# The J-Curve Phenomenon: Evidence from Commodity Trade Between South Africa and the United States

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**Abstract**

Previous studies on the J–curve phenomenon for South Africa have been carried out using either aggregate trade data between South Africa and the rest of the world or between South Africa and her major trading partners. The evidence of J–curve effects in South Africa's bilateral trade have been mixed. In this paper, we revisit this issue by examining the short–and long–run effects of exchange rate changes on trade flows in the context of disaggregated industry data on bilateral trade between South Africa and the United States. From estimates of trade balance models using the autoregressive distributed lag (ARDL) approach, we find evidence of significant J–curve effects as a depreciation of the South African currency has favourable short–run effects on trade balance for 8 industries. These short–run effects last into the long–run in a quarter of the industries considered in the study. The results also show that income has significant long–run effects on trade flows in industries that account for almost 55% of trade flows between South Africa and the United States.

**Key words**: Bilateral trade balance, Exchange rate, ARDL, J–curve, South Africa, United States.

**JEL classification**: F14, F31, C13.

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# 1 Introduction

In the decade before 1994, the combined effects of economic sanctions and deepening internal political opposition to the apartheid government had contributed to South Africa's worst period of economic performance since World War II (du Plessis and Smith, 2006). Following the country's democratic transition in 1994, the main economic objectives of successive African National Congress (ANC)–led administrations have been growth, employment creation and reduction of inequality. With the removal of economic sanctions assisting export sector growth and investment inflows, and the implementation of sound and transparent fiscal and monetary policies, South Africa entered its longest period of sustained economic performance between 1994 and 2008 when economic growth averaged 4% per annum.

Despite economic and political progress in the two decades since its post–democratic transition, South Africa continues to grapple with the triple challenges of significant levels of socio–economic inequalities, poverty and unemployment. In the aftermath of the 2008 financial crises, efforts to address these challenges have been made more difficult by the modest recovery in global economic activity, downward adjustments in major commodity prices and domestic factors including infrastructure constraints and the slow pace of labour market reforms (International Monetary Fund, 2017). Real growth in South Africa's Gross Domestic Product (GDP) has slowed from just over 3.3% in 2011 to 0.8% in 2016, and coincided with a deterioration in South Africa's export performance. Although South Africa's Real Effective Exchange Rate (REER) fell by 25% between 2011 and 2014, export growth was sluggish as it averaged 4% over the same period (National Treasury, 2017; Anand et al., 2016, p.3). As a result of this slowdown in export growth, South Africa's share of global exports has declined by almost 15% since the 2007/2008 global financial crises (South African Reserve Bank, 2017, p.37–39). Minimal export growth combined with relatively inelastic imports caused by large public sector infrastructure projects resulted in a widening of the current account deficit from 2% of GDP in 2011 to nearly 3.5% of GDP in 2016 (National Treasury, 2017, p.17).

The critical need for a comprehensive strategy to reignite growth prompted the introduction of the National Development Plan (NDP) in 2012. The plan represents South Africa's long–term blueprint for a range of socio–economic policies aimed at achieving the ambitious objectives of eliminating poverty, raising employment and halving income inequality by 2030 (National Planning Commission, 2011a). Meeting these objectives requires South Africa's economy to grow by about 5.5% per annum. The NDP places particular emphasis on improved export competitiveness and a well diversified export base as key drivers of the accelerated growth target. With export volume growth of 6% per annum, the NDP envisages that firms within a strong export sector, particularly in manufacturing, will create extensive linkages with the domestic economy (National Planning Commission, 2011b, p.119). Such linkages can lead to significant employment growth within small and expanding firms viewed as critical to the goal of reducing the current high levels of unemployment across the country's working population(Malan et al., 2014; Fourie, 2018).

While there is consensus around the need for improved export competitiveness, ambiguity remains on the appropriate direction South Africa's exchange rate needs to follow if the country is to sustain favourable trade balances. Since South Africa's full reintegration into the global economy, efforts to shape trade policy has generated significant debates on the ideal value of the country's currency (i.e. the Rand), with different parties advocating for a depreciation, an appreciation or a stabilisation of the exchange rate. Labour unions and manufacturing firms have consistently lobbied for government intervention to weaken or peg the Rand at a more competitive level (Oxford Business Group, 2012, p.116). The call for currency depreciation is largely shaped by the perception that a stronger rand tends to promote cheaper imports and act as a barrier to both industrial development as well as job creation in the manufacturing sector(Deloitte & Touche, 2016). Advocates of a stronger currency have countered this argument by noting that other factors such as consumer demand, level of growth and market penetration within the economies of trading partners may influence export performance and thus, a weaker currency will not necessarily stimulate export demand. Further, South Africa's strongest period of economic and export growth during the post–1994 transition coincided with relative stability and strength of the Rand (Draper, 2010).

The debate raises a vital policy question – what does the empirical evidence suggest about the effect of the Rand on South Africa's trade balance? The literature on the relationship between South Africa's trade balance and the Rand exchange rate tends to fall into one of the following three categories: (i) studies that employ aggregate trade data between South Africa and the rest of the world, (ii) studies that use bilateral level trade flows between South Africa and its major trading partners, and (iii) studies that utilize disaggregated industry level trade data between South Africa and one or more of its trading partners. Overall, the findings have been mixed on whether South Africa's trade balance exhibits the J–curve phenomenon defined as an initial post–currency depreciation (or devaluation) linked decline in trade balance followed by improvements once adjustment lags are realized.

The studies by Kamoto (2006), Schaling and Kabundi (2014) and Matlasedi et al. (2015) provided evidence supportive of the J–curve hypothesis as their empirical estimates indicated a long–run positive relationship between REER depreciation and South Africa's aggregate trade balance. Bahmani-Oskooee and Gelan (2012) examine post–devaluation behaviour of trade balance for a group of nine African countries including South Africa using the bounds test approach to cointegration and error–correction modelling developed by Pesaran et al. (2001). While the results did not support existence of short–run J–curve effect, they find that a real depreciation in the exchange rate has favourable long–run effects in the case of Africa's largest economies – Nigeria, South Africa and Egypt. Based on this finding, they conclude that real depreciation may promote positive trade balance in Africa's major economies. Using a similar econometric approach, Ziramba and Chifamba (2014) find that in both the short and long–run, a depreciation in REER of the Rand has no significant effect on South Africa's trade balance with the rest of the world. More recently, Moodley (2011) analyses the J–curve hypothesis for South Africa's bilateral trade with the BRIC countries (Brazil, Russia, India, and China) and reports mixed results on the impact of the real exchange rate on the trade balance. With the exception of Russia, the study found no relationship between the Rand exchange rate and South Africa's trade balance with Brazil, India and China. With no significant support for J–cuve effects, Moodley (2011) concludes that a devaluation of the Rand will not translate into long–term improvements in South Africa's trade balance with its BRIC partners.

Since 1994, various iterations of economic policy has emphasized the revitalization of the manufacturing (and mining) sector as a cornerstone of plans to expand the country's economic capabilities to design, manufacture and service products of increasing value (Department of Trade and Industry, 2015). In view of South Africa's strategy of re-industrialisation, a number of studies have examined the effect of exchange rate on manufacturing export performance. Using a Vector Error Correction Model (VECM), Chiloane et al. (2013) investigate the short and long–run effects of the REER of the Rand on the South African manufacturing trade balance and find evidence of J–curve effects. Additional sectoral evidence can be found in Joordan and Neshitenzhe (2015) and Edwards and Lawrence (2008). The former analysed among others, the dynamic effects of changes in the exchange rate on South Africa's manufacturing, mining and agricultural exports. They find that a real depreciation of the domestic exchange rate has positive long-run effect on manufacturing (and mining) export performance. In contrast, Edwards and Lawrence's (2008) empirical examination of the determinants of trade balance for a panel of 44 industries within South Africa's manufacturing sector shows that a real depreciation will not necessarily improve the manufacturing trade balance in South Africa.

The majority of the studies reviewed above have one common feature: they have used aggregate data on trade flows to analyse the impact of exchange rate on South Africa's trade balance. Where industry–level data has been employed, attention has focused exclusively on the manufacturing and mining sectors. To the best of our knowledge, no study has attempted to assess the the impact of the Rand exchange rate on South Africa's trade balance using bilateral industry level data. Noting this gap in the literature, the main contribution of this study is to employ industry trade data between South Africa and the United States (U.S.) to examine the dynamic relationship between the exchange rate and bilateral trade balance for an emerging, middle–income African economy. In addition to the disaggregated trade flow series, our research considers the relationship between the exchange rate and trade balance using data covering the period following the lifting of all trade sanctions and embargoes in the first half of 1991. This signalled a policy shift as the U.S. sought to support South Africa's transition to full democracy through initiatives that included the normalisation of trade between both countries. The focus on the post–sanction period represents a departure from existing studies on South Africa which tend to rely on post–1994 data when examining various aspects of the country's trade with the rest of the world.

The remainder of this paper is organized as follows.The next section provides some background to trade between South Africa and the U.S. In Section 3, we introduce a reduced form trade balance model and describe the empirical approach. We then present and discuss the results of the econometric tests in Section 4. Section 5 concludes and provides the policy implications of the study.

## 2 South Africa–U.S. Trade: Some Stylised Facts

Trade between South Africa and the U.S. can be traced back to 1680s when maritime facilities at the then Cape Colony's port city of Cape Town were utilised by American ships carrying enslaved Africans from Madagascar to the Americas. Along with slaves, the ships carried tobacco, wheat and lumber products, while delivering cotton and textiles sourced mainly from India and a range of consumer goods largely consisting of coffee, tea, sugar and spices to the Cape's growing European community (Ross, 1989). Following the formal abolishment of slavery across the western world between the mid–1820s and late 1860s, cotton and hides became prime commodities traded between South Africa and the U.S. The passing of the Wool and Woolens Act of 1867 placed a high tariff on wool imports into the U.S., effectively limiting foreign competition and assuring U.S. manufacturers a complete monopoly of the domestic market. The high tariff regime resulted in a marked reversal in the Cape's rising prominence in the wool trade market and the impairment of trade relations between both countries (Lulat, 2008).

The discovery of diamonds in Kimberly in 1867 and vast gold deposits on the Witwatersrand in 1886 reignited bilateral trade and significant levels of investment as U.S. Transnational Corporations (TNCs) sought to benefit from South Africa's mining revolution. In the aftermath of the 1899–1902 Anglo–Boer War, trade flows between both countries were enhanced by the rapid expansion of the US economy into world trade and South Africa's post–war economy benefiting from rapidly expanding gold production and a growing world economy (Ross, 1989). At the formation of the Union of South Africa in 1910, the value of trade flows between both countries was around U.S.$ 15 million with the U.S. accounting for 0.7% and 7.8% of South Africa's exports and imports, respectively (U.S. Department of Commerce, 1922, p.104). By 1933, value of total trade had risen to almost U.S.$ 60 million, with the U.S. market accounting for 5% and 13% of South Africa's total merchandise exports and imports, respectively (Jones and Müller, 1992, p.212).

Trade links between the U.S. and South Africa were further strengthened by the disruption of South Africa's traditional British sources of supply during World War II. Unlike most industrialized countries, South Africa avoided the ravages of the war and through expanded gold production and massive industrial developments, enjoyed rapid economic growth as gross national income almost doubled between 1939 and 1945. These factors encouraged the U.S. to pursue increased trading with South Africa (Worger, 1997). By 1960, some 160 U.S. businesses had direct operations in the South African market with their activities resulting in the doubling of U.S. private direct investment and exports directed to South Africa (Perkins, 1962, p.76).

Despite the formal adoption of the apartheid system by the old National Party in 1948, the country's largely pro–capitalist and strong anti–communist stance coupled with its status as the main supplier of strategically important minerals – uranium, vanadium, chromium and manganese, contributed to successive US administrations view of South Africa as valuable ally in the Cold War. This view ensured that in the three decades that followed South Africa establishing itself as a republican state in 1961, bilateral economic relations were largely shaped by political and strategic dynamics (Rich, 1988). Compared to most of the international community, U.S. foreign policy from the late 1950s to early 1980s emphasised economic engagement as a more viable option than embargoes and sanctions in ending apartheid (Ross, 1989). Without an explicit need to deal with the pernicious impact of apartheid on human rights, bilateral trade between both countries flourished. The value of South Africa's total trade (exports and imports) with the U.S. rose from just over U.S.$140 million in 1950 to almost U.S.$6 billion by 1980. A similar trend was observed in the levels of collective investments by U.S. firms, with direct investment by US based corporations increasing from just over U.S.$ 140 million in 1950 to U.S.$2.4 billion by 1980 (see Table 1).

**Table 1** South Africa–U.S. Bilateral Trade and Direct Investment, 1950–1990

| *Year* | *Total South Africa exports to the U.S. (U.S. $ millions)* | *Total South Africa imports from the U.S. (U.S. $ millions)* | *U.S. total direct investment in South Africa (U.S. $ millions)* |
|---|---|---|---|
| 1950 | 142 | 126 | 140 |
| 1955 | 96 | 28 | 257 |
| 1960 | 108 | 288 | 286 |
| 1965 | 226 | 438 | 528 |
| 1970 | 290 | 536 | 868 |
| 1975 | 840 | 1302 | 1582 |
| 1980 | 3321 | 2463 | 2350 |
| 1985 | 2071 | 1205 | 1394 |
| 1990 | 1698 | 1732 | 775 |

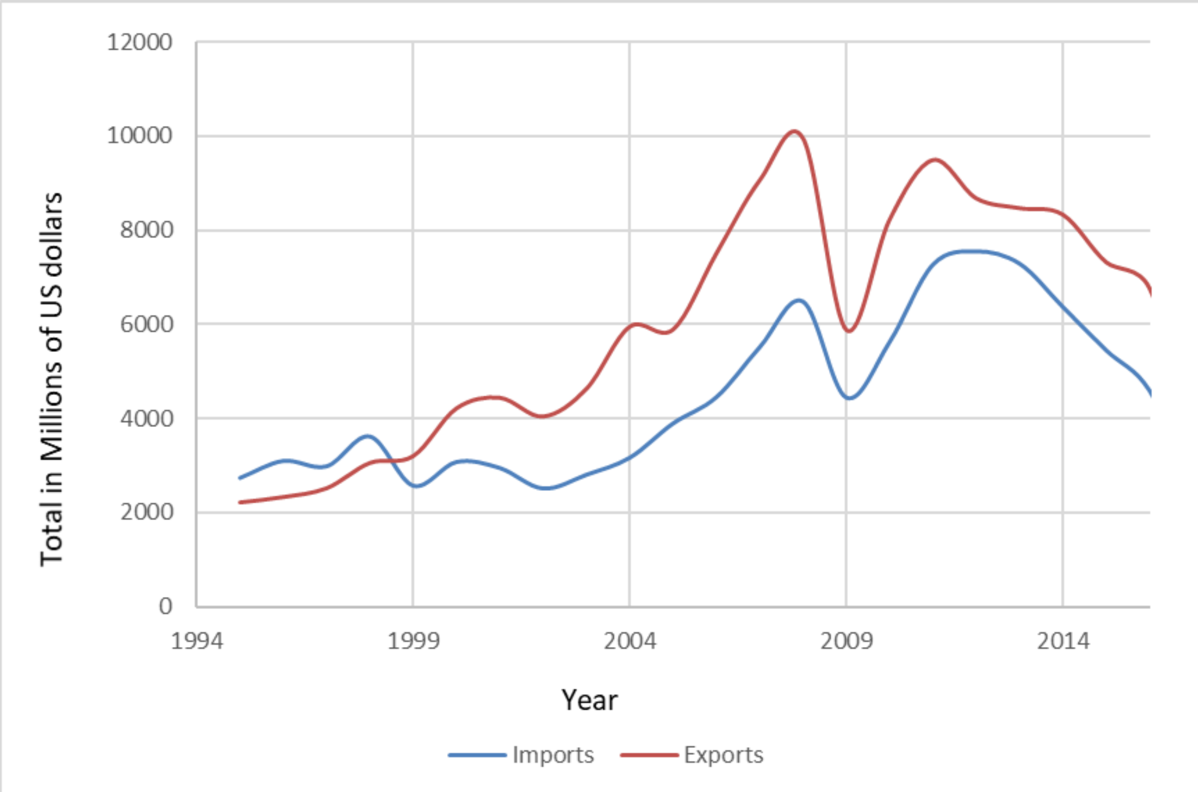
*Source*: U.S. Census Bureau (2017)

The 1976 Soweto uprisings began a wave of violent internal dissent against the apartheid regime. By the early 1980s, changing domestic perception on the need for political reforms in South Africa led to significant lobbying for the U.S. to adopt punitive economic sanctions (Manby, 1992). This eventually occurred with the imposition of the Executive Order 12532 of 1985 and the subsequent passing into law of the Comprehensive Anti–Apartheid Act (CAAA) in October 1986 which imposed import bans on iron, steel, coal, uranium, textiles, and agricultural goods (Redden, 1988; Evenett, 2002). Despite strategic materials, diamonds, and most forms of gold omitted from the list of CAAA sanctioned items, South Africa's export volumes to the U.S. declined by 40% in 1987 while direct investment fell to almost half of its 1980 levels due to disinvestments carried out by more than 120 U.S. firms between 1985 and 1987 (Harvey and Jenkins, 1994, p.197).

With South Africa's democratic transition in 1994 and subsequent full reintegration into global trade, bilateral trade between both countries has maintained a sustained pattern of expansion (Cook, 2013). In 1995, South Africa's total imports of U.S.$2.75 billion represented more than half of total U.S. exports purchased by sub-Saharan Africa (SSA). In the same year, South Africa exports totalled some U.S.$2.21 billion which was equivalent to 16% of all U.S. imports from SSA, and represented the main source of non–petroleum/energy–related SSA products shipped to the U.S. (Clark, 1996). Since 2001, trade between both countries has been largely facilitated through the Africa Growth and Opportunity Act (AGOA). Initiated with the objective of promoting sustainable economic growth and development through expansions in U.S. trade and investment with SSA countries, AGOA has proven to be an agreement providing mutual benefits to both countries. With the aid of the preferences set out in AGOA, South Africa has managed to grow and diversify its export volumes to the U.S., particularly in high value growth sectors of vehicles, machinery and agricultural products (Trade & Industrial Policy Strategies, 2016). For the U.S., duty–free status applied to a range of goods has allowed U.S. firms to utilise the South African market in building their regional value chains on the continent and expanding intra–industry trade in key advanced manufacturing activities within the chemical and automotive sectors (Prinsloo and Ncube, 2016). As a result, total trade between the U.S.

and South Africa has grown from U.S.$7.4 billion at the launch of AGOA in 2002, to a peak of U.S.$16.8 billion in 2011 before declining to U.S.$ 11.1 billion in 2016 (see Figure 1). Since 1994, the U.S. share of South Africa's total international trade has averaged between 7–9%, a trend that that has ensured the U.S.as the second most important single country destination for South African exports and the third highest source of imported goods into the country (South African Revenue Service, 2017).

**Figure 1** Value of total import and exports between the U.S. and South Africa, 1995–2016




*Source*: U.S. Census Bureau (2017)

## 3 Model Specification and Empirical Methodology

In assessing trade balance model at industry (or commodity) level, empirical studies typically rely on the theoretical framework developed by Ardalani and Bahmani-Oskooee (2007, p.2). In its simplest form the model can be stated as follows:

$$TB = F(Y, Y^*, E/P) \tag{1}$$

where $TB$ is the trade balance defined as the ratio of the value of exports to imports; $Y$ ($Y^*$) is domestic (trading partner) income. $E$ is the exchange rate and $P$ is the domestic price level with $E/P$ defined as the REER. Estimating the trade balance model for industry level trade between the U.S. and the rest of the world, Ardalani and Bahmani-Oskooee (2007) note that the inclusion of the REER in Eq.(1) embodies an aggregation bias. Subsequent studies (see for example Bahmani-Oskooee and Bolhasani (2008) and Bahmani-Oskooee et al. (2016)) have addressed this bias by replacing the REER with the real exchange rate. Following this approach, the modified trade balance model for industry $i$ can be written as:

$$TB_{i,t} = \alpha_0 + \alpha_1 Y_t^* + \alpha_2 Y_t^{SA} + \alpha_3 R_t + \epsilon_t \tag{2}$$

where $TB_i$ denotes the logarithm of the value of South Africa's exports of commodity $i$, divided by the value of its imports of commodity $i$ from the U.S.; $Y^{SA}$ and $Y^*$ denote measures of real income for South Africa and the U.S., respectively; $R$ represents the real bilateral exchange rate between the South African Rand and the U.S. Dollar and is defined as $\frac{P^{US} * NEX}{P^{SA}}$, where $P^{US}$ and $P^{SA}$ are the price levels measured by the consumer price index in the U.S. and South Africa, respectively, and $NEX$ is the nominal exchange rate defined as the number of South African Rands per U.S. dollar. Subscript $t$ denotes the time period and $\epsilon$ is a disturbance term. We transform all the variables in Eq.(2) into natural logarithms to allow for the slope coefficients to be interpreted as a measure of the elasticity of the dependent variable with respect to the regressors. As far as expected signs of the coefficients in Eq.(2) are concerned, we anticipate that $\alpha_1 > 0$ reflecting the fact that increased economic activity within the U.S. will stimulate demand for South Africa's exports of commodity $i$, leading to possible improvements in the trade balance for that commodity. However, increased incomes in the U.S. may promote the production of import substitute goods in that country. In that case, an increase in the levels of $Y^*$ may have a negative effect on South Africa's exports causing $\alpha_1 < 0$. [1] By the same token, the sign on real domestic income ($Y^{SA}$) is empirical and thus estimates of $\hat{\alpha}_2$ could be negative or positive. $R$ is defined in a way that an increase reflects real depreciation of the South African Rand. If an increase in $R$ creates increased domestic price competitiveness that results in greater volumes of South Africa's exports relative to import flows of commodity $i$ from the U.S. (i.e. the volume effect), then $\alpha_3 > 0$.

Estimating Eq.(2) will only yield long–run coefficients of the variables of interest. One of the objectives of this study is to examine both short and long–run relationship between exchange rate and bilateral commodity trade between South Africa and the U.S. To introduce the required dynamic adjustment mechanism into Eq.(2), we follow the literature (see for example Bahmani-Oskooee and Zhang (2013) and Baek (2013)) and rely upon Pesaran et al.'s (2001) ARDL bounds testing approach to reformulate Eq.(1) into an error–correction modelling format specified as:

$$\begin{aligned}\Delta TB_{i,t} = \alpha_0' + \sum_{k=1}^{n} \alpha_1' \Delta TB_{i,t-k} + \sum_{k=1}^{n} \alpha_2' \Delta Y_{t-k}^* + \sum_{k=1}^{n} \alpha_3' \Delta Y_{t-k}^{SA} \\ + \sum_{k=1}^{n} \alpha_4' \Delta R_{t-k} + \theta_1 TB_{i,t-1} + \theta_2 Y_{t-1}^* + \theta_3 Y_{t-1}^{SA} + \theta_4 R_{t-1} + \xi_t\end{aligned} \tag{3}$$

where $\Delta$ is the difference operator and $n$ is the lag order. In Eq.(3), short–run effects are captured by estimates of the coefficients attached to the first–differenced variables (i.e. $\alpha_1' - \alpha_4'$) while the long–run effects are reflected in estimates of $\theta_2$ –$\theta_4$ normalized on $\theta_1$. Eq.(3) differs from the standard vector autoregression (VAR) model of Engle and Granger (1987) by the addition of linear combination of lagged level variables as a proxy for the lagged error term. According

[1] For a detailed discussion of this hypothesis, see Bahmani-Oskooee (1986)

to Pesaran et al. (2001), the selected variables in Eq.(3) need to be cointegrated to ensure that long–run estimates are not spurious. The joint significance of lagged level variables as a sign of cointegration can be evaluated using an $F$–test with two sets of asymptotic critical values – upper and lower bound critical values, tabulated in Pesaran et al. (2001). Accordingly, An upper bound critical value is provided if all variables in the model are $I(1)$, or nonstationary, while a lower bound critical value is provided if they are all integrated of order zero ($I(0)$), or stationary. Where values of the calculated F–statistic exceed the upper bound critical value, lagged level variables are said to be jointly significant and thus cointegrated. On the other hand, computed $F$–statistic below the lower bound denotes no cointegration between selected variables. Finally, results are deemed inconclusive if the F–statistic lies between the two bounds.

# 4 Data and Empirical Results

## 4.1 Data

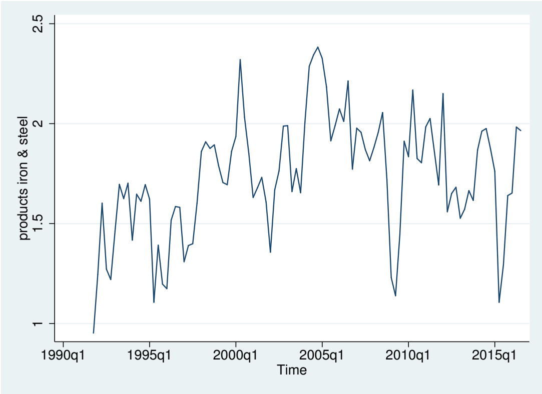
The empirical analysis in this study uses quarterly data incorporating the period of normalisation of trade between the U.S. and South Africa, i.e. from the first quarter of 1991 to the third quarter of 2016 (1991:Q4–2016:Q3). The values of commodity (or industry) exports and imports are based on the Harmonized System (HS) commodity code of trade flows between South Africa and the U.S. We utilise the HS2 level data in which merchandise trade statistics from the South African Revenue Service (SARS) are grouped under 23 commodity chapters (or sections as they are sometimes labelled). The relevant data was extracted from EasyData (https://www.easydata.co.za/), a comprehensive economic database managed by *Quantec*.

Based on the availability of continuous data over the study period, Eq.(3) is estimated for 19 of the 23 HS2 classified industries (or commodity trade). Together, these 19 industries account for over 98% of bilateral commodity trade between South Africa and the U.S. The incomes for South Africa and the U.S. are measured as seasonally adjusted GDP in constant 2010 U.S. Dollars and are taken from the Main Economic Indicators database of the Organization for Economic Co-operation (OECD). The nominal exchange rate between South African rand and the U.S. Dollar is obtained from the Online Statistical Query (historical macroeconomic time series information) system of the South African Reserve Bank (SARB). The consumer price indices (2010 = 100) for all items in South Africa and the US obtained from the OECD statistical database are used to derive the real bilateral exchange rate. Finally, all variables are in natural logarithms.

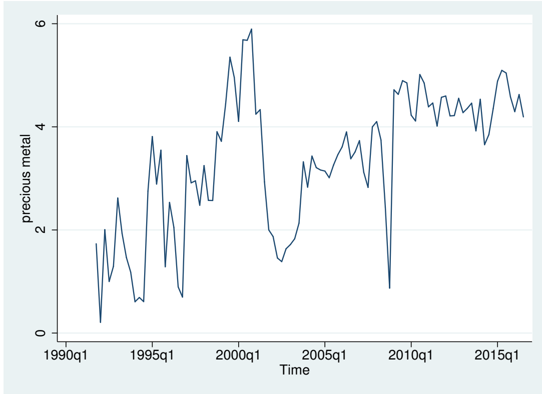
In order to gain some insight into the dynamic behaviour of inter–industry trade balance between South Africa and U.S., we plot these in Figure 2. For comparison, we also plot the behaviour of real GDP for both countries as well as the Rand/U.S.$ exchange rate over the period under review. For brevity, the plots are restricted to the top 5 industries/commodities: machinery, vehicles (aircraft & vessels), precious metals and iron& steel, which account for over 75% of all bilateral trade between South Africa and the U.S. From Figure 2, we note that real GDP for both countries largely exhibit a clear, upward linear trend over the period spanning 1991q4 – 2016q3. On the other hand, the exchange rate and trade balance variables display cyclical movements or random variations.[2]

[2]The plots for the trade balance for the other 14 industries exhibit similar cyclical and random variations.

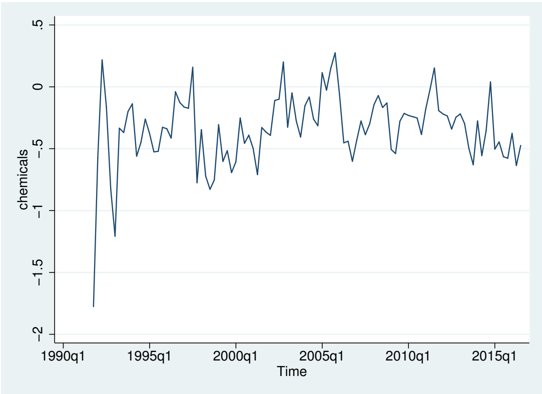
**Figure 2** Plot of Inter–Industry Trade Balance, Exchange Rate and Income



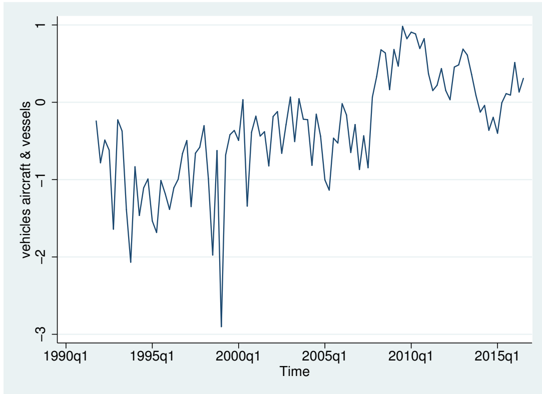

**(a)** Logarithm of Trade Balance for Iron & Steel




**(b)** Logarithm of Trade Balance for Precious Metals




**(c)** Logarithm of Trade Balance for Chemicals




**(d)** Logarithm of Trade Balance for Vehicles, Aircraft & Vessels

Shown in Table 2 are the descriptive statistics, such as the mean, standard deviation, skewness, and the Jarque and Bera (JB) statistics for industry–level trade balance, the real exchange rate and the real incomes for South Africa and the U.S., respectively. As the main objective of this study is to explore the effects of exchange rate changes on the trade balance, our focus is on both variables. The summary statistics show that there are substantial differences in the statistical properties of both the industry–level trade balance and the real effective exchange rate. For example, in comparison to the income measures, the industry–level trade balance and real exchange are largely symmetric based on the skewness coefficient; however, the Jarque–Bera statistic is significant at the 1% level for most of the variables. The means of the variables, particularly industry–level trade balance show large and wide variability, ranging from 0.196 to 60.1.

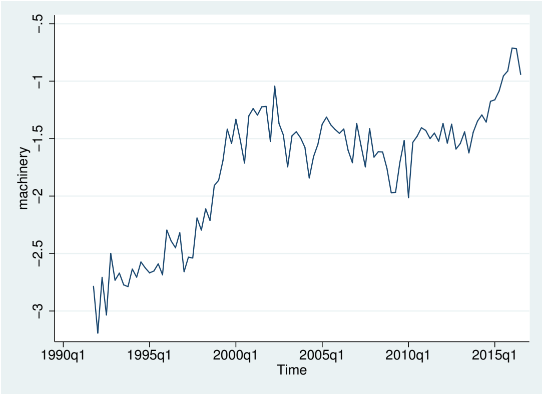
## 4.2 Empirical results[3]

In accounting for the integrating properties of the variables, the bounds testing approach dispenses with the need for pre-unit root testing (Bahmani-Oskooee and Baek, 2016).With most macroeconomic variables either $I(1)$ or $I(0)$, the advantage of using the bounds testing is that

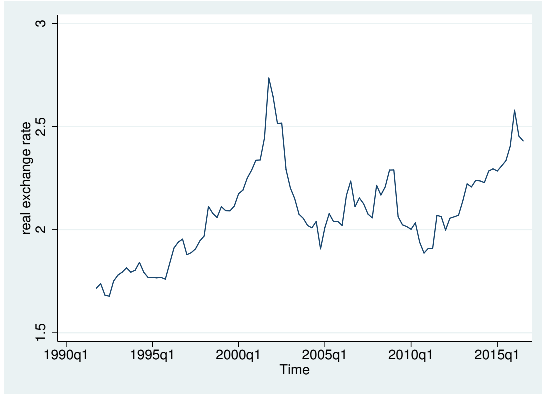
These are available from the authors upon request.

[3]The empirical results were generated from estimations carried out with Stata 14

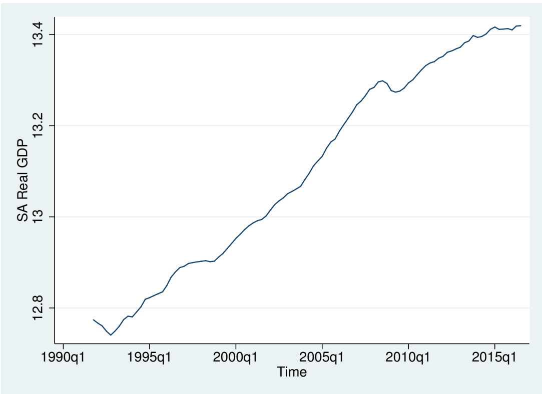
**Figure 2** (Continued)



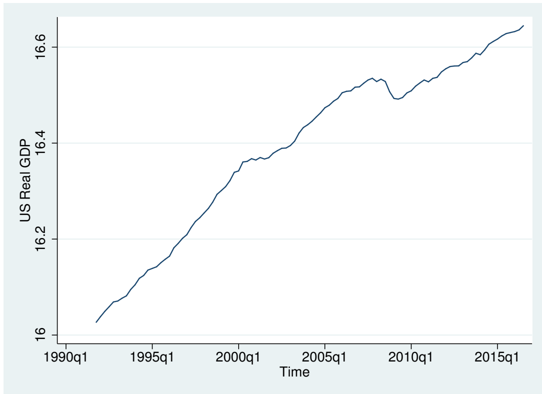

**(e)** Logarithm of Machinery




**(f)** Logarithm of Rand/$ Real Exchange Rate




**(g)** Logarithm of South Africa Real GDP




**(h)** Logarithm of U.S. Real GDP

**Table 2** Descriptive Statistics

| | **1991:Q1 – 2016:Q4** | | | | | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std.Dev | Minimum | Maximum | Skewness | JB |
| $TB_{16}$:Machinery (22.2%) | 0.196 | 0.096 | 0.032 | 0.495 | 0.04 | 5.32 |
| $TB_{17}$: Vehicles, aircraft & vessels (16.9%) | 0.898 | 0.599 | 0.049 | 2.64 | 0.00 | 13.63 |
| $TB_{06}$: Chemicals (12.9%) | 0.741 | 0.227 | 0.194 | 1.76 | 0.00 | 20.96 |
| $TB_{14}$: Precious Metals (11.7%) | 60.10 | 80.76 | 0.952 | 483.64 | 0.00 | 60.3 |
| $TB_{15}$: Iron & Steel (10.6%) | 5.94 | 1.80 | 2.46 | 10.82 | 0.02 | 5.71 |
| South Africa Real GDP – $Y^{SA}$ (billions of U.S.$) | 502.2 | 110924 | 341.3 | 672.8 | 0.61 | . |
| U.S. Real GDP– $Y^{*}$ (billions of U.S.$) | 1340 | 2261679 | 912 | 1690 | 0.14 | 19.4 |
| Real Rand/Dollar Exchange Rate – $R$ | 8.21 | 1.92 | 5.35 | 15.42 | 0.00 | 17.8 |

*Note*: $TB_k$ indicates trade balance for the $k^{th}$ industry/commodity where the numbers 16, 17, 06, 14 and 15 denote the industry classification for the listed traded items. Numbers inside the parentheses indicate the share of the industry in total South Africa–US bilateral trade, where trade shares are average values for the period 1991:Q4–2016:Q4. The selected industries represent the top 5 industry products traded between both countries.

the method dispenses with the need for pre-unit root testing of selected variables. We however note the the requirement of the bounds testing procedure that no I(2) variables that cause spurious results are employed in the analysis, and first examine the stationarity of the time series variables using the conventional Augmented Dickey–Fuller (ADF) and Phillips and Perron (PP) unit root tests. In both tests, the null hypothesis is that the variable contains a unit root, and the alternative is that the variable was generated by a stationary process. In the tests, we include both constant and trend terms and employ the SIC for the optimal lag order in the ADF test equation. The results of these tests for trade balance in selected industries as well as the income and exchange rate variables are given in Table 3. Both ADF and PP unit tests are in agreement that the majority of industry–specific trade balances as well as measures of real income and exchange rate are integrated of order 1.[4]

**Table 3** ADF and PP Unit root tests

| | Level | | First difference | |
|---|---|---|---|---|
| Variable | **ADF** | **PP** | **ADF** | **PP** |
| $TB_{16}$: Machinery | -1.594 | -2.790 | $-4.845^{***}$ | $-17.612^{***}$ |
| $TB_{17}$: Vehicles, aircraft & vessels | -3.116 | $-7.148^{***}$ | $-6.323^{***}$ | $-20.380^{***}$ |
| $TB_{06}$: Chemicals | -3.064 | $-8.016^{***}$ | $-6.850^{***}$ | $-15.428^{***}$ |
| $TB_{14}$: Precious Metals | $-3.219^{*}$ | $-4.484^{***}$ | $-5.583^{***}$ | $-13.227^{***}$ |
| $TB_{15}$: Iron & Steel | -3.131 | $-4.597^{***}$ | $-6.516^{***}$ | $-11.540^{***}$ |
| South Africa Real GDP – $Y^{SA}$ (billions of U.S.$) | -0.693 | 1.658 | $-3.544^{**}$ | $-6.516^{***}$ |
| U.S. Real GDP– $Y^{*}$ (billions of U.S.$) | -1.548 | -1.427 | $-3.789^{**}$ | $-5.028^{**}$ |
| Real Rand/Dollar Exchange Rate – $R$ | -2.242 | -2.262 | $-4.244^{***}$ | $-9.168^{***}$ |

† *Note*: The 1,5,and 10 % critical values are -4.05, -3.45, and -3.15 for the ADF tests, and -4.04, -3.45, and -3.15 for PP tests, respectively.$^{**}$, $^{**}$ and $^{*}$ indicate significance at the 1%, 5% and 10% levels, respectively.

Having established that none of the variables is integrated of order 2, we proceed to estimate the ARDL. As a first step, we determine the lag structure in Eq.(3). Following the empirical literature, we impose a maximum of four lags on each first–differenced variable in Eq.(3), and use the Akaike Information Criterion (AIC) to select an optimum model. Results from the selected optimum models detailing the short and long–run coefficient estimates are presented in Table 4.

The results of the trade balance model show that for almost half of the industries included in the analysis, at least one of the short–run real exchange rate coefficient estimates is statistically significant at the 10% level. In the context of each industry's trade share, this finding indicates that the real exchange rate is an important short–run determinant of the trade balance for commodities that account for almost 30% of total South Africa–U.S. bilateral trade. In the short–run, a pattern of negative coefficients followed by positive coefficients, supports the traditional definition of J–curve effects in a country's trade balance with its trading partners. Clearly, no such effect is observed from the estimation results of aggregate bilateral trade flows as the coefficient estimates of the real exchange rate in the short–run display a solely positive trend. If we are to end the analysis at this point, we would conclude that rather than cause an initial deterioration, a short–run depreciation of the rand (against the U.S. dollar) tends to improve South Africa's trade balance with the U.S. Does this finding hold at a disaggregated level? From the estimates in Table 4, we find that the traditional J–curve pattern is observed only in 3 industries (coded as 05, 13 and 18)[5] that collectively account for around 11% of total bilateral trade between South Africa and the U.S.

Unlike the traditional view which relies on specific short–run patterns, Rose and Yellen (1989, p. 67) posit that negative short–run coefficient combined with a positive long-run effect will

[4]The test results indicate that the trade balance for three industries/commodities – vegetables, prepared foodstuffs and raw hides and leather, are stationary in levels. The full set of unit root tests for the variables employed in the empirical analysis are available from the authors upon request.

[5]Where the codes relate to the HS classification for trade in mineral products, stone & glass and photographic & medical equipment, respectively

**Table 4** Short–run and long–run coefficient estimates of Eq.(3)

| Code | Industry (Trade share) | Panel A: Short–Run Estimates | | | Panel B: Long–Run Estimates | | | |
|---|---|---|---|---|---|---|---|---|
| | | $\Delta R_t$ | $\Delta\ R_{t-1}$ | $\Delta R_{t-2}$ | Constant | $Y^{SA}$ | $Y^{*}$ | $R$ |
| | **Aggregate** | 0.58(2.46)** | 0.57(3.21)*** | 0.47(3.14)*** | -67.11(6.12)*** | -4.27(6.26)*** | 7.48(7.27)** | -1.01(4.24)** |
| 01 | Live animals (0.61%) | -1.52(2.18)** | | | -15.51(1.18) | -8.02(2.40)** | 8.78(1.87)* | 1.75(1.74)* |
| 02 | Vegetables (2.66%) | | | | -84.02(4.31)*** | -3.03(2.02)** | 8.84(4.14)*** | 0.72 (1.59) |
| 04 | Prepared foodstuff (1.78%) | -1.47(2.55)*** | | | 2.48(0.26) | -1.31(1.08) | 0.71(0.41) | 1.13(2.96)** |
| 05 | Mineral products (5.43%) | -1.02(1.66)* | 1.22(2.01)** | -1.24(2.03)** | -18.23(1.55) | -2.45(1.13) | 4.02(1.31) | 0.72(1.06) |
| 06 | Chemicals(12.93%) | -0.21(0.73) | -0.46(1.58) | -0.54(1.80)* | 2.15(0.39) | 0.91(1.20) | -0.96(0.88) | 0.14(0.58) |
| 07 | Plastics & rubber(2.71%) | -0.37(1.58) | | | -20.66(3.37)*** | -4.57(5.29)*** | 6.17(5.01)*** | 0.37(1.42) |
| 08 | Raw hides & leather(0.35%) | | | | 40.11(2.72)*** | 8.66(3.10)*** | -12.3(3.09)*** | 2.25(2.65)*** |
| 09 | Wood products(0.53%) | | | | -15.12(1.22) | -8.65(2.32)** | 10.21(1.89)* | 1.36(1.17) |
| 10 | Wood pulp & paper(2.23%) | | | | -20.44(2.12)** | -4.76(2.51)*** | 6.30(2.43)** | -0.65(1.21) |
| 11 | Textiles(1.81%) | -0.54(1.86)* | -0.58(1.97)** | | -13.47(1.93)* | -10.67(7.12)*** | 11.05(4.99)*** | 1.20(2.36)** |
| 12 | Footwear(0.12%) | | | | -4.11(0.32) | 0.30(0.07) | 0.47(0.08) | 1.71(1.23) |
| 13 | Stone & glass(0.82%) | 0.02(0.07) | -0.95(2.47)** | 0.71(1.82)** | 1.84(0.26) | -4.02(1.06) | 2.48(0.46) | 0.18(0.15) |
| 14 | Precious metal(11.74%) | | | | -69.54(3.38)*** | -8.19(1.55) | 18.54(2.51)** | -3.71(2.33)** |
| 15 | Iron & steel(10.56%) | | | | -28.93(4.76)*** | -2.58(5.00)*** | 4.35(5.92)*** | -0.49(3.23)*** |
| 16 | Machinery(22.18%) | | | | -25.27(3.35)*** | -1.95(2.20)** | 4.70(3.89)*** | 0.77(2.99)*** |
| 17 | Vehicles, aircraft & vessels(16.92%) | -0.63(0.93) | -0.65(0.97) | 0.54(0.79) | -10.74(0.86) | 2.82(1.37) | -1.20(0.41) | 0.47(0.68) |
| 18 | Photographic & medical equipment(4.30%) | -0.11(0.26) | 0.22(0.53) | 0.96(2.24)** | -10.31(1.24) | -0.39(0.22) | 1.62(0.62) | -0.86(1.56) |
| 20 | Toys & sports apparel(0.89%) | -1.15(3.46)*** | | | 11.21(1.87)* | 0.20(1.31) | -1.84(0.95) | 1.01(2.29)** |
| 21 | Works of art(0.15%) | -2.04(1.90)* | | | -91.86(4.11)*** | -11.44(5.60)*** | 15.09(5.17)*** | 1.12(1.85)* |

† Numbers inside the parentheses denote the absolute value of the $t$–ratio. Trade shares are average values of the period 1991:Q4–2016:Q4, and are defined as the sum of exports and imports of industry (or commodity) $i$ as a percentage share of aggregate commodity trade (exports + imports) between South Africa and the US. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

support the J–curve hypothesis. If we rely upon this alternative definition, then evidence of the J–curve effect receives empirical support in bilateral industry–level trade in commodities coded 01, 04, 11, 20 and 21.[6] For these commodities, the short–run effects of real exchange rate on trade balance are not transitory as the respective long–run estimates (for the real exchange rate) are positive and statistically significant. Trade in these commodities are relatively small and they account for around 5.24% of total bilateral industry–level trade between South Africa and the U.S. Where the J–curve effects are absent, we observe that the long–run estimates of the real exchange rate are statistically significant in trade balance model for three commodities,namely precious metal, iron& steel as well as machinery. The results indicate that in the long–run, depreciation in real exchange rate benefits the balance in South Africa's trade with the U.S. in machinery, while a similar increase in the real exchange rate tends to worsen the trade balance of commodity flows for the other two industries coded 14 and 15, respectively. These findings are particularly important, as they suggest that the Marshall-Lerner (ML) condition only holds for a commodity (or industry) – machinery, accounting for the largest share (over 22%) of total bilateral trade flows between South Africa and the U.S.[7]

The level of economic activity in both countries is a major determinant of trade balance in the long–run. South Africa's income ($Y^{SA}$) carries a statistically significant coefficient in 10 of the 19 industries we investigated, and with the exception of commodity trade in raw hides (with industry code as 09), the estimates are expectedly negative. This finding suggests that expansions in South Africa's economy stimulates imports of commodities that account for a combined 44% of South Africa's commodity trade with the U.S. The coefficient estimates for U.S. income (i.e. $Y^{*}$) are statistically significant in 11 industries. The coefficient is expectedly

[6]Where the codes relate to the HS classification for trade in live animals, prepared foodstuff, textiles, toys & sports apparel and works of art.

[7]The ML condition states that for a devaluation of domestic currency to improve a country's trade balance or balance of payments, the sum of the price elasticities of demand for exports and imports must be greater than one.

positive for industries coded 01, 02, 07, 09, 10, 11, 14, 15, 16 and 21,[8] indicating that growth in U.S. economic activity or income levels has positive benefits for South Africa's merchandise exports by the coded industries. This finding is important given that three of these industries (precious metal, iron & steel and machinery) are among the top five by trade share and account for over 45% of total bilateral industry–level trade between South Africa and the U.S. (see Table 4).

The analysis carried out above are meaningful and long–run coefficient estimates valid only if we can establish cointegration. For this purpose, we turn to Table 5 which reports the results of the cointegration test as well as several other diagnostic statistics. Given the stated critical values of the $F$–test statistic, we note that the variables are cointegrated in most of the industry–specific trade balance models. Based on these findings, we note that the estimates are indeed meaningful for industries coded 01, 04, 05, 11, 13, 18, 20 and 21, where evidence of J–curve effects have been established. In the case of industries coded 12 and 13 where the $F$–test statistic is insignificant, we follow the literature and use an alternative test to verify cointegration. The preferred alternative test uses long–run normalized estimates and the long–run model specified in Eq.(1) to generate an error –correction term denoted as $ECM$. The linear combination of lagged level variables in Eq.(3) is replaced by $ECM_{t-1}$ following which each newly specified model is estimated using the same optimum lags as before. A significantly negative coefficient attached to $ECM_{t-1}$ will not only provide evidence of cointegration but also indicate convergence towards long–run equilibrium values (Banerjee et al., 1998, p.273). For all industries analysed in this study including those coded 12 and 13, the reported significantly negative coefficient of $ECM_{t-1}$ indicates that long–run estimates are non–spurious and provides support for cointegration across the the various industry–specific trade balance models.

Due to the presence of lagged variables in Eq.(3), we use the Lagrange Multiplier (LM) test to assess whether any of the estimated models suffer from serial correlation. The LM test is distributed as $\chi^2$ with one degree of freedom. From Table 5, we note that with the exception of industries coded 06, 08, 11 and 14, none of the the LM test statistics are significant. Based on this finding, we conclude that the residuals for most of the estimated error–correction trade balance models including industries where we find evidence of J–curve effects, are characterised by autocorrelation free residuals. Similar to the LM test, the RESET test is distributed as $\chi^2$ with one degree of freedom and is used to detect model misspecification. Compared to the calculated RESET statistics to the critical value of 3.84, we gather that with the exception of three industries coded 04, 14 and 17, the RESET test statistic is insignificant in most models implying that the majority of industry–specific error-correction trade balance models are correctly specified. Finally, following the literature we evaluate the stability of the short–run and long–run coefficient estimates by applying the well–known cumulative sum of squares tests to the residuals of the error–correction model specified in Eq.(3). The test statistics are indicated by $CUS^2$ and offer clear support that the estimated coefficients are stable in most models [9].

[8]The codes denote the HS classification for trade in the following industries: live animals, vegetables, plastics&rubber, wood products, wood pulp & paper, textiles, precious metal, iron & steel, machinery, and works of art.

[9]Stable estimates are denoted by "S" while unstable estimate are indicated by "U"

**Table 5** Diagnostic Statistics from Estimation of Eq.(3)

| Codes | Industry | $F$–Stat[a] | $ECM_{t-1}$[b] | LM[c] | RESET | Adj.$R^2$ | $CUS^2$ |
|---|---|---|---|---|---|---|---|
| | **Aggregate** | 29.38 | -1.04(10.37)** | 0.914 | 0.34 | 0.76 | S |
| 01 | Live animals | 6.46 | -0.37(4.94)** | 0.19 | 3.04 | 0.30 | S |
| 02 | Vegetables | 10.12 | -0.78(6.30)** | 0.01 | 0.82 | 0.34 | S |
| 04 | Prepared foodstuff | 15.02 | -0.74(7.70)** | 1.76 | 4.03 | 0.40 | U |
| 05 | Mineral products | 8.87 | -0.53(5.92)** | 1.33 | 1.59 | 0.50 | S |
| 06 | Chemicals | 15.51 | -0.69(7.73)** | 5.27 | 2.92 | 0.46 | U |
| 07 | Plastics & rubber | 10.51 | -0.47(6.14)** | 0.01 | 0.57 | 0.35 | U |
| 08 | Raw hides & leather | 6.22 | -0.46(4.75)** | 10.89 | 0.74 | 0.35 | S |
| 09 | Wood products | 4.35 | -0.26(3.84)** | 0.01 | 0.22 | 0.30 | S |
| 10 | Wood pulp & paper | 6.73 | -0.50(4.91)** | 0.75 | 2.51 | 0.39 | S |
| 11 | Textiles | 6.97 | -0.31(4.63)** | 5.43 | 2.97 | 0.28 | S |
| 12 | Footwear | 2.85 | -0.27(3.19)** | 0.07 | 0.60 | 0.26 | S |
| 13 | Stone & glass | 2.85 | -0.18(3.23)** | 0.04 | 1.96 | 0.22 | U |
| 14 | Precious metal | 7.76 | -0.38(5.15)** | 3.96 | 5.49 | 0.36 | S |
| 15 | Iron & steel | 10.69 | -0.83(6.52)** | 0.45 | 0.29 | 0.46 | S |
| 16 | Machinery | 4.05 | -0.46(4.02)** | 0.03 | 3.45 | 0.40 | S |
| 17 | Vehicles aircraft & vessels | 6.28 | -0.58(4.94)** | 1.64 | 5.42 | 0.49 | S |
| 18 | Photographic & medical equipment | 4.80 | -0.46(4.00)** | 0.152 | 2.49 | 0.37 | S |
| 20 | Toys & sports apparel | 9.93 | -0.47(5.15)** | 0.79 | 1.12 | 0.44 | S |
| 21 | Works of Art | 10.67 | -0.93(6.39)** | 1.34 | 1.74 | 0.62 | S |

Numbers inside parentheses are absolute values of $t$–ratios.
[a] The upper bound critical value of the $F$–test for cointegration when there are three exogenous variables ($k$=3) is 3.77 (4.35) at the 10% (5%) level of significance. These critical values are derived from Pesaran et al. (2001, Table CI – Case III, page 300). [b] At the 10% (5%) significance level when $k$=3, the critical value for significance of $ECM_{t-1}$ is -3.46(-3.78) and these are derived Pesaran et al. (2001, Table CII – Case III, page 303).
[c] LM is the Lagrange Multiplier test of residual serial autocorrelation. It is distributed as $\chi^2$ with one degree of freedom (first order). Its critical value at 5% (1%) is 3.84 (6.63). [d] RESET is Ramsey's test for model misspecification and is distributed as $\chi^2$ with one degree of freedom. The critical value is 3.84 at the 5% level and 6.63 at the 1% level. ** and * indicate significance at the 5% and 10% levels, respectively.

## 5 Summary and Conclusion

Across the world, efforts by countries to gain international competitiveness and boost export levels has generated renewed interest on the response of trade balances to exchange rate devaluations (or depreciations). The trade literature posits that the existence of adjustment lags delays improvements in a country's trade balance following a currency devaluation or depreciation. Instead, such currency devaluations or depreciations tend to worsen trade balance in the short–run before realization of lags cause an improvement in the long–run. The different patterns of short and long–run responses of trade balance to currency devaluation or depreciation describes the J–curve hypothesis.

Almost all previous research examining the J–curve phenomenon in South Africa's balance with its trading partners have either utilised aggregate trade flows between South Africa and the rest of the world or bilateral, aggregate trade flows between South Africa and its major trading partners. The very limited number of studies that have employed disaggregated trade flows have only considered manufacturing, mining and agricultural sectors in their analysis of the J–curve phenomenon. In this paper, we use the bounds testing approach of Pesaran et al. (2001) to re-examine the J–curve hypothesis in the context of disaggregated data on bilateral trade flows for 19 industries that are involved in trade between South Africa and the U.S. Under the

Harmonized System (HS) for recording merchandise trade statistics, the 19 industries represent those industries for which we were able to compile continuous quarterly trade (exports and imports) data over the period 1991:Q4–2016Q3. Combined, these 19 industries account for over 98% of trade between both countries.

The empirical results show that the traditional definition of the J–curve effect (where a real depreciation of the Rand against the U.S. dollar causes an initial deterioration of the trade balance followed by an improvement in the short run) holds for bilateral industry–level trade in mineral products, stone & glass as well as photographic & medical equipment. Combined, these products account for 11% of total trade between South Africa and the U.S. However, if we rely on a new definition of the J–curve as proposed by Rose and Yellen (1989, p.67) (short-run deterioration combined with long-run improvement in trade balance following exchange rate depreciation), then the concept receives empirical support in industry–level trade in live animals, prepared foodstuff, textiles, toys & sports apparel and works of arts, respectively. Thus, the J–curve effect (using the traditional and new definitions) receives support in the trade balance for eight industries that make up around 16% of total bilateral industry–level trade between South Africa and the U.S.

Favourable long–run effects of currency deprecation were observed in the trade balance model for trade in machinery, which accounts for over 22% of bilateral trade flows between the two countries. In addition, income in South Africa and the U.S. is found to have significant long–run effects, indicating that growth in both countries is an important determinant of bilateral trade flows. Growth in U.S. income is found to have significant and positive long–run effect on the trade balance of 11 cases including three of the five largest industries - precious metals, iron and steel and machinery, that collectively account for almost half of all bilateral trade flows between both countries. On the other hand, economic growth in South Africa will tend to raise levels of imports by industries that account for 44% of South Africa – U.S. trade flows.

An important implication that can be derived from our empirical results is the varied responses of aggregated data and disaggregated bilateral trade flow data to currency depreciation. Following realisation of adjustment lags, industries that account for a relatively small share (16%) of total South Africa–U.S. bilateral trade, benefit from a weakening of the rand against the US dollar. Hence, efforts to boost trade balance via improvements in industry–specific exports will require broader strategies beyond currency depreciation. Such strategies could include building competitiveness, particularly of small and medium exporting firms, through initiatives that aim to foster adoption of new technology and diversification towards products that require value–added inputs.

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