Nonlinear Effects of Exchange Rate Changes on the South African Bilateral Trade Balance

Njindan Iyke, Bernard and Ho, Sin-Yu

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Abstract

In testing for the J-curve, previous studies have shown that the trade balance model is better fitted using cointegration and error correction mechanisms. These mechanisms are able to incorporate the short-term deterioration and the long-term improvement of the trade balance – the definition of the J-curve. However, the drawback of the established cointegration and error correction frameworks is that they assume symmetry in the equilibrium adjustment process. Incidentally, studies which have used the linear frameworks have found little support for the J-curve. Since the adjustment process could be nonlinear, a fresh investigation of the J-curve using nonlinear approaches could provide competing evidence. This paper retested the J-curve by using quarterly data for South Africa and her key trade partners (China, Germany, India, Japan, the UK and the US) and found the linear specification to support the J-curve phenomenon in only two cases (India and the US) under relaxed conditions. In contrast, the nonlinear specification supported the J-curve phenomenon in all cases at no cost of serial correlation and functional misspecification. We also found the real exchange rate changes to have significant nonlinear effects on the South African trade balance.

Keywords: Bilateral Trade Balance; J-Curve; Real Exchange Rates; South Africa

JEL Code: C22; F31; F32

1. Introduction

In the international finance literature, it has been argued that the trade balance reacts to changes in the real exchange rate in a peculiar fashion. In particular, the argument has been that devaluations or depreciations could improve a deteriorating trade balance. However, such improvement may take some time to occur due to the adjustment lags in the underlying mechanism. Magee (1973) contended that production and delivery delays, recognition lag, among other factors, ensure that devaluations or depreciations do not improve a deteriorating trade balance instantaneously. Generally, the response of the trade balance to devaluation or depreciation is known as the J-curve, since the trade balance deterioration is eventually followed by an improvement in a fashion similar to the letter J (see Magee, 1973; Bahmani-Oskooee, 1985). A formal verification of the J-curve in the trade balance was first laid down by Bahmani-Oskooee (1985).[1] In his framework, he introduced the real exchange rate as one of the determinants of the trade balance. He 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.

In contrast to Bahmani-Oskooee (1985), Rose and Yellen (1989) contended that the appropriate way to model the trade balance is by introducing the short-run adjustment process, so that the short-run component will capture the short-term deterioration and the long-run component the

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

long-term improvement. In other words, they recommended the use of cointegration techniques and error correction modelling when testing the J-curve. By using the US trade balance model with six of her trade partners, Rose and Yellen (1989) found no support for the J-curve. Bahmani-Oskooee and Fariditavana (2016) challenged this approach by arguing that the adjustment of the trade balance to equilibrium may be nonlinear. That is, the response of the trade balance to depreciation may be different from appreciation in such a manner that if we were to filter depreciation from appreciation, the support for the J-curve may become more apparent. They found the nonlinear autoregressive distributed lag (ARDL) model of trade balance to be more supportive of the J-curve than the linear ARDL model in a sample of US and her six major trade partners. Moreover, they found the real exchange rate changes to mostly affect the trade balance asymmetrically.

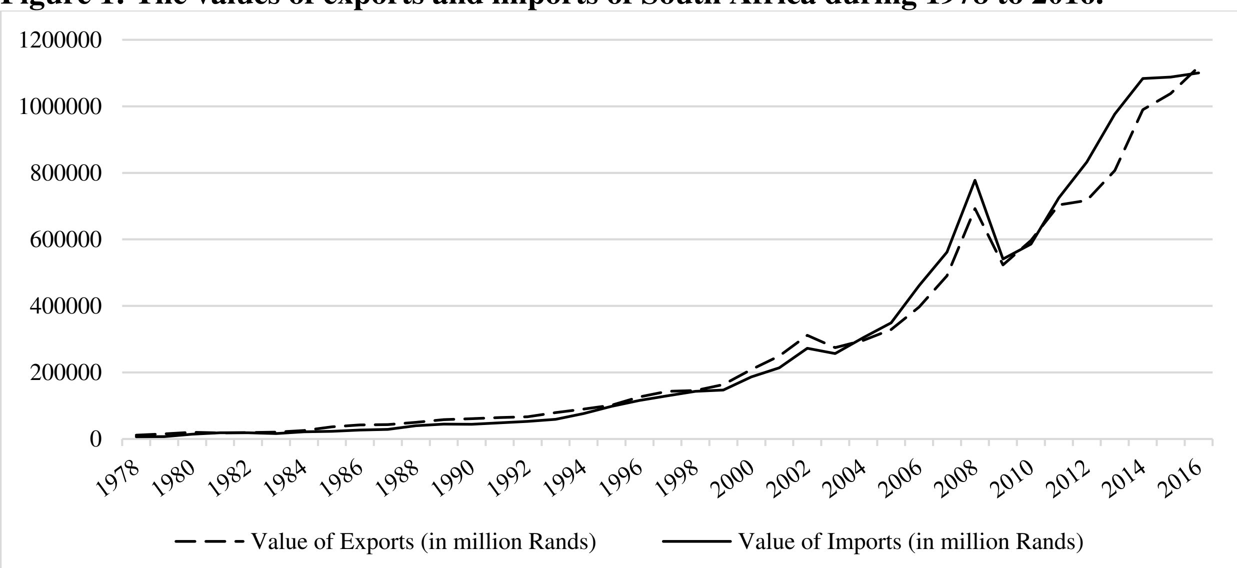
The US is a dominant economy in world trade. As such, it is possible that devaluation or depreciation of its currency against her major trade partners may enhance her trade balance in the long-term, thereby confirming the J-curve. However, will this be the case for South Africa, a country which has no influence in world trade? In this paper, we investigate the effects of real exchange rate changes on the trade balance of South Africa and her major trade partners. We follow Bahmani-Oskooee and Fariditavana (2016) by arguing that the linear trade balance model may not appropriately reflect the underlying relationship between the real exchange rate and the trade balance. Therefore, we formulate the trade balance model of South Africa and her major trade partners as a nonlinear ARDL model. The nonlinear ARDL model is a recently developed model by Shin et al. (2014). Unlike its predecessor, the linear ARDL model by Pesaran et al. (2001), it accounts for asymmetries in the movements of variables. It also contemporaneously performs well in small samples, applicable in mixed order integrated variables, and deals effectively with pre-testing bias.

Although the manner in which the trade balance responds to changes in the real exchange rate is an important issue to be considered in exchange rate policy formulation, no study has looked into it in the South African context. Investigating the trade balance model appears to be particularly interesting in the South African context because the country's currency (i.e. the rand) has depreciated rapidly against major currencies in recent years (Iyke, 2017). Therefore, a support of the J-curve will imply that policymakers should concern themselves with maintaining a reasonable size of rand depreciation because the short-term trade imbalances are likely to be corrected in the long-term. In the next section, we present a brief background of trade policies and liberalization in South Africa. We followed this by outlining our methodology in section 3. Then in section 4, we report and discuss our empirical results. Section 5 concludes the paper.

2. Trade Policies and liberalisation in South Africa

South Africa had undergone a gradual process of trade liberalization in the past few decades. In the early 1970s, the first signs of trade liberalization were the introduction of export subsidies on the export side as well as the replacement of quotas with equivalent tariffs on the import side. In the 1980s, the focus was more on improving the condition for exports in the forms of duty exemptions and custom duty drawbacks rather than on the import liberalization (Cassim et al., 2004; Edwards and Lawrence 2008). Such focus was further promoted with the promulgation of the General Export Incentive Scheme (GEIS) in 1990. This scheme was a national-wide package, which provided considerable incentive to exports based on value-added and local content (Cassim et al., 2004). Despite the gradual progress of trade liberalization in the 1970s and 80s, the remarkable and sustained progress in trade liberalization actually took place in the 1990s [Edwards and Lawrence 2008; Department of Trade and Industry in South Africa (DTI), 2014]. In particular, the country signed the General Agreement on Tariffs and Trade (later known as the World Trade Organization (WTO)) in 1994, with an agreement to phase out the GEIS in three-year's timeframe from 1995 onwards. The 1990s also witnessed the improvement of import liberalization. South Africa reached an agreement with the WTO on the tariff reduction schedule. After the tariff liberalization process, the simple average tariff reduced from 23% to 8.3% (DTI 2014). Moreover, the average weighted import duties were lowered from 11% to 5% for capital goods, 34% to 17% for consumption goods, and 8% to 4% for intermediate goods (Cassim et al., 2004). This showed the country's commitment to opening up its market to foreign firms. As a result of these liberalization policies, the value of both exports and imports increased significantly during the past few decades. There was a general upward trend in the value of trade, except during the period of global financial crisis in 2009 [International Financial Statistics (IFS), 2017). The value of exports surged from R11 106 million in 1978 to R1 118 810 million in 2016, representing an average annual growth of 12.7% during this period. On the import side, the value of imports increased from R6 263 million in 1978 to R1 100 540 million in 2016, showing an average annual growth of 14.5%. Figure 1 shows the value of exports and imports of South Africa during 1978 to 2016.

Figure 1: The values of exports and imports of South Africa during 1978 to 2016.



Note: Data for the empirical analysis span the period 1998 to 2016. We show the trends in exports and imports for period in which data are available in order to provide a better picture.
Source: International Financial Statistics (2017).

3. Methodology

To determine the effects of the real exchange rate changes on the trade balance, the literature has formulated the bilateral trade balance between a given country and her trade partner as a function of real income in both countries, and their bilateral real exchange rate (see Rose and Yellen, 1989; Bahmani-Oskooee and Fariditavana, 2016; Iyke and Ho, 2017). Hence, the bilateral trade balance model for South Africa and her trade partners will be of the form:

$$lnTB_{i,t} = \gamma_0 + \gamma_1 lnY_t + \gamma_2 lnY_{i,t}^{*} + \gamma_3 lnRER_{i,t} + \mu_t, \tag{1}$$

where TB_i denotes the trade balance between South Africa and her trade partner i; Y is the real income of South Africa measured as real GDP; Y_i^* is the real income of trade partner i measured as her real GDP; RER_i is the bilateral real exchange rate between South Africa and her trade partner, whereby an increase in it denotes real appreciation and a decrease real depreciation of the South African rand; ln is the natural logarithm operator; γ are the parameters to be estimated; μ is the iid error term; t is the time subscript.

It is expected that increases in South Africa's real income will affect her trade balance positively, while increases in her trade partner's real income will affect it negatively. This is because, as South Africa's real income increases, her propensity to import will also increase. Similarly, as her trade partner's real income increases, the demand for South Africa's export will increase. Real depreciation is expected to improve the trade balance because it will increase South Africa's exports and reduce her imports.

By definition, the J-curve indicates that the trade balance may continue to deteriorate before experiencing an improvement in the long term, following a depreciation or devaluation policy. Therefore, to capture the J-curve phenomenon better, it is important to formulate the short-term adjustment mechanism (Rose and Yellen, 1989). The ARDL approach advanced by Pesaran *et al.* (2001) is very suitable for capturing the short-term adjustment process of the trade balance model. The short-term dynamics of Eq. (1) can be formulated as:

$$\begin{aligned} \Delta lnTB_{i,t} \\ &= \rho_0 + \sum_{q=1}^{n} \rho_{1q}\, \Delta lnTB_{i,t-q} + \sum_{q=0}^{n} \rho_{2q}\, \Delta lnY_{i,t-q} + \sum_{q=0}^{n} \rho_{3q}\, \Delta lnY_{i,t-q}^{*} + \sum_{q=0}^{n} \rho_{4q}\, \Delta lnRER_{i,t-q} \\ &+ \sigma_1 lnTB_{i,t-1} + \sigma_2 lnY_{i,t-1} + \sigma_3 lnY_{i,t-1}^{*} + \sigma_4 lnRER_{i,t-1} \\ &+ \epsilon_t, \end{aligned} \tag{2}$$

where ϵ, ρ, and σ are the iid error term, the short-run coefficients, and the long-run coefficients of the model, respectively; Δ is the first difference operator. n denotes the maximum lag of the model. Note that the short-term effects are the coefficients of the first-differenced variables. The long-term effects, on the other hand, are derived by setting the non-first-differenced lagged component of Eq. (2) to zero and normalizing σ_2 to σ_4 on σ_1. In this case, if values of ρ_{4q} are initially negative and the subsequent values are positive, while σ_4/σ_1 is positive and significant, the J-curve is confirmed.

In order to ensure that estimates of Eqs. (1) and (2) are reliable, the coefficients σ_1, σ_2, σ_3, and σ_4 must be jointly significant. In other words, the variables have to be cointegrated. To this end, Pesaran et al. (2001) have developed two sets of critical values under this null hypothesis (i.e. $\sigma_1 = \sigma_2 = \sigma_3 = \sigma_4 = 0$). Under the first set of critical values, the variables in Eq. (2) are assumed to be integrated of order zero, I(0), while under the second set the variables are assumed to be integrated of order one, I(1). We reject cointegration if the calculated F-statistic is less than the first set of critical values. There is cointegration if the calculated F-statistic is greater than the second set of critical values. However, the test becomes inconclusive if the calculated F-statistic lies in-between both sets of critical values. The strength of this approach is that it does not require us to pre-test the integration properties of the variables.

It is possible that the above specification may fail to establish the existence of the J-curve in the trade balance model. However, such a failure may be as a result of the assumption that the real exchange rate changes have symmetric or linear effects on the trade balance. If we filter appreciations from depreciations and evaluate their separate effects on the trade balance, depreciations may have significant effects whereas appreciations may not (see Bahmani-Oskooee and Fariditavana, 2016; Iyke and Ho, 2017). This suggests that the effects of the real exchange rate changes on the trade balance may be nonlinear. In this sense, a suitable nonlinear model will improve the specification of the trade balance model and the testing for the J-curve. This can be achieved by decomposing the real exchange rate into positive (appreciation) and negative (depreciation) partial sums as follows:[2]

$$lnRER = lnRER_0 + lnRER_t^+ + lnRER_t^-, \tag{3}$$

where $lnRER_t^+$ and $lnRER_t^-$ denote, respectively, partial sums of the positive and negative changes in $lnRER$. They are defined formally as:

$$\begin{aligned} POS = lnRER_t^+ &= \sum_{j=1}^{t} \Delta lnRER_j^+ = \sum_{j=1}^{t} \max(\Delta lnRER_j, 0) \\ NEG = lnRER_t^- &= \sum_{j=1}^{t} \Delta lnRER_j^- = \sum_{j=1}^{t} \min(\Delta lnRER_j, 0) \end{aligned} \tag{4}$$

Eq. (4) can then be used to derive the nonlinear trade balance model. Following Shin et al. (2014), we substitute the real exchange rate, $lnRER$, in Eq. (2) by POS and NEG to arrive at the following nonlinear ARDL model:

[2] See, for instance, Delatte and Lopez-Villavicencio (2012), Verheyen (2013), Bahmani-Oskooee and Bahmani (2015), and Bahmani-Oskooee and Fariditavana (2016).

$$\Delta lnTB_{i,t} = \rho_0 + \sum_{q=1}^{n} \rho_{1q}\, \Delta lnTB_{i,t-q} + \sum_{q=0}^{n} \rho_{2q}\, \Delta lnY_{i,t-q} + \sum_{q=0}^{n} \rho_{3q}\, \Delta lnY^*_{i,t-q} + \sum_{q=0}^{n} \rho_{4q}\, \Delta POS_{i,t-q} + \sum_{q=0}^{n} \rho_{5q}\, \Delta NEG_{i,t-q} + \sigma_1 lnTB_{i,t-1} + \sigma_2 lnY_{i,t-1} + \sigma_3 lnY^*_{i,t-1} + \sigma_4 POS_{i,t-1} + \sigma_5 NEG_{i,t-1} + \epsilon_t. \quad (5)$$

Note that the coefficients and the iid error in Eq. (5) are different from those in Eq. (2). The nonlinearity in this model is associated with the partial sums POS and NEG. By construction, if the coefficients of POS and NEG have the same sign and size, then we can conclude that the real exchange rate changes have symmetric effects on the trade balance. The effects are asymmetric if the signs and sizes are different. Specifically, the short-term effects are the coefficients of the first-differenced variables, while the long-term effects are obtained by setting the non-first-differenced lagged component of Eq. (5) to zero and normalizing σ_2 to σ_5 on σ_1. If the J-curve exists, then we should expect the normalized coefficients σ_4/σ_1 and σ_5/σ_1 to be positive and significant. Analytically, Shin et al. (2014) have demonstrated that Pesaran et al. (2001) bounds testing procedure is applicable in this case. The empirical results that we obtained by taking these models to data are reported and discussed in what follows.

4. Empirical Results

This section presents the estimates of the specifications in Eqs. (2) and (5). The results are based on the bilateral trade data between South Africa and her key trade partners. According to the information available on the Observatory of Economic Complexity (OEC)[3], Trading Economics[4], and South Africa's Department of Trade and Industry (DTI)[5] websites, the key trade partners of South Africa are: China, Germany, India, Japan, the United Kingdom (UK), and the United States (US).[6] The variables used in the paper are provided in Table 1. The data is quarterly and spans the period 1998Q1 to 2016Q2.

Table 1: Definitions and Sources of the Variables

Variable	Name	Source
X	South Africa's export to her trade partner	Direction of Trade Statistics (DOTS) compiled by the IMF.
M	South Africa's import from her trade partner	Direction of Trade Statistics (DOTS) compiled by the IMF.

[3] This information is available at http://atlas.media.mit.edu/en/profile/country/zaf/.
[4] This information is available at http://www.tradingeconomics.com/south-africa/imports.
[5] This information is available at http://tradestats.thedti.gov.za/TableViewer/dimView.aspx.
[6] Although, countries such as Saudi Arabia, Botswana, Lesotho, Mozambique, Namibia, Swaziland and Zimbabwe are also important trade partners of South Africa, they are excluded because data on the variables used in this paper are not readily available for these countries.

CPI	Consumer price index	The International Financial Statistics (IFS) compiled by the IMF. China's CPI is taken from GVAR database and supplemented by IFS data.
Y	Real GDP	Global VAR (GVAR) database supplemented by IFS data.
NER	Nominal exchange rate (i.e. foreign currency to rand)	South African Reserve Bank (SARB).
RER	Real exchange rate	Calculated as the product of NER and South Africa's CPI divided by her trade partner's CPI.
TB	Bilateral trade balance	Calculated as South Africa's import (M) from trade partner divided by her export (X) to trade partner.

To prevent overfitting of the models, we restrict the maximum lags to 4 and utilized the Akaike information criterion (AIC) to choose the optimal lags. The empirical estimates are reported in Tables 2 to 6. Each of these tables is separated into two panels. Panel A reports the short and long-run estimates of the linear ARDL specification together with the diagnostic tests. Similarly, Panel B reports the short and long-run estimates of the nonlinear ARDL specification together with the diagnostic tests.

Let us consider South Africa's trade with China. The estimates for this case are reported in Table 2. The linear ARDL results shown in Panel A suggest that the real exchange rate has no significant short and long-run impacts on the trade balance. Also, the F-statistic fails to establish any evidence of cointegration among the variables. 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). The error correction term estimated here is clearly negative and significant, suggesting the presence of cointegration. For these results to be valid, serial correlation should be absent, the coefficients should be stable, and the functional form should be correctly specified. The LM, RESET, CUSUM, and CUSUMSQ tests[7] reported at the bottom of Panel A show that there is no serial correlation and functional misspecification, and that the coefficients are stable. Hence, the results are correctly estimated. We can conclude that the J-curve is not supported in the linear ARDL specification for the South Africa-China trade.

Could it be that we failed to establish the J-curve in the South Africa-China trade because we assumed linearity between the real exchange rate and the trade balance? In their study, Bahmani-Oskooee and Fariditavana (2016) found that the J-curve is more likely to be supported within nonlinear specifications than in linear specifications. Following their lead, we estimated a nonlinear ARDL specification and reported the results in Panel B of Table 2. The results suggest that depreciation of the real exchange rate has both short and long-run impacts on the South Africa-China trade balance at the conventional levels of significance, while real appreciation has no impact. That is, depreciation enhances the South Africa-China trade balance. The impact of the real exchange rate on the South Africa-China trade balance is nonlinear. Crucially, the J-curve is supported in the nonlinear ARDL specification. The diagnostic tests presented at the

[7] These tests are, respectively, the Lagrange Multiplier (LM) test, Ramsey's 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).

bottom of Panel B suggest that the specification is correctly estimated. Moreover, the evidence of cointegration is strongly supported using the F-test and the ECM-based test.

The estimates for the South Africa-Germany trade balance specification reported in Table 3 are similar to the above case. The J-curve is not supported in the linear ARDL specification but supported in the nonlinear specification, although both specifications are correctly specified as shown by the diagnostic tests. The evidence suggests that the real exchange rate changes have nonlinear impact on the trade balance as shown by the coefficient estimates of POS and NEG. Unlike these results, those of the South Africa-India and the South Africa-US trade balances reported in Tables 4 and 5 support the J-curve both in the short and the long run using the linear specification (see Panel A in Tables 4 and 5). However, the South Africa-India model fails the serial correlation test, while the South Africa-US model fails the functional specification test. This means that the estimates in both cases may be unreliable. Now, when we consider the estimates of the nonlinear ARDL model for both the South Africa-India and the South Africa-US trade balances reported under Panel B in Tables 4 and 5, there is clear evidence that the J-curve is supported in the short and the long run. Also, there is evidence in support of cointegration using the F-test and ECM-based test. The coefficients are structurally stable, and there is no serial correlation and functional misspecification.

Finally, let us consider the South Africa-Japan and the South Africa-UK trade balance models. The results for both the linear and nonlinear ARDL models are reported in Tables 6 and 7. Clearly, the linear ARDL results reported in Panel A of both tables suggest that the real exchange rate has no significant short and long-run impact on the trade balance. Hence, if we rely on the linear specification, we may conclude that the J-curve is refuted in both the South Africa-Japan and the South Africa-UK trade balance models. Note that the RESET test indicates that the linear model is misspecified for the South Africa-Japan trade balance model, while the CUSUMSQ test indicates that the parameters are not stable in the South Africa-UK trade balance model. Therefore, we must turn to the nonlinear models. The results for the nonlinear models are reported in Panel B of Tables 6 and 7. For these results, it is apparent that the J-curve is now supported both in the short and the long run in the South Africa-Japan trade balance model. Real depreciation improves the South Africa-Japan trade balance, while real appreciation has no effect on it in the long run. In other words, the real exchange rate changes have nonlinear effects on the South Africa-Japan trade balance. Similarly, there is support for the J-curve in the long run for the South Africa-UK trade balance model. Moreover, the real exchange rate changes appear to have asymmetric effects on the trade balance in this case. There is also evidence in support of cointegration, structural stability, no serial correlation, and no functional misspecification in both models.

To summarize, our empirical results suggest that the linear ARDL specification supports the J-curve phenomenon in only two cases, namely: India and the US. Even so, we have to permit serial correlation and/or functional misspecification for this to happen. In contrast, the nonlinear ARDL supports the J-curve phenomenon in all cases at no cost of serial correlation and functional misspecification. That aside, the nonlinear specification revealed that the real exchange rate changes have significant nonlinear effects on the South African trade balance. Our findings are generally in line with those recently documented by Bahmani-Oskooee and Fariditavana (2015; 2016).

5. Conclusion

Theoretically, the basic policy implication for economies that are suffering from trade balance deterioration is to devalue their currency or to pursue policies that promote real depreciations. But it is now an established fact that the trade balance does not respond to real depreciation or devaluation immediately. The deterioration in the trade balance will ensue for a while before improving following the depreciation. This characteristic of the trade balance in response to depreciation or devaluation is referred in the literature as the J-curve. Due to the short-term deterioration in the trade balance which may experience improvement in the long-term, cointegration techniques have been particularly suitable for the testing the J-curve. However, majority of the existing studies have assumed that the underlying relationship between the real exchange rate and the trade balance is linear in nature, thereby proceeding to use linear cointegration approaches. Recent studies have found that the linear approaches may not take into account all the information available and therefore may fail to support the J-curve in most cases. The recent studies recommend the nonlinear ARDL approach to be used for testing the J-curve. Following this recommendation, we retested the validity of the J-curve phenomenon in South Africa by using the linear ARDL approach and the recently developed nonlinear ARDL approach. Using a quarterly data for South Africa and her key trade partners (China, Germany, India, Japan, the UK and the US) which covered the period 1998Q1 – 2016Q2, we found that the linear ARDL specification supported the J-curve phenomenon in only two cases, namely: India and the US. In order for the J-curve to be supported for these two cases, we allowed serial correlation and/or functional misspecification. In contrast, the nonlinear ARDL supported the J-curve phenomenon in all cases at no cost of serial correlation and functional misspecification. We also found that the real exchange rate changes have significant nonlinear effects on the South African trade balance.

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Table 2: Empirical Results for South Africa-China Trade

Lags	0	1	2	3	4
Panel A: Optimal ARDL Specification of Linear Model – ARDL(2,0,0,0)					
Short run					
ΔlnTB		-0.329[-2.879]			
ΔlnY_SA	0.100[0.112]				
ΔlnY_CHI	0.090[0.139]				
ΔlnRER	-0.299[-0.610]				
Long run					
lnY_SA	-0.162[-0.868]				
lnY_CHI	-0.576[-3.244]				
lnRER	0.392[0.742]				
Constant	-2.173[-3.474]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.458[-3.531]	3.454	1.050[0.592]	2.003[0.162]	S	S
Adj. R-squared	0.567				
Panel B: Optimal ARDL Specification of Nonlinear Model – ARDL(2,0,1,2,4)					
Short run					
ΔlnTB		-0.350[-3.317]			
ΔlnY_SA	-0.677[-0.848]				
ΔlnY_CHI	-0.365[-3.637]				
ΔPOS	1.548[1.619]	-2.047[-2.368]			
ΔNEG	1.650[2.178]	1.265[1.593]	-0.777[-0.992]	-1.841[-2.589]	
Long run					
lnY_SA	-1.201[-0.916]				
lnY_CHI	-1.551[-1.558]				
POS	2.015[0.648]				
NEG	0.651[1.810]				
Constant	5.600[3.547]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.411[-3.550]	6.246	0.722[0.697]	1.049[0.310]	S	S
Adj. R-squared	0.637				

Notes: Values in block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S denotes stable. lnY_SA and lnY_CHI denote the natural log of real income of South Africa and China, respectively.

Table 3: Empirical Results for South Africa-Germany Trade

Lags	0	1	2	3	4
Panel A: Optimal ARDL Specification of Linear Model – ARDL(2,3,1,0)					
Short run					
ΔlnTB		-0.237[-2.351]			
ΔlnY_SA	-1.219[-3.150]	0.235[1.764]	-0.298[-2.213]		
ΔlnY_GER	-5.210[-3.767]				
ΔlnRER	-0.110[-0.521]				
Long run					
lnY_SA	0.316[2.729]				
lnY_GER	1.200[0.799]				
lnRER	0.291[0.766]				
Constant	-1.869[-3.586]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.324[-3.586]	3.060	2.425(0.298)	0.458(0.501)	S	S
Adj. R-squared	0.449				
Panel B: Optimal ARDL Specification of Nonlinear Model – ARDL(2,2,4,2,3)					
Short run					
ΔlnTB		-0.249[-2.306]			
ΔlnY_SA	-1.559[-3.401]	-0.296[-0.571]			
ΔlnY_GER	-6.395[-3.780]	-1.621[0.846]	1.560[3.492]	0.343[0.687]	
ΔPOS	0.018[0.060]	0.881[2.936]			
ΔNEG	-0.059[-0.090]	-0.387[-0.665]	0.911[1.644]		
Long run					
lnY_SA	-0.846[-1.375]				
lnY_GER	-4.024[-1.713]				
POS	-0.389[-0.933]				
NEG	2.103[2.317]				
Constant	8.537[4.295]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.370[-4.293]	3.423	0.558(0.757)	0.593(0.445)	S	S
Adj. R-squared	0.490				

Notes: Values in block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S denotes stable. lnY_SA and lnY_GER denote the natural log of real income of South Africa and Germany, respectively.

Table 4: Empirical Results for South Africa-India Trade

Lags	0	1	2	3	4
Panel A: Optimal ARDL Specification of Linear Model – ARDL(1,0,0,4)					
Short run					
ΔlnTB					
ΔlnY_SA	0.393[2.910]				
ΔlnY_IND	-0.996[-0.576]				
ΔlnRER	0.250[2.400]	0.034[0.053]	0.957[1.598]	-1.543[-2.608]	
Long run					
lnY_SA	0.244[2.817]				
lnY_IND	0.467[1.528]				
lnRER	1.351[2.543]				
Constant	-3.725[-5.474]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.623[-5.520]	7.457	1.988(0.370)	5.892(0.018)	S	S
Adj. R-squared	0.409				
Panel B: Optimal ARDL Specification of Nonlinear Model – ARDL(1,0,0,0,4)					
Short run					
ΔlnTB					
ΔlnY_SA	0.576[1.539]				
ΔlnY_IND	-1.717[-1.167]				
ΔPOS	2.320[2.277]				
ΔNEG	-2.094[-2.380]	-1.151[-1.237]	0.708[0.739]	-3.777[-4.996]	
Long run					
lnY_SA	0.776[2.229]				
lnY_IND	-0.874[-0.813]				
POS	2.855[4.366]				
NEG	1.853[2.274]				
Constant	0.144[2.182]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.597[-6.059]	6.241	0.901(0.637)	0.263(0.610)	S	S
Adj. R-squared	0.545				

Notes: Values in block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S denotes stable. lnY_SA and lnY_IND denote the natural log of real income of South Africa and India, respectively.

Table 5: Empirical Results for South Africa-US Trade

Lags	0	1	2	3	4
Panel A: Optimal ARDL Specification of Linear Model – ARDL(1,2,2,3)					
Short run					
ΔlnTB					
ΔlnY_SA	1.262[1.534]	-1.917[-2.484]			
ΔlnY_US	-3.455[-1.495]	5.033[2.318]			
ΔlnRER	0.658[3.566]	0.334[1.814]	1.001[5.738]		
Long run					
lnY_SA	3.219[8.313]				
lnY_US	-7.790[-8.919]				
lnRER	0.253[2.565]				
Constant	-1.785[-9.069]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.827[-9.084]	19.631	4.656(0.098)	0.701(0.406)	S	S
Adj. R-squared	0.809				
Panel B: Optimal ARDL Specification of Nonlinear Model – ARDL(1,1,0,0,3)					
Short run					
ΔlnTB					
ΔlnY_SA	1.476[1.856]				
ΔlnY_US	-3.995[-1.528]				
ΔPOS	0.224[0.729]				
ΔNEG	1.109[2.359]	0.102[0.218]	1.635[3.582]		
Long run					
lnY_SA	3.331[5.890]				
lnY_US	-8.148[-5.916]				
POS	0.092[0.798]				
NEG	0.007[2.415]				
Constant	1.673[7.207]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.744[-7.207]	9.650	2.819(0.244)	0.599(0.440)	S	S
Adj. R-squared	0.729				

Notes: Values in block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. lnY_SA and lnY_US denote the natural log of real income of South Africa and US, respectively.

Table 6: Empirical Results for South Africa-Japan Trade

Lags	0	1	2	3	4
Panel A: Optimal ARDL Specification of Linear Model – ARDL(1,0,0,4)					
Short run					
ΔlnTB					
ΔlnY_SA	-3.096[-1.419]				
ΔlnY_JAP	1.789[1.833]				
ΔlnRER	-0.189[-0.791]	-0.604[-2.519]	0.419[1.666]	-0.554[-2.346]	
Long run					
lnY_SA	-1.620[-3.275]				
lnY_JAP	1.110[3.035]				
lnRER	0.324[0.794]				
Constant	-1.265[-3.875]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.385[-3.855]	3.597	1.549(0.461)	6.257(0.015)	S	S
Adj. R-squared	0.787				
Panel B: Optimal ARDL Specification of Nonlinear Model – ARDL(1,0,0,1,0)					
Short run					
ΔlnTB					
ΔlnY_SA	-3.610[-1.613]				
ΔlnY_JAP	2.026[1.585]				
ΔPOS	-1.324[-2.711]				
ΔNEG	0.051[0.144]				
Long run					
lnY_SA	-1.412[-0.766]				
lnY_JAP	0.955[1.878]				
POS	-0.588[-1.315]				
NEG	0.544[1.863]				
Constant	0.895[4.064]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.384[-3.886]	6.039	1.765(0.414)	0.871(0.363)	S	S
Adj. R-squared	0.787				

Notes: Values in block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S denotes stable. lnY_SA and lnY_JAP denote the natural log of real income of South Africa and Japan, respectively.

Table 7: Empirical Results for South Africa-UK Trade

Lags	0	1	2	3	4
Panel A: Optimal ARDL Specification of Linear Model – ARDL(2,4,2,1)					
Short run					
ΔlnTB		-0.253[-1.915]			
ΔlnY_SA	1.305[2.918]	-1.3452[-2.887]	-0.278[-0.902]	0.588[1.824]	
ΔlnY_UK	-8.549[-2,949]	8.949[2.958]			
ΔlnRER	0.630[1.320]				
Long run					
lnY_SA	0.780[2.921]				
lnY_UK	-0.791[-3.282]				
lnRER	-0.113[-0.288]				
Constant	-0.043[-2.861]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.548[-4.073]	3.939	2.215(0.330)	0.865(0.369)	S	NS
Adj. R-squared	0.216				
Panel B: Optimal ARDL Specification of Nonlinear Model – ARDL(1,0,0,1,0)					
Short run					
ΔlnTB		-0.251[-1.860]			
ΔlnY_SA	1.596[3.567]	-1.359[-2.875]	-5.611[-1.313]	0.626[1.889]	
ΔlnY_UK	-1.041[-3.592]	9.099[2.958]	3.485[1.252]		
ΔPOS	0.710[0.945]				
ΔNEG	-0.221[-0.163]				
Long run					
lnY_SA	3.630[1.636]				
lnY_UK	-2.681[-1.753]				
POS	-0,237[-0.668]				
NEG	0.623[2.472]				
Constant	2.774[4.314]				
ECT	F-Statistic	LM	RESET	CUSUM	CUSUMSQ
-0.637[-4.189]	3.856	0.851(0.653)	0.647(0.436)	S	S
Adj. R-squared	0.221				

Notes: Values in 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. lnY_SA and lnY_UK denote the natural log of real income of South Africa and UK, respectively.