competing ones are imperfect substitutes), which is based on the Marshall–Learner condition (see Boyd, Caporale, & Smith, 2001; Gopalan, Malik, & Reinert, 2013; Shieh, 2009). The Marshall–Lerner condition suggests that the effect of domestic currency devaluation on the improvement of the trade balance is contingent on the ability of the domestic production or output to outweigh the cost of imported intermediate inputs. This argument is consistent with the premise that a fall in domestic exchange rate makes domestically produced goods more competitive in the international market. Because exchange rate devaluation tends to make the cost of imports to be highly relative to the domestic outputs (see e.g. Alexander, 1952; Bahmani-Oskooee, 2001; Bhattarai & Armah, 2005), increase in competitiveness will likely reduce imports and stimulate exports (see e.g. Sugema, 2005).

Although, exchange rate depreciations appear to have a profound effect on addressing balance of payments problems, it has been warned that its relative merits in achieving this goal would depend on the nation's capacity to competitively meet up with any change in demand for domestically produced goods (getting, 1976 & Dornbusch, 1988; in Kandil et al., 2007). Perhaps the most dramatic example in connection with the view that exchange rate depreciation does not guarantee a country to gain favourable balance of trade is the case of resource-dependent economies. For example, as argued by Auty (2001), an analogy to the Dutch disease hypothesis, overdependence on primary product exports tends to delay industrialization, which in effect could weaken the international competitiveness of the economy.

The Dutch disease hypothesis suggests that economies with ample natural resources have a tendency of experiencing low performance in their manufacturing and service sectors through crowding out and real exchange rate appreciations, or may likely experience what is often referred to as "de-industrialization" and slow economic performance compared to those with scarce natural resources (Drelichman, 2005; Gylfason, 1984; Gylfason & Zoega, 2003; Sachs & Warner, 2001; Smith, 2014; Stijns, 2003; Van der Ploeg, 2011). A possible explanation for deindustrialization in resource-dependent countries is that a boom in resource exports will likely create disincentives in the manufacturing sector, perhaps by discouraging entrepreneurship (see Berry, 1984; Van der Ploeg, 2011).

This argument (though is out of the scope of the present study) seems suggestive of the role of natural resource boom in hampering the acquisition of entrepreneurial skill. It is therefore not surprising that, since the discovery of crude oil in the early 1970s, the Small and Medium Scale Enterprises (SMES) in Nigeria are being persistently faced with low labour and managerial skills (see e.g. Ayanda & Laraba, 2011; Osotimehin, Jegede, Akinlabi, & Olajide, 2012). Van der Ploeg (2011), for example, observed that oil boom has significantly discourage entrepreneurship, particularly in the oil-dependent economies, which Sala-i-Martin and Subramanian (2013) among others have described as the manifestation of institutional failure.

It is therefore not surprising that SMES in the country, which are vital for export-led growth (see Zhang, Sarker, & Sarker, 2008), remain undeveloped (see Jibrilla, 2013) and many Nigerians being trapped in subsistence agriculture and few unskilled jobs in the oil industry (see Ross, 2003;

Sala-i-Martin & Subramanian, 2013). The scenario, described above, tended to question the ability of domestic currency devaluation to improve the trade balance or the possibility of fulfilling the Marshall–Learner conditions. This issue may sound even more reasonable by recognizing that overdependence on a primary product exports might have little effect on a country's trade balance in the face of exchange rate devaluation (see Kandil et al., 2007). Within this scenario, it seems safe to argue that the adjustment process of trade balance following currency devaluation may vary from when there is currency appreciation. However, formal verification of this hypothesis requires an empirical investigation.

3. Empirical literature review

It has been observed that many of the previous studies that investigated the impact of changes in exchange rate on trade balance have assumed linear adjustment of the trade balance in response to changes in the terms of trade. For example, results from studies by Bahmani-Oskooee (2001), Liew, Lim, and Hussain (2003), Onafowora (2003) and Singh (2002) found linear and positive relationships between trade balance and the real exchange rate. More recently, Kennedy (2013) and Yuen-Ling, Har, and Tan (2009) also found similar evidence. Although, Wilson and Tat (2001) could not establish robust effect of exchange rate in the case of bilateral trade balance between Singapore and the USA, all these studies, however, suggested conventional linear relationships between the terms of trade and trade balance.

A common assumption of these studies is that the relationship between exchange rate and trade balance is linear. This assumption is based on using standard linear econometric modelling as well as the standard unit roots and cointegration analysis. Enders and Siklos (2001) however note that such assumption may be misleading since it tends to result in model misspecification if the actual relations are non-linear. In fact, researchers have recognized that key macroeconomic variables tend to exhibit uneven (non-linear) adjustment through business cycles.[4] Because of this, it is possible to allow for non-linear relationship between trade balance and exchange rates.

Notwithstanding, the significant contribution of the previous findings, their assumption of a linear relationship between the two variables may fail to appropriately identify the actual comovement between them. In fact, asymmetries have been found in the impact of exchange rate appreciations and depreciations in terms of trade (see e.g. Bussiere, 2013; Frankel, Parsley, & Wei, 2012; Pollard & Coughlin, 2004 among others). This also meant that the volume of trade and hence trade balance could respond asymmetrically to exchange rate depreciations and appreciations. As a result, there are recent efforts that examined the possible asymmetries in the impact of exchange rate changes on both international trade volumes (see e.g. Hasanov, 2013) and its balance (Duasa, 2009).

In an attempt to examine how non-oil exports respond to real exchange rate changes in Azerbaijan, Hasanov (2013) used Enders and Siklos (2001)'s TAR and M-TAR cointegration analysis. His results show evidence of symmetric cointegration between non-oil exports and real exchange rates in the country. A related study by Duasa (2009) has also examined the possible non-linear relationship between trade balance and real exchange rates using similar methodology, and found evidence of asymmetric cointegration and error correction mechanism between the trade balance and real exchange rates in Malaysia.

Although, there have been studies that examined the exchange rate–trade balance nexus in Nigeria (recent examples, include Igue & Ogunleye, 2014; Iyoboyi & Muftau, 2014; Ogundipe, Ojeaga, & Ogundipe, 2013 among others), they did not depart from assuming a linear relationship between the variables. However, as noted above, such assumption may lead to wrong policy prescription if the trade balance reacts asymmetrically over exchange rate appreciations–depreciation cycles.

Given the situation described above, one wonders how the trade balance has been reacting to exchange rate changes in Nigeria. The subsequent sections of this study are designed to address this issue.

4. Data, models and methodology

4.1. The data

We used monthly data on Nigerian foreign trade balance and official exchange rates. All the monthly data are obtained from the official websites of the Nigerian National Bureau of Statistics (NBS).[5] Available data for the study were between the periods of June 1999–April 2012. The choice of the sample period is dictated by the considerations of (i) the period when the Nigerian foreign exchange market was liberalized, particularly following the introduction of an inter-bank foreign exchange market (IFEM) in 1999[6] and (ii) data availability.

4.2. The models and methodology

The degree of pass through in the long run between the exchange rate and the trade balance is examined by estimating the following bivariate relationship (see e.g. Bahmani-Oskooee & Alse, 1994).

$$LTB_t = \theta_0 + \theta_1 LEX_t + \varepsilon_t \tag{1}$$

where *LTB* is the natural log of the trade balance (taken as the ratio to total foreign trade), while *LEX* represents a natural log of the official exchange rate. θ_0 is the intercept and θ_1 is the slope coefficient that explains the relationship between exchange rate and foreign trade balance. ε_t is the stochastic disturbance term that may be serially correlated (Enders & Siklos, 2001). This stochastic term represents any deviation from the long-run equilibrium between *LTB* and *LEX* variables,[7] that is, $LTB_t - (\theta_0 + \theta_1 LEX_t)$. Sustainability of any international trade deficit requires that the two variables be cointegrated.

Before testing for cointegration on the variables, we follow the conventional practice, by first testing for stability in the individual series using Augmented Dickey–Fuller (ADF) unit root tests. If the variables are found to be non-stationary at their level and, have to be transformed d times before they become stationary, they are said to be I(d) series.[8] In this case, Engle and Granger (1987) showed that the variables can only be cointegrated in the long run when they are integrated of the same order.

Since the prime objective of this study is to test for the possible existence of a non-linear relation between our variables of interest, we follow the methodologies proposed by Enders and Siklos (2001) which was based on the Engle and Granger (1987) two-step cointegration technique. Using a two-stage procedure, the first stage involves estimating the long-run regression (for Equation 1) using conventional ordinary least squares (OLS); the second stage involves running a stationarity test on the residual from the estimated OLS as follows:

$$\Delta\hat{\varepsilon}_t = \rho\hat{\varepsilon}_{t-1} + \sum_{i=1}^{p} \lambda_i \Delta\hat{\varepsilon}_{t-j} + v_t \tag{2}$$

where v_t is assumed to be independently and identically distributed with zero mean and a constant variance. The null hypothesis of no cointegration is specified as $\rho = 0$. Rejecting this null hypothesis implies stationarity of the residuals sequence, $\hat{\varepsilon}_t$. In this case, we can conclude that long-run cointegration relationships exist between exchange rate and trade balance variables. However, cointegration between these variables can only be considered correctly specified if the adjustment process exhibit symmetric behaviour. If the adjustment to any deviation of the variables from equilibrium is asymmetric, Enders and Siklos (2001) proposed an alternative specification, which is an extended version of Eagle and Granger cointegration test in the form of threshold autoregression (TAR) model based on Tong (1990). This model requires incorporation of Heaviside indicator function that partitions lagged sequence of residual in Equation 1 as

$$\Delta\hat{\varepsilon}_t = I_t\rho_1\hat{\varepsilon}_{t-1} + (1 - I_t)\rho_2\hat{\varepsilon}_{t-1} + v_t \quad (3)$$

where I_t is the Heaviside indicator function. To account for possible serial correlation problems in the residuals and its dynamic adjustment towards long-run equilibrium value, Equation 3 can be written in an augmented *p*th-order process as

$$\Delta\hat{\varepsilon}_t = I_t\rho_1\hat{\varepsilon}_{t-1} + (1 - I_t)\rho_2\hat{\varepsilon}_{t-1} + \sum_{i=1}^{p-1}\lambda_i\hat{\varepsilon}_{t-i} + v_t \quad (4)$$

where I_t as specified in Equation 3 is the Heaviside indicator function that can be denoted as

$$I_t = \begin{cases} 1 & \text{if} \quad \hat{\varepsilon}_{t-1} \leq \tau \\ 0 & \text{if} \quad \hat{\varepsilon}_{t-1} < \tau \end{cases} \quad (5)$$

The stationarity condition of the sequence, $\hat{\varepsilon}$, is satisfied when $-2 < (\rho_1, \rho_2) < 0$. If the deviation of $\hat{\varepsilon}_{t-1}$ is above the threshold, the adjustment is represented by $\rho_1\hat{\varepsilon}_{t-1}$, while the adjustment for the deviation of $\hat{\varepsilon}_{t-1}$ below threshold is denoted by $\rho_2\hat{\varepsilon}_{t-1}$. These adjustments are represented by dummy values: for deviation above threshold, the indicator function will take the value one (1), while for deviation below threshold, it takes zero (0) value. Whether positive and negative divergences have different effects on the behaviour of exchange rate–trade balance nexus[9] could be determined by the estimated values of ρ_1 and ρ_2. For instance, if $|\rho_1| < |\rho_2|$, the adjustment is sluggish for deviation above threshold value.

Alternatively, if the speed of adjustment is characterized by more momentum or tend to be more persistent in one direction than the other, then the speed of adjustment can be allowed to depend on the changes of the sequence, $\hat{\varepsilon}_{t-1}$ so that Equation 5 becomes

$$I_t = \begin{cases} 1 & \text{if} \quad \Delta\hat{\varepsilon}_{t-1} \leq \tau \\ 0 & \text{if} \quad \Delta\hat{\varepsilon}_{t-1} < \tau \end{cases} \quad (6)$$

This specification is referred to as momentum threshold autoregression (M-TAR, Enders & Siklos, 2001). The Heaviside indicator variable in Equation 6 hinges on the previous disequilibrium of the sequence $\hat{\varepsilon}_{t-1}$. In the case of an adjustment that exhibit more persistence whenever the sequence, $\hat{\varepsilon}_{t-1} < 0$ in a TAR or M-TAR model, Chan (1993) showed that a super-consistent estimate of the threshold can be obtained by searching over all values of the lagged residuals sequence. This is to minimize the sum of squares errors (SSE) from the fitted threshold model(s). As in Enders and Chumrusphonlert (2004), we follow the standard procedure of using only 80% of the sample observations as potential thresholds.

The null hypothesis of no cointegration for both TAR and M-TAR models is specified as $\rho_1 = \rho_2 = 0$. The *F*-Statistics for this null hypothesis, as denoted by Φ_c in Enders and Siklos (2001) has non-standard distribution (whose critical values are found in Tables 1 and 2 of Enders and Siklos (2001) and, as stated earlier, the coefficients of ρ_1 and ρ_2 represent different speed of adjustments for the discrepancies from the long-run equilibrium exchange rate–trade balance nexus. If the null hypothesis is rejected, implying either of ρ_1 or ρ_2 is at least greater than zero, it is then possible to test for the presence of linear (symmetric) adjustment process. This can be done by setting the null hypothesis as $\rho_1 = \rho_2$ which can be tested using standard *F*-test (or Fisher test) statistic. However, if this null is rejected, one can conclude that the relationship between the variables is non-linear and the adjustment is asymmetric.

If an asymmetric cointegration relation is established, an asymmetric or non-linear error correction relation between the variables can be modelled to evaluate possible short-run and long-run dynamics between exchange rate and trade balance in Nigeria.

4.2.1. Asymmetric error correction models

Assuming weak exogeneity of the exchange rates to the trade balance, the estimates of their asymmetric error correction is modelled in the form of[10]

$$\Delta LTB_t = \delta_0 + I_t\rho_1 EC_{t-1} + (1 - I_t)\rho_2 EC_{t-1} + \sum_{i=1}^{p} \varpi_i \Delta LTB_{t-1} + \sum_{i-1}^{p} \gamma_i \Delta LEX_{t-1} + v_{1t} \quad (7)$$

where EC_{t-1} is the one-period lagged error term for the cointegrating model (1), represented as $LTB_{t-1} - \theta_0 - \theta_1 LEX_{t-1}$. As suggested by Enders and Siklos (2001), to evaluate the possible non-linearity in the transmission of trade balance, LTB_t in response to changes in the exchange rate, LEX_t, the following asymmetric threshold model can be estimated (see Chen et al., 2005).

$$\Delta LTB_t = \delta_0 \begin{cases} \lambda^+ + \sum_{i=1}^{p} \varpi_i \Delta LTB_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta LEX_{t-1} + v_{it} & \text{if} \quad LTB_{t-1} < \theta_0 + \theta_1 LEX_{t-1} \\ \lambda^- + \sum_{i=1}^{p} \varpi_i \Delta LTB_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta LEX_{t-1} + v_{it} & \text{if} \quad LTB_{t-1} < \theta_0 + \theta_1 LEX_{t-1} \end{cases} \quad (8)$$

where p is lag-length, LEX_t is the exchange rate, LTB_t is the trade balance, $\lambda^+ = I_t EC_{t-1}$ and $\lambda^- = (1 - I_t)EC_{t-1}$ are the error correction terms, ν_{1t} is the stochastic error which is assumed to be normally distributed with zero mean and constant variance. This specification allows different adjustment processes for trade balance in response to positive and negative deviations from equilibrium. The indicator λ^+ measures the speed of adjustment when the variables are above their equilibrium level, whereas λ^- measures the speed of adjustment when they are below their equilibrium level. A rise in the official exchange rate can lead to $LTB_t < \theta_0 + \theta_1 LEX_t$, with balance of trade being below its equilibrium level relative to exchange rate. Trade balance will adjust upward to trail exchange rate so as to correct balance of trade disequilibrium. A decline in exchange rate can lead to $LTB_t > \theta_0 + \theta_1 LEX_t$. In the case of trade balance is above its equilibrium level relative to exchange rate, trade balance will adjust downward, thus all things being equal, leading to gradual return to equilibrium level.

From Equations 7 or 8, adjustment to the long-run trade balance is determined by the parameters λ^+ and λ^- with the long-run symmetric null hypothesis, $\lambda^+ = \lambda^-$. The case for $\lambda^+ \neq \lambda^-$ indicates asymmetry in the long-run adjustment of trade balance. On the other hand, its short-run adjustments are captured by the parameters ϖ_i and γ_i for $i = 1, 2, ..., p$, which may come from its lagged dynamics or lagged effects of the official exchange rate. If the null hypothesis of $\gamma_i = 0$ is rejected, then causality runs from the exchange rate to trade balance. If $\lambda^+ > \lambda^-$ in absolute term, it means that trade balance adjust downward faster than upward, but the case of $|\lambda^+| < |\lambda^-|$ implies that trade balance adjust upward faster than downward.

From Equation 7, if the trade balance is above the threshold value following a decline in the exchange rate, it will then adjust by ρ_1. And if it is below the threshold value following an increase in the exchange rates, then the trade balance will adjust by ρ_2. For exchange rate exogeneity assumption to hold, non-linear ECM terms of the exchange rate need to be statistically significant. If they are statistically insignificant, it implies that the exchange rates do not respond to the disequilibrium error terms, which also suggests weak exogeneity of the exchange rate.

5. Empirical findings

Results from Table 1 show that the ADF test results could not reject the null hypothesis at level of the series, *LTB* and *LEX*. However, each of the differenced series is found to be stationarity at one per cent significance levels. These tests support the hypothesis that exchange rate and trade balance are both integrated of order one. This allows for cointegration analysis based on Engle and Granger's (1987) two-step methodology.

In what follows our analysis employed OLS to estimate the long-run relations between the variables of interest and the estimated results are presented as follows:

cogent • economics & finance

Table 1. ADF unit root tests for trade balance and exchange rates

Variables		LTB_t	ΔLTB_t	LEX_t	ΔLEX_t
		−2.65(3)	−12.40***(2)	−2.41(1)	−7.88***(1)
Critical values	1%	−3.47	−3.47	−3.47	−3.47
	5%	−2.88	−2.88	−2.88	−2.88
	10%	−2.58	−2.58	−2.58	−2.58

Notes: To allow for representation of alternative hypotheses, we include both a constant term and linear time trends in levels of the variables, while at their first difference, only a constant term is included. Numbers in parentheses are lag lengths used in the ADF test (as determined by HQC) to remove serial correlation in the residuals.

***Rejection of the null hypothesis at the 1% significant level.

Source: Own results.

$$LTB = 2.823 - .515LEX + \hat{\varepsilon}_t \quad (9)$$

(.109) (.530)

R^2 = .13, D.W. Stat. = 1.40, *P*-value = 0.000

The estimated intercept, which represents the intermediation margin of the official exchange rate, is 2.82%, whereas the estimated slope coefficient that measures the degrees of exchange rate pass through is 0.515. Since this slope coefficient estimate is significantly less than one, it is an indication that, pass through from the official exchange rate to the trade balance appears to be incomplete.

Table 2 reports the estimated results for Eagle–Granger (EG) cointegration, threshold and momentum adjustments. The EG cointegration was estimated using Equation 2, while Equations 4 and 5 are used to estimate TAR model and Equations 4 and 6 for the M-TAR model. The appropriate lags for the TAR and M-TAR adjustment processes were chosen by HQC. The EG test result rejects the null hypothesis of no cointegration at 1% significance level. This suggests the existence of long-run relationship between the official exchange rates and the trade balance in Nigeria. The point estimates for ρ_1 and ρ_2 of both TAR and M-TAR with zero threshold exhibit convergence and their estimates reject the null hypothesis of $\rho_1 = \rho_2 = 0$ at 5% significance levels. However, the null hypothesis of symmetric cointegration, $\rho_1 = \rho_2$, could not be rejected at all levels of significance. Thus, long-run cointegration fails when we assume asymmetric adjustment between the variables of interest.

Table 2. Estimated Eagle–Granger, TAR and MTAR cointegration tests

	(1)ADF	(2)TAR	(3)MTAR	(4)TAR-consistent	(5)MTAR-consistent
ρ_0^a	−2.61***(−2.58)	–	–	–	–
ρ_1^a	–	−.275 (−2.021)	−.369 (−2.770)	−.246 (−2.013)	−.274 (−2.543)
ρ_2^a	–	−.420 (−3.63)	−.359 (−3.01)	−.487 (−3.89)	−.566 (−3.94)
λ_1	–	−.490 (−4.74)	−.501 (−4.81)	−.467 (−4.48)	−.429 (−3.94)
λ_2	–	−.133 (−1.61)	−.135 (−1.64)	−.130 (−1.59)	−.118 (−1.43)
Φ_μ	–	7.213**	6.272**	8.118**	8.621**
$\rho_1 = \rho_2^s$	–	.895	.004	2.555	3.476**
τ	–	0	0	.164	−.205

Notes: Entries of Φ_μ represent the *F*-statistics that follows a non-standard distribution of the sample values for the null hypothesis $\rho_1 = \rho_2 = 0$. S Entries represent the sample *F*-statistics for the null hypothesis of symmetric adjustment $\rho_1 = \rho_2$ and, τ denotes threshold values.

[a]Entries in parentheses are the *t*-statistics for the null hypothesis of the ρ_i values.

**Level of significance level at 5%.

***Level of significance at 1%.

Source: Own results.

cogent • economics & finance

With regard to TAR- consistent ($\tau = -.614$), though, its point estimates for ρ_1 and ρ_2 are both negative, which suggest convergence and, its corresponding *F*-statistics reject the null hypothesis of no cointegration ($\rho_1 = \rho_2 = 0$) at five per cent level of significance, the hypothesis of symmetric of coefficients ($\rho_1 = \rho_2$) based on the standard Fisher test, which is approximately 3.0, cannot be rejected. This suggests no evidence for asymmetric adjustment.

However, based on Chan's (1993) method, a consistent momentum threshold value of −.205 is found with a strong evidence for M-TAR cointegration at 5% significance level. Notice that the *F*-statistics of $\Phi_\mu = 8.621$ is slightly greater than its corresponding simulated value of 8.230. Thus, the null hypothesis ($\rho_1 = \rho_2 = 0$) cannot be rejected, which allows for testing symmetry adjustment under the null hypothesis ($\rho_1 = \rho_2$) against the alternative of asymmetry ($\rho_1 \neq \rho_2$) that is clearly rejected based on the standard Fisher *F*-test. In addition, the point estimates of $\rho_1 = -.274$ and $\rho_2 = -.566$ are also established, which fulfil the condition for stationarity (i.e. convergence).

This point estimates suggest that the speed of adjustment is relatively sluggish for a decrease in the exchange rate and relatively faster for a rise in exchange rate relative to trade balance. This evidence of asymmetry in the MTAR model supports the hypothesis that the adjustment of the trade balance to any change in the exchange rate is not linear or symmetric.

The establishment of non-linear cointegration made it possible to evaluate the movement of the trade balance in response to exchange rate in the context of asymmetric error correction model shown in Table 3.

Estimates of the asymmetric error correction for trade balance and exchange rate models (that is, the trade balance dynamics) are reported in Table 3. The models were estimated using the general-to-specific procedure to trim all the insignificant explanatory variables. Based on the estimation results, both the conditional error correction (trade balance equation) and marginal error correction (exchange rate equation) are absent of serial correlation and serious misspecification in the estimated error correction results as dictated by diagnostic test involving Breusch–Godfrey serial correlation test. In addition, the variance of the conditional model also passed homoscedasticity test as expected. Concerning the error correction coefficients for the trade balance, both the coefficient of λ^+ and λ^- are statistically significant at one per cent significance levels, respectively. The balance of trade adjusts to positive deviation in the speed of approximately 42 and 111% to a negative deviation.

Table 3. Estimated asymmetric error correction models

	ΔLTB_t	ΔLEX_t
λ^+ coefficient	−.417*** (−4.476)	−.010 (−1.206)
λ^- coefficient	−1.117***(−4.146)	−.012 (−.439)
$\varpi_i = 0$	18.56ϖ1 [.000]	22.85 [.000]
$\gamma_i = 0$	12.46ϖ1 [0.00]	.45 [.501]
R^2	.50	.145
DW- statistic	2.13	1.88
Serial correlation LM test	5.00Sc [.082]	4.61 [.100]
Hetroskedasticity test	.420H [.517]	27.06 [.000]
F-statistics	36.93 [.000]	6.265 [.000]

Notes: ϖ1, Sc and H denote Wald, Breusch–Godfrey Chi-square values for serial correlation (set to a maximum of 2 lags as determined by HQC) and autoregressive conditional hetroskedasticity test values respectively. Figures in parentheses are *t*-statistics and numbers in curly brackets are probability values.

***Rejection of the null hypothesis at the 1% significance level.

Source: Own results.

The *F*-statistics indicate short-run bidirectional Granger—causality between the trade balance and the official exchange rate in Nigeria for the period under review. The statistical insignificance of the exchange rate asymmetric error correction coefficient suggests that official exchange rates are weakly exogenous to the trade balance. Moreover, the *t*-statistics for the error term in the conditional error correction equation shows that the response of trade balance, λ^{+}, to any decrease in the official exchange rate is slower in absolute term than the response of the trade balance (denoted by λ^{-}) to an increase in the official exchange rate, suggesting downward rigidity of the trade balance (that is, downwards rigidity of imports and upward rigidity of import substitutes). This could imply that considering the marginal contribution of the non-oil sectors of the Nigerian economy to the total exports, exchange rate devaluation could not restrain imports of non-oil products and possibly boost exports to meet up with the surge in demand for domestically produced goods due to relatively higher import prices, thus, domestic currency devaluation tends to have little positive effect on the country's balance of trade. The results seem to be consistent with the views put forth by getting (1976) and Dornbusch (1988) in Kandil et al. (2007). This further tended to suggest that the total national production which mainly constitutes a crude oil production could not be sufficient enough to timely offset any devaluation of the domestic currency.

Our evidence, which show asymmetric cointegration and non-linear adjustment of the trade balance to exchange rate changes appear to be consistent with that of Duasa (2009) who find similar results for Malaysia and provide evidence against Igue and Ogunleye (2014), Iyoboyi and Muftau (2014) and Ogundipe et al. (2013) among others who reported linear cointegration and symmetric adjustment of the trade balance to exchange rate changes in Nigeria. However, it is important to note that given the relatively short-sample size of our data calls into question the robustness of our results which suggest that they should to be interpreted with caution. Therefore, the rest of this article focuses on a number of robustness checks.

5.1. Robustness checks

In an attempt to assess the robustness of the results presented in Table 3, we relatively shorten and expand the sample size. We also controlled for crude oil prices to check for the robustness.[11] As reported in Table 4, the results of the re-estimated asymmetric error correction models (models 7) pass serial correlation and hetroscedasticity tests via Breusch–Godfrey serial correlation and autoregressive conditional hetroskedasticity tests.[12] Moreover, the significance of the *F* statistics indicates the suitability of the models.

As can be observed from Table 4, the magnitudes of these results appear to be very similar to those reported in Table 3. Specifically, as shown in the estimated models *a, b* and *c* of Table 4, the entireties of the lagged trade balance coefficients in all the equations are significantly negative at either 1 or 5% significance levels. Moreover, the exchange rates also appear to have negative and significant short-run effects on the trade balance. While the short-run influence of the crude oil prices (in model "*c*") appears to be positive and significant. The results also suggest that, in all equations, both the coefficients λ^{+} and λ^{-} are statistically significant and the error correction coefficients (88, 73 & 101%) appear to be larger for upward adjustments (similar to those reported in Table 3). Thus, the trade balance tends to adjust faster once there is exchange rate appreciation, which may, for example, follow a hike in crude oil prices.

It is important to note, however, that our results need to be interpreted with caution as our model specifications are not identical with that of Ogundipe et al. (2013), Igue and Ogunleye (2014) and Iyoboyi and Muftau (2014) among others (who reported linear relationships between exchange rates and trade balance) and the data-sets and their frequencies are also not the same. Notwithstanding, our robustness tests are suggestive of the asymmetric and non-linearity in the adjustment process of the trade balance–exchange rates nexus in Nigeria at least since the introduction of an IFEM in 1999.

cogent • economics & finance

Table 4. Estimated asymmetric error correction models

(a) Exchange rates and the trade balance dynamics (1999M01-2010M12)	
$\Delta LTB_t = \underset{(.557)}{.007} - \underset{(-5.526)}{.502}\lambda^{+a} - \underset{(-2.834)}{.881}\lambda^{-a} - \underset{(-2.290)}{.187}\Delta LTB^{b}_{t-1} - \underset{(-2.290)}{.379}\Delta LEX^{a}_{t-1}$	
$R^2 = 42$	LM = 1.193(.167)
F-statistics = 25.37(.000)	ARCH = .527(.468)
(b) Exchange rates and the trade balance dynamics (1999M01-2013M12)	
$\Delta LTB_t = \underset{(.279)}{.013} - \underset{(-3.837)}{.320}\lambda^{+a} - \underset{(-2.405)}{.733}\lambda^{-b} - \underset{(-5.327)}{.495}\Delta LTB^{a}_{t-1} - \underset{(-2.791)}{.257}\Delta LTB^{a}_{t-2} - \underset{(-2.713)}{.189}\Delta LTB^{a}_{t-3} - \underset{(-3.340)}{2.390}\Delta LEX^{a}_{t-1}$	
$R^2 = 49$	LM = .004(.947)
F-statistics = 26.85(.000)	ARCH = .373(.541)
(c) Exchange rates, oil prices and the trade balance dynamics (1999M01-2013M12)	
$\Delta LTB_t = \underset{(.813)}{.009} - \underset{(-3.672)}{.314}\lambda^{+a} - \underset{(-3.201)}{1.010}\lambda^{-a} - \underset{(-5.158)}{.484}\Delta LTB^{a}_{t-1} - \underset{(-2.992)}{.268}\Delta LTB^{a}_{t-2} - \underset{(-2.869)}{.198}\Delta LTB^{a}_{t-3} - \underset{(-2.821)}{1.99}\Delta LEX^{a}_{t-1} + \underset{(-1.840)}{.226}\Delta Lop^{c}_{t-1}$	
$R^2 = 50$	LM = .659(.417)
F-statistics = 24.35(.000)	ARCH = .197(.657)

Notes: $^{a, b}$ and ^{c} denote rejection of the null hypothesis at the 1, 5 and 10% significance levels. Figures in parentheses are *p*-values. LM and ARCH denote Breusch–Godfrey Chi-square values for serial correlation and autoregressive conditional hetroskedasticity test values respectively. Figures in parentheses are *t*-statistics and numbers in curly brackets are probability values.

Source: Own results.

This work contributes to the literature in the following ways. It explores a recent development in the time series literature in the examination of asymmetric cointegration between exchange rates and the trade balance. It specifically explores the implications of exchange rate changes in an economy that heavily depend on crude oil exports as the main source of both foreign exchange and earnings. The fundamental proposition that the adjustment process of the trade balance to changes in the exchange rate may not be linear appears to be strongly supported through the empirical results we presented in the present study. Note that the estimated asymmetric error correction coefficients in all the trade balance dynamic models (presented in Tables 3 and 4) show that the trade balance adjust slower in response to exchange rate depreciations than when the domestic currency is appreciated. This tended to cast some doubt on the ability of currency devaluation to maintain a positive current account and to the fulfilment of the Marshall–Leaner conditions.

Throughout this study, we assume that because of the Nigerian overdependence on the crude oil exports, exchange rate changes may not produce symmetric and/or timely adjustment of trade imbalance towards the long-run equilibrium. Clearly, the estimated asymmetric error correction models presented in Tables 3 and 4appear to justify these assumptions. A possible reason for our findings is that the majority of Nigerians could be trapped in low-skill or resource-based small-scale enterprises such as agriculture and other mineral exploitation activities (as observed, for example, by Ayanda & Laraba, 2011; Jibrilla, 2013; Osotimehin et al., 2012). This thus has a tendency of making them fail to advance their intellectual capability for good investments that can restrain imports and encourage exports, and that which can enhance their earning power.

Finally, the evidence provided by this study seems to serve as a reminder of the economic threats of recent falling crude oil prices on the Nigerian economy. In sum, exchange rate depreciations transmit slowly to the trade balance, whereas in contrast, the exchange rate appreciations tend to transmit quickly and/or immediately into the trade balance. In other words, with currency devaluation, imports tend to exhibit downward rigidity, whereas import substitutes appear to be rigid upwards.

6. Conclusions

This study focuses on the different approaches in evaluating adjustments of the trade balance in response to changes in exchange rates. We provide new evidence that the balance of trade responds asymmetrically to changes in official exchange rate in Nigeria in the form of downward rigidity. Moreover, this study also reveals a bidirectional causal relationship between the changes in exchange rates and trade balance for our sample period. The policy implication of this finding is that the downward rigidity of the trade balance suggests that currency devaluation as a policy tool is less effective as a means of improving the country's balance of trade, hence, resulting in incomplete pass through of the domestic currency devaluation in the long run.

Our findings appear to serve as a reminder that the recent falling crude oil prices do indicate a revenue threat to Nigeria. The findings also seem to serve as a confirmation of the arguments in the literature which suggest that overreliance on natural resource as the major component of national production hurts the international competitiveness of an economy (Auty, 2001; Smith, 2014; Van der Ploeg, 2011). In addition, our findings of asymmetric adjustment behaviour and downward rigidity of the trade balance in response to the domestic currency devaluation seems to offer partial support for the Dutch disease hypothesis. Therefore, policy-makers should not continue to be overly optimistic on total dependence on crude oil exports–rather, they should appreciate the need for economic policies directed towards the accumulation of productive human and physical capital, which eventually would help diversify the economy away from dependence on crude oil exports and into more productive manufacturing and other non-oil exports. Therefore, Nigerian authority and its community should not continue being overconfident of the natural resources, particularly oil. They should appreciate the need for effective expenditure on education.

Finally, the basic proposition of trade theory is that exchange rate changes lead to adjustment of the trade balance. Several studies have shown this to be the case. But taking the case of a developing country such as Nigeria, the prediction of trade theory that there is a symmetric relationship between exchange rate and trade balance such that a devaluation, for instance, is expected to lead to improvement in the trade balance may be far wide of the mark. This study, using threshold cointegration and asymmetric error correction models has shown that, for a developing country that solely depends on oil exports, devaluation may not necessarily lead to improvement in the trade balance. This conclusion may, however, not necessarily hold for all developing countries since there may be a great variation amongst them. Further research (within the context of non-linear modelling) is required, particularly in other resource-dependent and/ or oil-dependent economies to better understand exchange rates and trade balance dynamics.

Funding
The authors received no direct funding for this research.

Author details
Alhaji Jibrilla Aliyu[1]
E-mail: aliyumaiha@gmail.com
Shehu Mohammed Tijjani[2]
E-mail: mohammedconnectyou@gmail.com
[1] Faculty of Arts, Social and Management Sciences, Department of Economics, Adamawa State University, PMB 25, Mubi, Adamawa, Nigeria.
[2] Faculty of Social and Management Sciences, Department of Economics, Bayero University, P.M.B 3011, Kano, Nigeria.

Citation information
Cite this article as: Asymmetric cointegration between exchange rate and trade balance in Nigeria, Alhaji Jibrilla Aliyu & Shehu Mohammed Tijjani, *Cogent Economics & Finance* (2015), 3: 1045213.

Notes

1. See Section 2.
2. See Appendix A for figures of the data in logs.
3. See, for example, Igue and Ogunleye (2014).
4. See, for example, Ibrahim and Chancharoenchai (2014).
5. Retrieved on 25 June, 2014 from http://nigeria.prognoz.com/
6. See the online facts sheet of the central bank of Nigeria on the country's Foreign Exchange Market, available at: http://www.cenbank.org/IntOps/FXMarket.asp
7. See, Ibrahim (2011).
8. See, Engle and Granger (1987).
9. For more examples on this adjustment process, see for example, Enders and Granger (1998); Enders and Siklos (2001) among others.
10. To test for the validity of weak exogeneity of the exchange rate to the trade balance, non-linear ECM for the exchange rate is also estimated.
11. Data for crude oil prices was obtained from the official website of the central bank of Nigeria (CBN), available at: http://statistics.cbn.gov.ng/cbn-onlinestats/
12. See Appendices A, B, C, and D for unit roots, Engel-Granger cointegration, TAR and M-TAR cointegration tests, monthly log values of study variables, and descriptive statistics, respectively.

References

Adedeji, O. (2001). *The size and sustainability of the Nigerian current account deficits* (IMF Working Paper WP/01/87). Washington, DC: International Monetary Fund.

Alexander, S. S. (1952). Effects of a devaluation on a trade balance. *Staff Papers-International Monetary Fund, 2*, 263–278. http://dx.doi.org/10.2307/3866218

Atsegbua, L. A. (2012). The Nigerian oil and gas industry content development act 2010: An examination of its regulatory framework. *OPEC Energy Review, 36*, 479–494. http://dx.doi.org/10.1111/opec.2012.36.issue-4

Auty, R. M. (Ed.). (2001). *Resource abundance and economic development*. New York, NY: Oxford University Press.

Ayanda, A. M., & Laraba, A. S. (2011). Small and medium scale enterprises as a survival strategy for employment generation in Nigeria. *Journal of Sustainable Development, 4*, p. 200.

Babatunde, M. A. (2015). Oil price shocks and exchange rate in Nigeria. *International Journal of Energy Sector Management, 9*, 2–19.

Bahmani-Oskooee, M. (2001). Nominal and real effective exchange rates of middle eastern countries and their trade performance. *Applied Economics, 33*, 103–111. http://dx.doi.org/10.1080/00036840122490

Bahmani-Oskooee, M., & Alse, J. (1994). Short-run versus long-run effects of devaluation: Error-correction modeling and cointegration. *Eastern Economic Journal, 20*, 453–464.

Bahmani-Oskooee, M., & Ratha, A. (2004). The J-curve: A literature review. *Applied Economics, 36*, 1377–1398. http://dx.doi.org/10.1080/0003684042000201794

Banjoko, S. A., Iwuji, I. I., & Bagshaw, K. (2012). The performance of the Nigerian manufacturing sector: A 52-year analysis of growth and retrogression (1960–2012). *Journal of Asian Business Strategy, 2*, 177–191.

Berry, S. S. (1984). Oil and the disappearing peasantry: Accumulation, differentiation and underdevelopment in Western Nigeria. *African Economic History, VII*(13), 1–22. http://dx.doi.org/10.2307/3601477

Bhattarai, K. R., & Armah, M. K. (2005). *The effects of exchange rate on the trade balance in Ghana: Evidence from cointegration analysis*. Cottingham: Business School, University of Hull.

Boyd, D., Caporale, G. M., & Smith, R. (2001). Real exchange rate effects on the balance of trade: Cointegration and the Marshall–Lerner condition. *International Journal of Finance & Economics, 6*, 187–200.

Bussiere, M. (2013). Exchange rate pass-through to trade prices: The role of nonlinearities and asymmetries. *Oxford Bulletin of Economics and Statistics, 75*, 731–758. http://dx.doi.org/10.1111/obes.2013.75.issue-5

Campa, J. M., & Goldberg, L. S. (2005). Exchange rate pass-through into import prices. *Review of Economics and Statistics, 87*, 679–690. http://dx.doi.org/10.1162/003465305775098189

Chan, K. S. (1993). Consistency and limiting distribution of the least squares estimator of a threshold autoregressive model. *The Annals of Statistics, 21*, 520–533. http://dx.doi.org/10.1214/aos/1176349040

Chao, C. C., Chen, L. J., Hu, S. W., Huang, C. Y., & Wang, V. (2014). Stock prices, foreign reserves, and regime collapse. *Asia-Pacific Journal of Accounting & Economics, 21*, 207–225.

Chen, L. H., Finney, M., & Lai, K. S. (2005). A threshold cointegration analysis of asymmetric price transmission from crude oil to gasoline prices. *Economics Letters, 89*, 233–239. http://dx.doi.org/10.1016/j.econlet.2005.05.037

Dornbusch, R., & Fischer, S. (1980). Exchange rates and the current account. *The American Economic Review, 70*, 960–971.

Drelichman, M. (2005). The curse of Moctezuma: American silver and the Dutch disease. *Explorations in Economic History, 42*, 349–380. http://dx.doi.org/10.1016/j.eeh.2004.10.005

Duasa, J. (2009). *Asymmetric cointegration relationship between real exchange rate and trade variables: The case of Malaysia* (MPRA Paper No. 14535). Retrieved from http://mora.ub.uni-muenchen.de/14535/

Enders, W., & Chumrusphonlert, K. (2004). Threshold cointegration and purchasing power parity in the pacific nations. *Applied Economics, 36*, 889–896. http://dx.doi.org/10.1080/0003684042000233104

Enders, W., & Granger, C. W. J. (1998). Unit-root tests and asymmetric adjustment with an example using the term structure of interest rates. *Journal of Business & Economic Statistics, 16*, 304–311.

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

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica, 55*, 251–276. http://dx.doi.org/10.2307/1913236

Frankel, J., Parsley, D., & Wei, S. J. (2012). Slow pass-through around the world: A new import for developing countries? *Open Economies Review, 23*, 213–251. http://dx.doi.org/10.1007/s11079-011-9210-8

Gopalan, S., Malik, A. A., & Reinert, K. A. (2013). The imperfect substitutes model in South Asia Pakistan-India trade liberalization in the negative list. *South Asia Economic Journal, 14*, 211–230. http://dx.doi.org/10.1177/1391561413500170

Gylfason, T. (1984). Lessons from the Dutch disease: Causes, treatment, and cures. *Oxford Economic Papers, 36*, 359–380.

Gylfason, T., & Zoega, G. (2003). Inequality and growth: Do natural resources matter? (chapter 9). In T. S. Eicher & S. J. Turnovsky (Eds.), *Growth and inequality: Theory and policy implications* (pp. 255–292). Cambridge, MA: MIT Press.

Hasanov, F. (2013). The impact of real exchange rate on non-oil exports. Is there an asymmetric adjustment towards the equilibrium? *Actual Problems of Economics/Актуальні проблеми економіки, 6*, 487–502.

Ibrahim, M. H. (2011). Inflation hedging effectiveness of an emerging Asian market: The case of Malaysia. *International Journal of Economics and Business Research, 3*, 514–525. http://dx.doi.org/10.1504/IJEBR.2011.042315

Ibrahim, M. H., & Chancharoenchai, K. (2014). How inflationary are oil price hikes? A disaggregated look at Thailand using symmetric and asymmetric cointegration models. *Journal of the Asia Pacific Economy, 19*, 409–422. http://dx.doi.org/10.1080/13547860.2013.820470

Igue, N. N., & Ogunleye, T. S. (2014). Impact of real exchange rate on trade balance in Nigeria. *African Development Review, 26*, 347–358. http://dx.doi.org/10.1111/afdr.v26.2

Ito, H. (2009). US current account debate with Japan then, with China now. *Journal of Asian Economics, 20*, 294–313. http://dx.doi.org/10.1016/j.asieco.2009.02.006

Iyoboyi, M., & Muftau, O. (2014). Impact of exchange rate depreciation on the balance of payments: Empirical evidence from Nigeria. *Cogent Economics & Finance, 2*(1) 1–23.

Jibrilla, A. A. (2010). Savings and domestic investment in Nigeria: A causal relationship. *ADSU Journal of Social and Development Studies, 4*, 112–121.

Jibrilla, A. A. (2013). Impact of government interventions on small scale entreprises in Mubi North local government area, Adamawa state, Nigeria. *Journal of Economics and Sustainable Development, 4*, 121–128.

Kandil, M., Berument, H., & Dincer, N. N. (2007). The effects of exchange rate fluctuations on economic activity in Turkey. *Journal of Asian Economics, 18*, 466–489. http://dx.doi.org/10.1016/j.asieco.2006.12.015

Kennedy, O. (2013). Kenya's foreign trade balance: An empirical investigation. *European Scientific Journal, 9*, 176–189.

Liew, K. S., Lim, K. P., & Hussain, H. (2003). Exchange rate and trade balance relationship: The experience of ASEAN countries. *International Trade, 307003*, 1–11.

Ogundipe, A. A., Ojeaga, P., & Ogundipe, O. M. (2013). Estimating the long run effects of exchange rate devaluation on the trade balance of Nigeria. *European Scientific Journal, 9*, 233–249.

Onafowora, O. (2003). Exchange rate and trade balance in East Asia: Is there a J-curve. *Economics bulletin, 5*(18), 1–13.

Osotimehin, K. O., Jegede, C. A., Akinlabi, B. H., & Olajide, O. T. (2012). An evaluation of the challenges and prospects of micro and small scale enterprises development in Nigeria. *American International Journal of Contemporary Research, 2*, 174–185.

Payne, J. E., & Waters, G. A. (2008). Interest rate pass through and asymmetric adjustment: Evidence from the federal funds rate operating target period. *Applied Economics, 40*, 1355–1362. doi:10.1080/00036840600806233

Pollard, P. S., & Coughlin, C. C. (2004). *Size matters: Asymmetric exchange rate pass-through at the industry level* (Research Paper No. 2004/13). St. Louis, MO: University of Nottingham.

Ross, M. L. (2003). *Nigeria's oil sector and the poor* (Position Paper for DFID-Nigeria). Los Angeles, CA: UCLA.

Sachs, J. D., & Warner, A. M. (2001). The curse of natural resources. *European Economic Review, 45*, 827–838. http://dx.doi.org/10.1016/S0014-2921(01)00125-8

Sala-i-Martin, X., & Subramanian, A. (2013). Addressing the natural resource curse: An illustration from Nigeria. *Journal of African Economies, 22*, 570–615. http://dx.doi.org/10.1093/jae/ejs033

Shieh, Y. (2009). The tight money effect of devaluation: An alternative interpretation of contractionary devaluation. *Journal of Applied Business and Economics, 4*, 1–7.

Shimizu, J., & Sato, K. (2015). *Abenomics, yen depreciation, trade deficit and export competitiveness* (RIETI Discussion Papers Series No. 15-E-020). Tokyo: Research Institute of Economy, Trade & Industry.

Singh, T. (2002). India's trade balance: The role of income and exchange rates. *Journal of Policy Modeling, 24*, 437–452. http://dx.doi.org/10.1016/S0161-8938(02)00124-2

Smith, B. (2014). *Dutch disease and the oil and boom and bust* (No. 133). Oxford: Oxford Centre for the Analysis of Resource Rich Economies, University of Oxford.

Stijns, J. P. (2003). *An empirical test of the Dutch disease hypothesis using a gravity model of trade*. Retrieved from SSRN 403041: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=403041

Sugema, I. (2005). *The determinants of trade balance and adjustment to the crisis in Indonesia*. Adelaide: Centre for International Economic Studies, University of Adelaide.

Tong, H. (1990). *Non-linear time series: A dynamical system approach*. Oxford: Oxford University Press.

Tsai, I. C., Lee, C. F., & Chiang, M. C. (2012). The asymmetric wealth effect in the US housing and stock markets: Evidence from the threshold cointegration model. *The Journal of Real Estate Finance and Economics, 45*, 1005–1020. http://dx.doi.org/10.1007/s11146-011-9304-5

Van der Ploeg, F. (2011). Natural resources: Curse or blessing? *Journal of Economic Literature, 49*, 366–420. http://dx.doi.org/10.1257/jel.49.2.366

Wilson, P., & Tat, K. C. (2001). Exchange rates and the trade balance: The case of Singapore 1970 to 1996. *Journal of Asian Economics, 12*, 47–63. http://dx.doi.org/10.1016/S1049-0078(01)00072-0

Yuen-Ling, N., Har, W. M., & Tan, G. M. (2009). Real exchange rate and trade balance relationship: An empirical study on Malaysia. *International Journal of Business and Management, 3*, 130–137.

Zhang, M., Sarker, S., & Sarker, S. (2008). Unpacking the effect of IT capability on the performance of export-focused SMEs: A report from China. *Information Systems Journal, 18*, 357–380. http://dx.doi.org/10.1111/isj.2008.18.issue-4

Zhao, H. (2010). Dynamic relationship between exchange rate and stock price: Evidence from China. *Research in International Business and Finance, 24*, 103–112. http://dx.doi.org/10.1016/j.ribaf.2009.09.001

Appendix A

Table A1. The stationarity tests for trade balance and exchange rates (1999M01-2010M12)

Variables		LTB_t	ΔLTB_t	LEX_t	ΔLEX_t
		−3.13	−10.94***	−2.71	−7.84***
Critical values	1%	−4.02	−4.02	−4.02	−4.02
	5%	−3.44	−3.44	−3.44	−3.44
	10%	−3.15	−3.15	−3.15	−3.15

Notes: To allow for representation of alternative hypotheses, we include both a constant term and linear time trends in levels of the variables, while at their first difference, only a constant term is included. Numbers in parentheses are lag lengths used in the ADF test (as determined by HQC) to remove serial correlation in the residuals.

***Rejection of the null hypothesis at the 1% significant level.

Source: Own results.

Table A2. The stationarity tests for trade balance and exchange rates (1999M01-2013M12)

Variables		LTB_t	ΔLTB_t	LEX_t	ΔLEX_t	LOP	ΔLOP
		−3.20	−13.05***	−2.99	−8.90***	−2.88	−11.27***
Critical values	1%	−4.01	−4.01	−4.01	−4.01	−4.01	−4.01
	5%	−3.43	−3.43	−3.43	−3.43	−3.43	−3.43
	10%	−3.14	−3.14	−3.14	−3.14	−3.14	−3.14

Notes: To allow for representation of alternative hypotheses, we include both a constant term and linear time trends in levels of the variables, while at their first difference, only a constant term is included. Numbers in parentheses are lag lengths used in the ADF test (as determined by HQC) to remove serial correlation in the residuals.

***Rejection of the null hypothesis at the 1% significant level.

Source: Own results.

cogent • economics & finance

Appendix B

Table B1. Estimated Eagle–Granger, TAR and MTAR cointegration tests (1999M01-2010M12)

	(1) ADF	(2) TAR	(3) MTAR	(4) TAR-consistent	(5) MTAR-consistent
$\rho_0{}^a$	−2.61*** (−2.58)	–	–	–	–
$\rho_1{}^a$	–	−.202 (−1.49)	−.307 (−2.45)	−.210 (−1.92)	−.251 (−2.36)
$\rho_2{}^a$	–	−.441 (−3.54)	−.351 (−2.85)	−.661 (−4.89)	−.661 (−4.54)
λ_1	–	−.454 (−4.01)	−.481 (−4.20)	−.289 (−2.88)	−.289 (−2.79)
λ_2	–	−.326 (−3.18)	−.149 (−1.68)	−.197 (−2.47)	−.204 (−2.54)
Φ_μ	–	6.55**	5.49*	12.47**	11.44**
$\rho_1 = \rho_2{}^s$	–	2.02	.071	8.22**	6.37**
τ	–	0	0	−.185	−.172

Notes: Entries of Φ_μ represent the *F*-statistics that follows a non-standard distribution of the sample values for the null hypothesis $\rho_1 = \rho_2 = 0$. S Entries represent the sample *F*-statistics for the null hypothesis of symmetric adjustment $\rho_1 = \rho_2$and, τ denotes threshold values.

[a]Entries in parentheses are the *t*-statistics for the null hypothesis of the ρ_i values.

*Level of significance at 10%.

**Level of significance at 5%.

***Level of significance at 1%.

Source: Own results.

Table B2. Estimated Eagle–Granger, TAR and MTAR cointegration tests, excluding crude oil prices (1999M01-2013M12)

	(1) ADF	(2) TAR	(3) MTAR	(4) TAR-consistent	(5) MTAR-consistent
$\rho_0{}^a$	−3.31** (−2.88)	–	–	–	–
$\rho_1{}^a$	–	−.260 (−2.21)	−.375 (−3.22)	−.234 (−2.40)	−.959 (−3.64)
$\rho_2{}^a$	–	−.431 (−4.35)	−.355 (−3.46)	−.572 (−4.86)	−.344 (−4.18)
λ_1	–	−.446 (−4.97)	−.466 (−5.10)	−.385 (−4.13)	−.419 (−4.68)
λ_2	–	−.107 (−1.46)	−.112 (−1.53)	−.089 (−1.23)	−.072 (−.977)
Φ_μ	–	10.42**	9.58**	12.40**	12.71**
$\rho_1 = \rho_2{}^s$	–	1.53	.020	6.05**	5.66**
τ	–	0	0	−.214	.162

Notes: Entries of Φ_μ represent the *F*-statistics that follows a non-standard distribution of the sample values for the null hypothesis $\rho_1 = \rho_2 = 0$. S Entries represent the sample *F*-statistics for the null hypothesis of symmetric adjustment $\rho_1 = \rho_2$and, τ denotes threshold values.

[a]Entries in parentheses are the *t*-statistics for the null hypothesis of the ρ_i values.

*Level of significance at 10%.

**Level of significance at 5%.

***Level of significance at 1%.

Source: Own results.

Table B3. Estimated Eagle–Granger, TAR and MTAR cointegration tests, including crude oil prices (1999M01-2013M12)

	(1) ADF	(2) TAR	(3) MTAR	(4) TAR-consistent	(5) MTAR-consistent
$\rho_0{}^a$	−3.28 (−2.88)	–	–	–	–
$\rho_1{}^a$	–	−.254 (−2.14)	−.367 (−3.03)	−.247 (−2.42)	−.997 (−3.39)
$\rho_2{}^a$	–	−.467 (−4.54)	−.387 (−3.73)	−.564 (−4.84)	−.375 (−4.43)
λ_1	–	−.443 (−4.87)	−.464 (−5.06)	−.404 (−4.34)	−.409 (−4.41)
λ_2	–	−.116 (−1.59)	−.121 (−1.66)	−.104 (−1.44)	−.083 (−1.12)
Φ_μ	–	11.07**	9.79**	12.74**	12.45**
$\rho_1 = \rho_2{}^s$	–	2.32	.021	5.32**	4.12**
τ	–	0	0	−.193	.167

Notes: Entries of Φ_μ represent the *F*-statistics that follows a non-standard distribution of the sample values for the null hypothesis $\rho_1 = \rho_2 = 0$. S Entries represent the sample *F*-statistics for the null hypothesis of symmetric adjustment $\rho_1 = \rho_2$and, τ denotes threshold values.

[a]Entries in parentheses are the *t*-statistics for the null hypothesis of the ρ_i values.

*Level of significance at 10%.

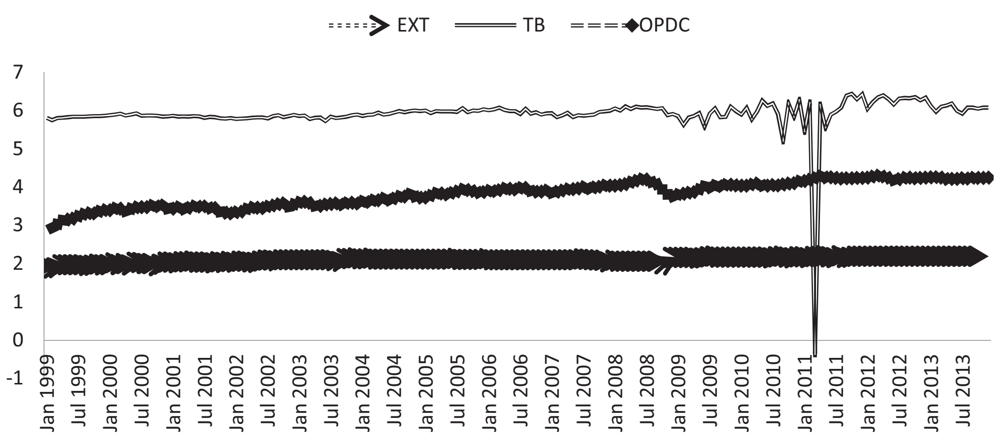
**Level of significance at 5%.

***Level of significance at 1%.

Source: Own results.

Appendix C

Figure C1. Monthly log values of study variables.



Appendix D

Table D1. Descriptive statistics: Monthly time series -1999M01-2013M12

	Mean	**Minimum**	**Maximum**	**Standard deviation**	**Observation**
LTB	12.48	8.75	14.59	1.03	172
LEX	4.86	4.45	5.07	.152	172
LOP*	3.56	2.32	4.93	.622	172

Notes: Both the *LTB* and *LEX* are as defined in Section 4, while, LOP is the log of crude oil price in US dollars (used as control variable).