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The Real Exchange Rate, the Ghanaian Trade Balance, and the J-curve

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Abstract

Using linear and nonlinear specifications, we studied the effects of real exchange rate changes on the trade balance of Ghana during the period 1986Q1 to 2016Q3. We found no evidence in support of the short- and long-run impact of exchange rate changes on the trade balance in the linear specification. The J-curve is refuted in this case. In contrast, exchange rate changes affected the trade balance in the nonlinear specification. Depreciations improve the trade balance in the long run, but appreciations have no impact. Hence, exchange rate changes have nonlinear effects on the trade balance. This is consistent with the J-curve phenomenon.

Keywords: Trade balance; J-curve; real exchange rates; nonlinearities; Ghana.

JEL Classification: F31; F32; C22.

1. Introduction

In this paper, we examine the effects of real exchange rate changes on the trade balance of Ghana for the period 1986Q1 to 2016Q3. This is critical because prior knowledge of the exchange rate–trade balance relationship will enable policymakers to pursue better exchange rate policies during periods of trade imbalances. Despite the relevance of such information, few studies have explored how real exchange rate changes influence the trade balance in the African context, and the Ghanaian context in particular.[1] While studying this issue, Schaling and Kabundi (2014), for example, found that real depreciation enhances the South Africa–US trade balance in the long run, thereby supporting a J-curve exchange rate–trade balance relationship. Similarly, Bahmani-Oskooee and Hosny (2013) examined the relationship between currency devaluation and the trade balance of Egypt and the European Union (EU). They found devaluation to improve the trade balance in 39 out of 59 sectors traded between the two economies. Edwards and Lawrence (2008), using a panel of data for 44 manufacturing industries for the period 1990 to 2002, found real depreciations to be associated with the improvement of the South African trade balance, especially for non-commodity manufacturers, while Bhattarai and Armah (2005) found the short-run elasticities of imports and exports to suggest the contractionary effects of devaluation. However, these

[1] Instead of exchange rate changes, it is possible to examine how exchange rate volatility affects the trade balance. A study doing this is Musila and Al-Zyoud (2012), who found a statistically significant and negative correlation between the volatility in exchange rates and the volume of trade in sub-Saharan African countries.

elasticities added up to almost one in the long-run estimates, meaning that devaluations may only enhance the trade balance in the long run in Ghana.

The main limitation of these studies is that they are based largely on linear specifications. However, the relationship between the trade balance and the real exchange rate may be nonlinear. For example, Bahmani-Oskooee and Fariditavana (2016) argue that the trade balance may adjust to equilibrium in a nonlinear pattern. Engel and West (2005) note that while exchange rates are good predictors of economic fundamentals, the reverse is not true. A similar argument is put forward by Meese and Rogoff (1983), and Della Corte et al. (2009), who found a simple random walk model to predict exchange rates better than models with economic fundamentals. In a recent study, however, Li et al. (2015) found that under a kitchen-sink regression with the elastic-net shrinkage method, economic fundamentals can predict exchange rates. These arguments suggest that a linear model cannot adequately capture the complex relationship between exchange rates and economic fundamentals including the trade balance. Therefore, in order to arrive at a more convincing conclusion, it is important to compare the results of linear specifications of the trade balance model with their nonlinear counterparts.

Taking the limited number of studies in the African context into account and the notion that the relationship could be nonlinear, we re-examined the exchange rate–trade balance relationship using both linear and nonlinear ARDL specifications by focusing on Ghana. The nonlinear ARDL model is a model recently developed by Shin et al. (2014). Unlike the linear ARDL model developed by Pesaran et al. (2001), the nonlinear ARDL model accounts for nonlinearities in the movements of variables. It also contemporaneously performs well in small samples, is applicable to mixed order integrated variables, and deals effectively with pre-testing bias. We focus on Ghana for two main reasons. First, apart from that of Bhattarai and Armah (2005), to the best of our knowledge no study on the real exchange rate–trade balance relationship has been conducted. Second, Ghana has experienced episodes of real depreciations (undervaluations), appreciations (overvaluations) and trade imbalances. From 1957 to 1982, the country practised a fixed exchange regime, which led to an overvalued cedi, deteriorating economic performance, excessive import of finished goods, and balance-of-payment crisis (see Baffoe-Bonnie, 2004; Bhattarai and Armah, 2005). To realign the exchange rate, the country undertook a series of devaluation exercises between 1983 and 1986 under the Economic Recovery Programme (Baffoe-Bonnie, 2004; Alagidede and Ibrahim, 2017). From 1986 onwards, the country has gradually shifted from a fixed exchange regime to a managed-float regime (see Bhattarai and Armah, 2005). Therefore, the country provides a suitable case study to re-examine the exchange rate–trade balance relationship.

Theoretically speaking, the real exchange rate is very important in economic activities for at least two reasons. First, changes in the real exchange rate (real appreciation and depreciation) have a strong influence on the direction of trade (i.e. exports and imports). If a country's real exchange rate experiences depreciation, other factors unchanged, her goods and services become cheaper relative to those of her trade partners. Therefore, the country should experience a surge in its exports (see Sekkat and Varoudakis, 2000). In contrast, if the real exchange rate appreciates, then the country's goods and services become expensive, leading to a surge in her imports (Salehi-Isfahani, 1989). Second, an unstable real exchange rate creates uncertainty, which may produce undesirable consequences.[2] Generally, investors will

[2] Caballero and Corbo (1989) and Chowdhury (1993) have found that increases in real exchange rate uncertainty have significant negative impact on exports.

be less motivated to invest in an economy with high exchange rate uncertainty (see Servén, 2003) – although Aizenman (1992) has shown that nominal exchange rate uncertainty is more likely to discourage investment than real uncertainty. Servén (2003) has shown that the impact of real exchange rate uncertainty on developing countries, in particular, depends on their degree of openness to trade. More open developing countries suffer more from real exchange rate uncertainty. Additionally, Bacchetta and Van Wincoop (2000) have found that the size of net capital flows is higher under a more stable exchange rate regime.

The clear importance of the real exchange rate in economic activities has led to extensive discussions regarding what form of exchange rate management is optimal for achieving and maintaining long-term growth. To this end, most economies have practised the various forms of exchange rate arrangements: fixed, managed-float, and flexible regimes. In recent times, most countries have adopted the managed-float regime, which permits their policymakers to intervene in the foreign exchange markets during periods of exchange rate uncertainty and trade imbalances. One such policy intervention for countries experiencing trade imbalances (in this case, deterioration in the trade balance) entails devaluing or depreciating the real exchange rate. However, will such a policy reverse the trade imbalances? Theoretically speaking, real devaluation or depreciation can overturn a deteriorating trade balance, but this will not occur immediately due to the adjustment lags in the underlying mechanism. Magee (1973) argues that due to production and delivery delays and recognition lags, among other factors, a devaluation or depreciation will not reverse a deteriorating trade balance in the short run. The trade balance will continue to deteriorate before improving in the long run. This behaviour of the trade balance in response to real depreciation or devaluation is known in the international finance literature as the J-curve (see Magee, 1973; Bahmani-Oskooee, 1985).

Some of the earliest formal verifications of the J-curve are those presented by Bahmani-Oskooee (1985) and Rose and Yellen (1989).[3] In his study, Bahmani-Oskooee (1985) found that the coefficients of the initial lags of the real exchange rate are negative, while the subsequent ones are positive, thus supporting the J-curve. Rose and Yellen (1989) argue that since the trade balance may only respond to real exchange rate changes in the future, a suitable approach for verifying the J-curve is cointegration testing and error correction modelling. This allows the short-run adjustment process of the trade balance to be captured. Using the US trade balance model with six of her trade partners and the error correction mechanism, Rose and Yellen (1989) found no support for the J-curve, suggesting that the trade balance does not respond to real depreciation of the US dollar. In a recent paper, Bahmani-Oskooee and Fariditavana (2016) argue that the adjustment process of the trade balance to equilibrium may be nonlinear. Hence, the linear approach used by previous studies may be inappropriate. They argue that the trade balance may respond to real appreciations and depreciations differently, so that if appreciations are filtered from depreciations, the support for the J-curve may become clearer. As evidence in support of this argument, Bahmani-Oskooee and Fariditavana (2016) find nonlinear specifications of the trade balance model to be more supportive of the J-curve than the linear specifications in a sample of US and her six major trade partners. They also found the real exchange rate changes in most cases to affect the trade balance nonlinearly. Our paper follows this recent revelation by using linear and nonlinear models to investigate the J-curve phenomenon.

[3] A survey of the literature has been provided by Bahmani-Oskooee and Hegerty (2010).

The rest of the paper is organised as follows. In the next section, we present our empirical methodology. In section 3 we present the empirical results, and the conclusion is offered in section 4.

2. Empirical Methodology

Although variant forms of the trade balance model exist in the literature (see, for example, Bhattarai and Armah, 2005; Schaling and Kabundi, 2014), we follow the seminal papers of Bahmani-Oskooee (1985) and Rose and Yellen (1989) in formulating a country's trade balance as a function of her real income, the real income of her trade partners, and their real exchange rate. In the case of Ghana, her trade balance model will take the following form:

$$lnTB_t = \alpha_0 + \alpha_1 lnY_t + \alpha_2 lnY_t^* + \alpha_3 lnREER_t + \mu_t, \tag{1}$$

where TB is Ghana's trade balance defined as her imports divided by her exports; Y denotes Ghana's real income, which is measured as her real GDP; Y^* denotes the US real income measured as US real GDP; $REER$ is the real effective exchange rate, of which an increase denotes real appreciation and a decrease real depreciation of the Ghana cedi; ln is the natural logarithm operator; α are the coefficients of the model; μ is the white-noise error term; and t denotes the time subscript.

An increase in the real income of Ghana is expected to have a positive impact on her trade balance. In contrast, an increase in the US real income is expected to have a negative impact on Ghana's trade balance. The reasons for this are that the propensity to import in Ghana will increase whenever her real income increases, and her exports will increase whenever her major trade partners experience positive real income growth. Also, real depreciation of the Ghana cedi is expected to improve the trade balance by enhancing exports and reducing imports.

In order to properly fit the trade balance model in Eq. (1), Rose and Yellen (1989) proposed capturing the short-run deterioration and the long-run improvement in the trade balance. These important dynamics, also known as the J-curve, underlie the observed pattern of the trade balance, following a depreciation or devaluation policy. According to Rose and Yellen (1989), error correction frameworks are the most suitable techniques for fitting the trade balance model. Although a number of previous studies have utilised the vector error correction model (VECM) when fitting the trade balance model for developing countries (see Bhattarai and Armah, 2005; Schaling and Kabundi, 2014), we utilised the ARDL framework developed by Pesaran et al. (2001). The approach performs well in small samples. Hence, it is the most suitable for our empirical analysis. Also, the approach does not require pre-testing of the integration properties of the variables. Hence, it avoids the pre-testing bias that the other approaches are prone to. The ARDL specification of Eq. (1) will be of the following form:

$$\Delta lnTB_t = \beta_0 + \sum_{i=1}^{q} \beta_{1i}\, \Delta lnTB_{t-i} + \sum_{i=0}^{q} \beta_{2i}\, \Delta lnY_{t-i} + \sum_{i=0}^{q} \beta_{3i}\, \Delta lnY_{t-i}^* + \sum_{i=0}^{q} \beta_{4i}\, \Delta lnREER_{t-i} + \delta_1 lnTB_{t-1} + \delta_2 lnY_{t-1} + \delta_3 lnY_{t-1}^* + \delta_4 lnREER_{t-1} + \epsilon_t, \tag{2}$$

where ϵ, β, and δ are the white-noise error term, the short-run and the long-run coefficients of the model, respectively; Δ is the first difference operator; and q is the maximum lag of the model. The short-run effects are the coefficients of the first-differenced variables, while the long-run effects are calculated by setting the non-first-differenced lagged component of Eq. (2) to zero and normalizing δ_2 to δ_4 on δ_1. The dynamics of the trade balance, following a depreciation or devaluation (i.e. the J-curve), is said to be valid if values of β_{4i} are initially negative and subsequently positive, while δ_4/δ_1 is positive and significant.[4] That is, if these conditions hold, then the J-curve exists in Ghana's trade balance. This means that short-run deterioration in the country's trade balance will be followed by long-run improvement, if the cedi is depreciated or devalued.

The reliability of the estimates of Eqs. (1) and (2) depends on the joint significance of the coefficients δ_1, δ_2, δ_3, and δ_4. That is, the variables in Eq. (2) should be cointegrated in order to ensure that the coefficients are efficiently estimated. We can verify the existence of cointegration by testing the hypothesis that $\delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$. Pesaran et al. (2001) derived two sets of critical values under this null hypothesis. The first set of critical values is derived by assuming that the variables in Eq. (2) are integrated of order zero, I(0), while the second set is derived by assuming that they are integrated of order one, I(1). We can reject the presence of cointegration if the calculated F-statistic is smaller than the first set of critical values. Similarly, we do not reject the presence of cointegration if the calculated F-statistic is larger than the second set of critical values. The test is inconclusive if the calculated F-statistic lies in between both sets of critical values.

The main limitation of the trade balance model in Eq. (2) is that it may fail to detect the nonlinear dynamics of the trade balance (see Bahmani-Oskooee and Fariditavana, 2016). That is, it may fail to identify any short-run deterioration and long-run improvement in the trade balance (i.e. the J-curve) if nonlinearities are present. This is because Eq. (2) assumes that the trade balance is linearly related to the real effective exchange rate. In reality, such an assumption may be flawed. It is known that the trade balance responds differently to real depreciations and appreciations. In their study, Bahmani-Oskooee and Fariditavana (2015) noted that real depreciations are more likely to influence the behaviour of the trade balance than real appreciations. Moreover, other studies have noted that the relationship between exchange rates and economic fundamentals is complex (see Engel and West, 2005; Li et al., 2015). Therefore, the relationship between the trade balance and the real effective exchange rate cannot be adequately captured by a linear specification. Eq. (2) may fail to capture this complex information. A more reliable way to fit the trade balance model is by using a nonlinear ARDL framework. Following the recent literature (see, for example, Delatte and Lopez-Villavicencio, 2012; Verheyen, 2013; Bahmani-Oskooee and Bahmani, 2015; Bahmani-Oskooee and Fariditavana, 2016), we formulate the nonlinear ARDL trade balance model by decomposing the real exchange rate into positive (appreciation) and negative (depreciation) partial sums as follows:

$$lnREER_t = lnREER_0 + lnREER_t^+ + lnREER_t^-, \quad (3)$$

where $lnREER_t^+$ and $lnREER_t^-$ are the partial sums of the positive and negative changes in $lnREER_t$, respectively. They are defined as follows:

[4] Note that the J-curve will still be supported even if the short-run coefficients are insignificant provided that the long-run coefficient is positive and significant (see Bahmani-Oskooee and Fariditavana, 2016, p. 53).

$$POS_t = lnREER_t^+ = \sum_{j=1}^{t} \Delta lnREER_j^+ = \sum_{j=1}^{t} \max(\Delta lnREER_j, 0)$$

$$NEG_t = lnREER_t^- = \sum_{j=1}^{t} \Delta lnREER_j^- = \sum_{j=1}^{t} \min(\Delta lnREER_j, 0) \tag{4}$$

Following Shin et al. (2014), we replace the real effective exchange rate, $lnREER_t$, in Eq. (2) with POS_t and NEG_t to obtain the following nonlinear ARDL trade balance model for Ghana:

$$\begin{aligned}\Delta lnTB_t = \gamma_0 &+ \sum_{i=1}^{q} \gamma_{1i}\,\Delta lnTB_{t-i} + \sum_{i=0}^{q} \gamma_{2i}\,\Delta lnY_{t-i} + \sum_{i=0}^{q} \gamma_{3i}\,\Delta lnY_{t-i}^{*} + \sum_{i=0}^{q} \gamma_{4i}\,\Delta POS_{t-i} \\ &+ \sum_{i=0}^{q} \gamma_{5i}\,\Delta NEG_{t-i} + \lambda_1 lnTB_{t-1} + \lambda_2 lnY_{t-1} + \lambda_3 lnY_{t-1}^{*} + \lambda_4 POS_{t-1} \\ &+ \lambda_5 NEG_{t-1} \\ &+ \varepsilon_t. \end{aligned} \tag{5}$$

where ε, γ, and λ are the white-noise error term and the short-run and the long-run coefficients of the model respectively, which are different from those in Eq. (2). The nonlinearity is introduced into the model through the partial sums POS and NEG. We can say that changes in the real effective exchange rate have linear effects on the trade balance if the coefficients of POS and NEG have the same sign and size. Otherwise, the effects are nonlinear or asymmetric. Similar to Eq. (2), the short-run effects are the coefficients of the first-differenced variables, while the long-run effects are calculated by setting the non-first-differenced lagged component of Eq. (5) to zero and normalizing λ_2 to λ_5 on λ_1. The J-curve is supported if the normalized coefficients λ_4/λ_1 and λ_5/λ_1 are positive and statistically significant.[5] Shin et al. (2014) have shown that the bounds testing procedure of Pesaran et al. (2001) is applicable in this case, meaning that we can verify the existence of cointegration by testing the hypothesis that $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$. In what follows, we report and discuss the empirical results obtained by taking these models to data.

3. Results

In this section, we report and discuss the empirical estimates of the specifications in Eqs. (2) and (5). But first, let us look at the data. The data is quarterly and covers the period 1986Q1 to 2016Q3. The time period was chosen based on data availability: data on Ghana's real GDP before the first quarter of 1986 is currently not available. We calculated the trade balance (TB) of Ghana as her imports of goods and services (M) divided by her exports of goods and services (X). Data for M and X are obtained from the Direction of Trade Statistics compiled by the IMF. This is in line with the recent literature (see Bahmani-Oskooee and Fariditavana, 2016). Although in their study Schaling and Kabundi (2014) used real exports and imports, the trade balance will not be affected because the consumer price index or the GDP deflator in the numerator and the denominator of the trade balance will have cancelled out. Real

[5] This is not a strict condition. If one of the coefficients is positive and significant, the J-curve is still supported.

income (Y) is the GDP at constant prices, taken from Ghana Statistical Service, various Ghana Budget Statements, and the Bank of Ghana's Quarterly Bulletins and Economic Reviews for the period 1990Q1 to 2016Q3.[6] We took data for the years 1986Q1 to 1989Q4 from Takumah and Iyke (2017). The US real income (Y^*) is the real GDP of the US, millions of chained 2009 dollars, taken from the Federal Reserve Economic Data (FRED).[7] The $REER$ is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs. We used real effective exchange rate index (2010 = 100) to measure $REER$. Data on this variable is taken from the IMF's International Financial Statistics (IFS). The descriptive statistics of the variables used in the paper are provided in Table 1.

Table 1: Descriptive Statistics of the Variables

Statistic	lnTB	lnY	lnY*	lnREER
Mean	0.423	9.348	13.080	2.062
Median	0.437	9.320	13.103	2.024
Maximum	1.277	9.714	13.223	2.458
Minimum	-0.510	8.911	12.891	1.798
Standard Deviation	0.383	0.198	0.101	0.131
Skewness	-0.135	0.338	-0.340	0.595
Kurtosis	2.335	2.097	1.704	3.072
Jarque-Bera	2.636	6.517	10.984	7.274
P-value	0.268	0.038	0.004	0.026
Sum	52.027	1149.823	1608.780	253.585
Sum of Squared Deviation	17.919	4.772	1.243	2.107
Observations	123	123	123	123

We avoided overfitting of the models by restricting the maximum lags to 4. We then utilized the Akaike information criterion (AIC) to choose the optimal lags. Tables 2 and 3 show the empirical estimates. Table 2 reports the short- and long-run estimates of the linear ARDL specification along with the diagnostic tests. Similarly, Table 3 reports the short- and long-run estimates of the nonlinear ARDL specification along with the diagnostic tests.

Now let us consider the linear trade balance model. Table 2 clearly shows that the real exchange rate has no significant short- and long-run impacts on the trade balance. The F-statistic, however, shows that the variables are cointegrated.[8] As mentioned earlier, an alternative way to assess the presence of cointegration is by normalizing the long-run coefficients in Eq. (2), calculating the error correction term (ECT), and testing its significance (see Bahmani-Oskooee and Fariditavana, 2015).[9] The estimated error correction term following this approach is negative and statistically significant, indicating the presence of cointegration. Further diagnostic tests, namely the LM, RESET, CUSUM, and CUSUMSQ

[6] These data are available at http://www.statsghana.gov.gh/gdp_new.html, http://www.mofep.gov.gh/budget-statements and https://www.bog.gov.gh/statistics/time-series-data.
[7] This can be obtained at https://fred.stlouisfed.org.
[8] The F-statistic is compared with Table CI(iii) Case III: Unrestricted intercept and no trend of Pesaran et al. (2001, p. 300) for three independent variables (i.e. k = 3).
[9] The t-statistic under the ECT is compared with the critical values developed by Banerjee et al. (1998, Table I).

tests[10] reported at the bottom of Table 2 suggest that there is structural stability, no serial correlation, and no functional misspecification in the linear trade balance model. This means that the results are correctly estimated. Clearly, using the linear trade balance model, we can conclude that the J-curve is not supported. Alternatively, the results imply that if Ghana is experiencing trade deterioration, a depreciation or devaluation policy will not help in the long run, since the trade balance does not respond to the real exchange rate.

Is it possible that we were unable to establish any links between the real exchange rate and the trade balance because we assumed them to be symmetrically related? As discussed in the earlier section, it is possible that there is a nonlinear relationship between real exchange rate and the trade balance, and so by assuming that they are related linearly, we discount important information. Bahmani-Oskooee and Fariditavana (2016), for example, found this to be the case. They found that the trade balance exhibits the J-curve within nonlinear settings rather than in linear settings. Therefore, we proceeded to estimate the nonlinear ARDL model in Eq. (5) to see whether this is true. Table 3 reports the nonlinear estimates.

The estimated coefficients suggest that depreciation of the real exchange rate has both short- and long-run effects on the trade balance. In the short run, real depreciation appears to have a negative effect on the trade balance at lags zero and one, while in the long run, the impact is reversed. Apart from a contemporaneous short-run effect (i.e. at lag zero), real appreciation had no effect on the trade balance during the study period. These results are consistent with the J-curve phenomenon. This evidence is also similar to the one documented by Bhattarai and Armah (2005). Additionally, the real exchange rate changes have nonlinear or asymmetric effects on the trade balance in the long run. This is shown by the signs and sizes of POS and NEG. Moreover, the diagnostic tests at the bottom of Table 3 indicate that the variables are cointegrated,[11] the model is structurally stable, and there is no serial correlation and functional misspecification.

Table 2: Results from the Linear Model

Lags	0	1	2	3	4
Optimal ARDL Specification of Linear Model: ARDL (3, 0, 2, 3)					
Short-run					
ΔlnTB		-0.252[-2.487]	0.260[2.920]		
ΔlnY	0.427[3.134]				
ΔlnY*	0.270[2.122]	0.317[1.902]			
ΔlnREER	-0.119[-0.306]	-0.389[-0.760]	0.026[0.343]		
Long-run					
lnY	0.529[2.045]				
lnY*	3.271[2.316]				
lnREER	-1.822[-1.475]				
Constant	-1.982[-2.509]				
ECT	-0.364[-3.618]				

[10] These tests are, respectively, the Lagrange multiplier (LM) test, Ramsey Regression Equation Specification Error Test (RESET), the cumulative sum of recursive residuals (CUSUM) test and the cumulative sum of squares of recursive residuals (CUSUMSQ) test (see Breusch, 1978; Brown et al., 1975; Godfrey, 1978; Ramsey, 1969).

[11] The F-statistic is compared with Table CI(iii) Case III: Unrestricted intercept and no trend of Pesaran et al. (2001, p. 300) for four independent variables (i.e. k = 4).

Diagnostics					
Adj. R-squared	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
0.595	4.086	0.962(0.431)	0.553(0.458)	S	S

Notes: The values in the block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S denotes stable.

Table 3: Results from the Nonlinear Model

Lags	0	1	2	3	4
Optimal ARDL Specification of Nonlinear Model: ARDL (3, 1, 2, 3, 3)					
Short-run					
ΔlnTB		-0.243[-2.383]	0.254[2.850]		
ΔlnY	0.332[2.158]				
ΔlnY*	0.535[1.924]	0.980[1.442]			
ΔPOS	-0.177[-2.605]	0.292[0.770]	0.206[0.874]		
ΔNEG	-0.128[-2.390]	-0.330[-2.741]	0.266[1.872]		
Long-run					
lnY	-0.528[-2.118]				
lnY*	1.401[3.304]				
POS	-0.265[-0.327]				
NEG	1.472[2.623]				
Constant	5.395[4.297]				
ECT	-0.383[-3.726]				
Diagnostics					
Adj. R-squared	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
0.602	3.562	0.254(0.775)	1.898(0.171)	S	S

Notes: The values in the block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S denotes stable.

It has been empirically established that the different information criteria available for choosing the optimal lags in a model may diverge. This meant that the choice of the information criterion would determine the final specification and estimates of Eqs. (2) and (5). Hence, was it possible that our results could be sensitive to our lags choices? Answering this question constituted our sensitivity analysis. Here we used an alternative information criterion, the Schwarz information criterion (SIC), to select the optimal lags in Eqs. (2) and (5). The optimal lags selected for both specifications using the SIC turned out to be different from those presented above. That is, for Eq. (2) the preferred lags were ARDL (2, 2, 1, 3), while for Eq. (5) the lags were ARDL (3, 1, 1, 3, 2). We therefore proceeded to estimate these specifications. The results obtained from these specifications are reported in Tables 4 and 5.

Table 4: Results from the Linear Model using SIC

Lags	0	1	2	3	4
Optimal ARDL Specification of Nonlinear Model: ARDL (2, 2, 1, 3)					
Short-run					
ΔlnTB		-0.426[-3.046]			
lnY	0.038[2.182]	0.211[1.855]			
lnY*	0.201[2.581]				
lnREER	-0.069[-0.187]	-0.367[-1.451]	0.078[1.260]		
Long-run					

lnY	0.453[3.160]				
lnY*	2.908[2.701]				
lnREER	-1.096[-1.181]				
Constant	-3.969[-3.078]				
ECT	-0.532[-6.503]				
Diagnostics					
Adj. R-squared	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
0.571	11.041	0.928[0.452]	0.973[0.325]	S	NS

Notes: The values in the block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S and NS denote stable and not stable, respectively.

From Table 4, it is evident that the real exchange rate has no significant short- and long-run impacts on the trade balance. The F-statistic and the estimated error correction term indicate the presence of cointegration. Also, the diagnostic tests shown at the bottom of Table 4 suggest that there is weak evidence in support of structural stability. There is, however, no serial correlation, and no functional misspecification in the linear trade balance model, meaning that the results are correctly estimated. As compared with Table 2, the results here also suggest that the J-curve cannot be supported using the linear trade balance model. Now let us consider Table 5, which shows the nonlinear results based on the SIC. In this case, depreciation has both short- and long-run effects on the trade balance. That is, real depreciation has a negative short-run effect on the trade balance at lags zero and one, which reverses in the long run. Similar to the previous results, real appreciation has no effect on the trade balance during the study period – apart from a negative short-run effect at lag zero. In addition, the results suggest that changes in the real exchange rate have asymmetric effects on the trade balance in the long run, as shown by the signs and sizes of POS and NEG. The diagnostic tests reveal that the results are correctly estimated.

Table 5: Results from the Nonlinear Model using SIC

Lags	0	1	2	3	4
Optimal ARDL Specification of Nonlinear Model: ARDL (3, 1, 1, 3, 2)					
Short-run					
ΔlnTB		-0.169[-1.600]	0.199[2.100]		
ΔlnY	0.392[1.771]				
ΔlnY*	1.557[2.159]				
ΔPOS	-0.323[-2.259]	1.161[1.459]	-0.701[-1.533]		
ΔNEG	-0.116[-2.078]	-0.101[-2.274]	0.636[1.846]		
Long-run					
lnY	-0.512[0.834]				
lnY*	2.128[3.892]				
POS	-0.982[-1.284]				
NEG	1.224[3.151]				
Constant	3.555[4.082]				
ECT	-0.418[-4.091]				
Diagnostics					
Adj. R-squared	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
0.599	8.967	1.893(0.117)	1.859(0.173)	S	S

Notes: The values in the block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S denotes stable.

To summarize, our empirical results show that the linear ARDL specification does not establish any short- or long-run links between the trade balance and the real effective exchange rate, meaning that the linear model does not support the J-curve phenomenon in both the short and the long run. The nonlinear model, on the other hand, shows that changes in the real exchange rate affect the trade balance. That is, real depreciation improves the trade balance in the long run, but real appreciation does not affect it. This is consistent with the J-curve phenomenon, which has also been documented by Bahmani-Oskooee and Fariditavana (2015; 2016). Also, the impact of the real exchange rate changes on the trade balance is nonlinear. The complex behaviour of the exchange rate as documented in earlier studies may explain why the linear model does not identify any links between the real exchange rate and the trade balance. Some studies found the exchange rate to follow a random walk behaviour, showing that while the variable is a good predictor of economic fundamentals, the reverse is not true (see Engel and West, 2005; Della Corte et al., 2009). However, part of this conclusion has been proven to be inappropriate, since under a kitchen-sink regression with the elastic-net shrinkage method, economic fundamentals can predict exchange rates (see Li et al., 2015). This complexity of the exchange rate means that linear models may not correctly reflect its relationship with economic fundamentals, the trade balance included.

4. Conclusion

In theory, the basic policy implication for economies that are suffering from trade balance deterioration is devaluation of their currency or pursuit of policies that promote real depreciations. However, will real depreciation or devaluation overturn a deteriorating trade balance? It has been established that the deterioration of the trade balance will continue in the short run before reversing in the long run following real depreciation or devaluation. This feature of the trade balance in reaction to depreciation or devaluation is known in the literature as the J-curve. The recommended approach for testing this behaviour of the trade balance is the error correction mechanism. The main limitation of the previous studies is that they assumed linearity in the relationship between the trade balance and the real exchange rate changes, thereby using linear error correction mechanisms to analyse the J-curve. Recent studies have shown that nonlinear trade balance models may accurately reflect the J-curve phenomenon.

Following this recent evidence, we re-examined the validity of the J-curve phenomenon in Ghana by using the linear ARDL approach and the recently developed nonlinear ARDL approach. Based on quarterly data which spanned the period 1986Q1 to 2016Q3, we found no evidence in support of the short- and long-run impact of exchange rate changes on the trade balance in the linear specification – meaning that the J-curve is refuted in this case. In contrast, exchange rate changes affect the trade balance in the nonlinear specification. Specifically, real depreciations improve the trade balance in the long run, but real appreciations do not have any impact on it. This is consistent with the J-curve phenomenon. Real exchange rate changes also have nonlinear effects on the trade balance. This evidence suggests that policymakers in the country should concern themselves with maintaining a reasonable size of cedi depreciation because most short-term trade imbalances are likely to be corrected in the long-term.

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