Industry-Level Evidence of J-Curve Effects in the SACU Region

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Our study examines the cointegration relationship between exchange rate movements and trade balances for the five Southern African Customs Union (SACU) countries between 1995 and 2020. We disaggregate trade activity at an industry-level for 19 trade products and then determine whether industries benefit or are at a disadvantage during periods of currency depreciations over the short- and long-run. Applying pooled mean group (PMG) estimators to panel regression specifications of the industry-level J-curve, we find that exchange rate depreciations would be beneficial in 8 out of the 19 trade industries in the SACU region whilst harming the remaining 11 industries. In the strict, theoretical sense we only find J-curve effects in 6 of the 19 industries in which exchange depreciation initially hurt trade balances and then 'adjust' towards positive long-run effects. Altogether, we advise policymakers in SACU countries to consider devising (i) export-oriented policies for industries whose trade balance is strengthened by currency depreciations and (ii) import substitution industrialization policies and currency-risk mitigation strategies for industries whose trade balance is weakened by currency depreciations.

Key Words: real exchange rates, trade balances, J-curve, industry-level, Pooled Mean Group (PMG) estimators, African countries
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Introduction

This study examines the relationship between exchange rates and trade balances (i.e. J-curve) for Southern African Custom Union (SACU) countries which form one of the oldest customs unions in the world (Manwa, Wijeweera, and Kortt 2019). Theoretically, the J-curve postulates that real currency devaluation initially deteriorates the trade balance in the short-run but then subsequently, via adjustment lags, leads to improved trade balance over the long-run (Magee 1973; Bahamani-Oskooee 1985). Estimating the J-curve for SACU countries is an interesting case study as these countries have strong exchange rate and trade ties via their affiliation to a Common Monetary Area (CMA) and Free Trade Area (FTA).

On one hand, the SACU nations are bound by a Trilateral Monetary Agreement signed in 1986, and existing bilateral agreements between the smaller nations and South Africa create a platform for conducting monetary policy and forming exchange rate policies in the region (Asongu, Nwachukwu, and Tchamyou 2017). In particular, the Central Banks in Lesotho, Namibia and Eswatini have sacrificed their monetary policy independence and pegged their domestic currencies 'one-for-one' against the South African Rand, which, in turn, is floated in currency markets. Although Botswana is no longer part of the CMA, its currency is linked to a basket of currencies where the South African Rand accounts for a majority of the currency basket, and therefore it can be interpreted that by implication, the Botswana Pula is informally pegged to the South African Rand.

On the other hand, the SACU region constitutes a customs-free zone with a common external tariff and the 5 countries are bound by a Customs Union 'agreement' formally introduced in 1969 and later refined in 2002 following the abolishment of Apartheid rule in South Africa and the formation of the World Trade Organization (WTO). At the core of the trade agreements is a revenue sharing formula which divides the customs and excise revenue collected from trade activity, with the smaller nations financing a significant proportion of their domestic 'public bill' and supporting industrial development initiatives through received customs revenue (Gibb and Treasure 2006).

To strengthen the vulnerability of the SACU countries to external shocks and improve competitiveness in international markets, the World Bank (2020a) has suggested structural transformations at industry level aimed at diversifying trade activity away from traditional commodity and mining sectors into innovative manufacturing and services economies. Currently, exports in the smaller SACU nations are concentrated in a small number of products, namely diamonds, sugar, beverages, textiles, and wood products, produced by very few firms (World Bank 2020a) and manufacturing sectors have experienced very little growth over the last two decades, particularly in the textile industry (Mlambo 2020). Makokera and Makokera (2020) suggest that industrial policies in SACU countries should not be limited to the manufacturing sector and SACU policymakers need to identify less explored yet highly innovative industries like trade in services and the digital economy.

At the centre of industrial policy, the exchange rate policy has been viewed as being instrumental to facilitating industrial development in SACU countries. Interestingly, there have been some observations recently made by academics and international governing agencies on how currency appreciations or depreciations influence industrial-level trade activity in the SACU region. For instance, Amusa and Fadiran (2019) show that South Africa's period of strong export performance and economic growth coincided with periods when the exchange rate was appreciating. Moreover, the World Bank (2015a) highlighted that, despite Botswana's reliance on natural resource exports, the country has not been affected by the 'Dutch Disease' even though the Pula has been overvalued since the global financial crisis. Conversely, the World Bank (2015a; b) argues that the overvaluation of the Lilangeni and Loti in the post-2009–2010 recessionary period remains a major source of concern for the textile industries in Eswatini and Lesotho whilst a more recent report by the World Bank (2020b) shows that recent currency depreciations resulting from the coronavirus pandemic may offer opportunities for manufacturing exports as well as for other trade areas.

However, the available empirical literature investigating the effects of currency movements on industry-level trade in SACU countries is mainly constrained to South African studies with a focus on manufacturing (Chiloane, Pretorius, and Botha 2014; Mlambo 2020) or agriculture industries (Poonyth and van Zyl 2000; Kargbo 2007). The consensus drawn from these studies is that exchange rate depreciations (appreciations) enhance (deteriorate) manufacturing and agricultural trade activity in South Africa. It is only the more recent studies of Amusa and Fadiran (2019) and Bahmani-Oskooee and Gelan (2020) which have examined the effects of exchange rate on a range of industry-level trade sectors in South Africa. On one hand, Amusa and Fadiran (2019) find J-curve effects in 6 out of 22 industries (live animals, prepared foodstuffs, textiles, machinery, toys and sports apparel, art works) whilst on the other hand, Bahmani-Oskooee and Gelan (2020) verify J-curve effects in 8 out of 25 industries (agriculture, marine products, food products, beverages and tobacco, wood products, printed material, machinery, computer and electronics). Together, the studies of Amusa and Fadiran (2019) and Bahmani-Oskooee and Gelan (2020) imply that exchange rate depreciations only benefit approximately a third of all trade products to the US, which are mainly agricultural and textile manufacturing trade.

Our study contributes to the developing literature in two ways. Firstly, it presents regional specific evidence of J-curve effects for the SACU countries, which to the best of our knowledge is the first study to do so. We find our panel approach convenient since the available industry-level trade data is constrained to annual data which would not yield enough data points to conduct country-specific analysis on individual SACU countries. Secondly, our study focuses on trade balances for 19 industry-level trade sectors against the rest of the world and not only confined to the U.S. bilateral trade. We argue that by focusing only on the bilateral trade with the US, previous works ignore the impact of industry-level trade activity with other key trading partners in Europe, the United Kingdom, Asia, Latin America and other African countries. The inclusion of other trading partners will provide a more complete picture of J-curve effects at industrial level trade activity for SACU countries.

Having provided a background to our study, the rest of the paper is organized as follows. Section 2 outlines the empirical framework of the study. Section 3 presents the empirical data along with the tests of integration. Section 4 presents our main empirical findings. Section 5 concludes the study in the form of policy implications and avenues for future research.

Empirical Framework

For each of the 19 industries, we model the J-curve specification similar to those used in Bahmani-Oskooee and Gelan (2012):

$$tb_{ij,t} = \beta_{0i} + \beta_{1i} dgdp_{i,t} + \beta_{2i} wgdp_{i,t} + \beta_{3i} reer_{i,t} + e_t,$$
$$i = 1, 2, \ldots, N, t = 1, 2, \ldots, T, \quad (1)$$

where, *tb* is natural logarithm of trade balance for industry *j* in country *i*, *dgdp* is natural logarithm of gross domestic product for country *i*, *wgdp* is natural logarithm of world gross domestic product, and *reer* is natural logarithm real effective exchange rate for country *i*.

As far as the expected signs on the regression coefficients are concerned, economic theory proposes that $\beta_1 < 0$ and $\beta_2 > 0$. In other words, an increase in domestic income induces local people to import more, hence worsening the trade balance, whereas an increase in the world income causes the rest of the world to substitute from exporting their products towards importing locally produced goods, which increases domestic exports and strengthens the trade balance. Moreover, in accordance with the J-curve theory, the sign on the β_3 coefficient is expected to be negative over the short-run and positive over the long-run, hence reflecting the 'J'-shaped relationship between real exchange rates and the trade balance.

To capture the short-run and long-run cointegration dynamics between the real exchange rate and the industrial trade balance we make use of the Pooled Mean Group (PMG) estimators of Pesaran, Shin, and Smith (1999). Notably, this econometric framework presents advantages over other contending panel models such as the panel vector autoregressive (PVAR) and the panel vector error correction model (PVECM) in the sense of accommodating a mixture of I(0) and I(1) variables. This is important as other panel models require all employed time series to be integrated of similar order and in most cases GDP and trade data evolve as unit root processes whereas real exchange rates would be stationary series, especially if they satisfy the purchasing power parity (PPP) condition (Nusair 2017). Pesaran, Shin, and Smith (1999) describe the PMG as a more efficient estimator than the mean group (MG) estimator and the dynamic fixed-effects (DFE) estimator since it involves both pooling and averaging and allows short-run coefficients and error correction coefficients to vary across countries but converge to a common long-run trend. In this regard, the PMG estimators provide an added advantage of dealing with possibly heterogeneous dynamics across countries and producing reliable estimates even with relatively small sample sizes.

We compactly re-formulate the trade balance equation (1) as the following panel autoregressive distributive lag (P-ARDL) specification:

$$tb_{it} = \sum_{j=1}^{p-1} \lambda_{i,j} tb_{i,t-j} + \sum_{j=0}^{q-1} \sigma_{1i,j} dgdp_{i,t-j} + \sum_{j=0}^{q-1} \sigma_{2i,j} wgdp_{i,t-j} + \sum_{j=0}^{q-1} \sigma_{3i,j} wgdp_{i,t-j}) + \varepsilon_{it}, \qquad (2)$$

where $\varepsilon_{it} = (\varepsilon_{i1}, \ldots, \varepsilon_{iT})$ is a vector of residual terms, and $\lambda_{i,j}$ and $\sigma_{i,j}$ are vectors of regression coefficients. The long-run coefficients (and intercept) in regression (1) are then computed as

$$\beta_{0i} = \frac{u}{1 - \sum_{j=1}^{p-1} \lambda_{i,j}}, \quad \beta_{1i} = \frac{\sum_{j=0}^{q-1} \sigma_{1i,j}}{1 - \sum_{j=1}^{p-1} \lambda_{i,j}},$$

$$\beta_{2i} = \frac{\sum_{j=0}^{q-1} \sigma_{2i,j}}{1 - \sum_{j=1}^{p-1} \lambda_{i,j}}, \quad \beta_{3i} = \frac{\sum_{j=0}^{q-1} \sigma_{3i,j}}{1 - \sum_{j=1}^{p-1} \lambda_{i,j}}.$$

The error correction representation of equation (2) can then be specified as:

$$\begin{aligned} \Delta tb_{i,t} = {} & \phi_i(tb_{i,t-1} - \beta_{0i} - \beta_{1i}dgdp_{i,t} - \beta_{2i}wgdp_{i,t} - \beta_{2i}reer_{i,t}) \\ & + \sum_{j=1}^{p-1} \lambda^{*}_{i,j}\Delta tb_{i,t-j} + \sum_{j=0}^{q-1} \sigma^{*}_{1i,j}\Delta dgdp_{i,t-j} \\ & + \sum_{j=0}^{q-1} \sigma^{*}_{2i,j}\Delta wgdp_{i,t-j} + \sum_{j=0}^{q-1} \sigma^{*}_{2i,j}\Delta reer_{i,t-j} + u_{it}, \end{aligned} \tag{3}$$

where Δ is a first difference operator, $\lambda^{*}_{i,j} = -\sum_{m=j+1}^{p} \lambda_{i,m}$, $\sigma^{*}_{i,j} = -\sum_{m=j+1}^{q} \sigma_{i,m}$, and $\phi_i = -(1-\sum_{j=1}^{p} \lambda_{i,j})$ is the error correction term which measures the speed of adjustment back to steady state equilibrium subsequent to a shock to the system and the parameter is expected to be significantly negative in value. To formally test for cointegration effects amongst the variables, we conduct the Pedroni (1999) panel cointegration tests for (i) within-dimension and (ii) between dimension. To compute the test statistics, Pedroni (1999) suggests the two-staged empirical process. Under the first stage, we estimate baseline regression equation (1) using the first differences of the variables, i.e.

$$\Delta tb_{i,t} = \beta_{0i} + \beta_{1i}\Delta dgdp_{i,t} + \beta_{2i}\Delta wgdp_{i,t} + \beta_{3i}\Delta reer_{i,t} + \eta_{i,t} \tag{4}$$

and we then compute the variable L^2 as the long-run variance of $\eta_{i,t}$ using the Newey-West estimator. Under the second stage, we extract the error term, $e_{i,t}$, from long-run cointegration regression (1) and estimate two regressions to extract parametric and non-parametric test statistics. For the parametric statistics, we estimate:

$$e_{i,t} = \psi ß e_{i,t-1} + \Delta e_{i,t-1} + \Delta e_{i,t-2} + \ldots + \Delta e_{i,t-p} + v_{i,t} \tag{5}$$

and use the residuals, $v_{i,t}$, to compute the long-run and simple variance of the errors as σ^2 and s^2, respectively. For the non-parametric statistics, we estimate:

$$e_{i,t} = \psi_i e_{i,t-1} + v_{i,t} \tag{6}$$

and, as before, we compute the long-run and simple variance of the errors as σ^2 and s^2, respectively and use them to create the variable, γ, as $\gamma = (\sigma^2 - s^2)/2$.

From regressions (5) and (6), Pedroni (1999) proposes the testing of two sets of hypotheses. Under the first set, the null hypothesis of no cointegration (i.e. H_{10}: $\psi_i = 1$ for all i) is tested against the alternative of cointegration effects (i.e. H_{11}: $\psi_i = \psi < 1$ for all i) which is tested using the following 4 within-dimension statistics (i.e. Panel v-statistic, Panel ρ-statistic, Panel ADF-statistic (parametric), Panel PP-statistic (parametric)). Under the second set of hypotheses, the null hypothesis of no cointegration (i.e. H_{10}: $\psi_i = 1$ for all i) is tested against the alternative of cointegration effects (i.e. H_{11}: $\psi_i < 1, \psi_i \neq \psi$) which is tested using the following 3 between-dimension statistics (i.e. Group ρ-statistic, Group ADF-statistic (parametric), Group PP-statistic (non-parametric)). The aforementioned test statistics are then compared with critical values tabulated in Pedroni (1999) to determine significance of cointegration effect amongst the observed series.

Empirical Data and Unit Root Tests

The empirical data used in our study is collected for the 5 SACU countries (South Africa, Botswana, Eswatini, Namibia and Lesotho) and is sourced from two main databases. Firstly, from the World Bank Development Indicators we source three variables, those being domestic GDP in millions of US dollars at 2015 constant prices (DGDP), world GDP in millions of US dollars at 2015 constant prices (WGDP) and the real effective exchange rate weighted against several foreign currencies (REER). Secondly, from the United Nations Conference on Trade and Development (UNCTAD) database, we collect import and export trade data with the rest of the world for 19 industries and we construct the trade balance (TB) variable by subtracting imports (M) from exports (X) and dividing the trade balance by GDP (i.e. (X – M)/GDP), which is consistent with previous literature, i.e. Bahmani-Oskooee and Gelan (2012), and Bahmani-Oskooee, Huseynov, and Jamilov (2013). Note that we collect our empirical data on annual frequencies between 1995 and 2020, and further transform our empirical data into their natural logarithm for empirical purposes.

The definitions and descriptive statistics of our empirical data is summarized in table 1 and as can be observed, the averages for the trade balance for all products produces a negative mean, implying an overall trade deficit for the SACU countries over the period 2001–2018. How-

TABLE 1 Summary of Panel Time Series Variables

Dependent variables	(1)	(2)	(3)	(4)	(5)
Domestic GDP	*dgdp*	W	9.098	3.875	0.00
World GDP	*wgdp*	W	17.710	4.237	0.00
Real effective exchange rate	*reer*	W	4.586	1.843	0.00
Trade balance: All products	ALL	U	−0.264	0.461	0.00
All food items	AFI	U	−0.461	1.186	0.00
Agricultural raw materials	ARM	U	0.044	1.239	0.30
Beverages and tobacco	BNT	U	−0.881	1.888	0.00
Chemical products	C	U	−1.338	1.655	0.00
Crude materials, inedible, except fuels	CI	U	0.814	1.311	0.00
Commodities and transactions	CNT	U	−0.371	2.567	0.13
Electronic excluding parts and components	E	U	−1.789	0.919	0.66
Fuels	F	U	−3.220	2.335	0.00
Food and live animals	FNL	U	−0.480	1.365	0.00
Iron and steel	INS	U	−2.020	2.425	0.48
Manufactured goods	MG	U	−0.984	0.927	0.00
Mineral fuels, lubricants and related materials	MLNR	U	−3.220	2.335	0.00
Miscellaneous manufactured articles, n.e.s.	MMA	U	−1.646	1.393	0.02
Machinery and transport equipment	MNT	U	−1.592	0.765	0.03
Ores and metals	ONM	U	0.519	2.012	0.00
Primary commodities	PC	U	0.154	1.098	0.00
Parts and comp. for elect. and electronic goods	PNC	U	−2.309	1.238	0.49
Pearls, precious stones and non-monetary gold	PPN	U	−2.310	2.941	0.00
Textile fibres, yarn, fabrics and clothing	TYFC	U	−0.619	1.046	0.00

NOTES Column headings are as follows: (1) notation, (2) source, (3) mean, (4) standard deviation, (5) JB (*p*-value). W – World Bank Development Indicators, U – United Nations Conference on Trade and Development.

ever, when the trade basket is disaggregated into 19 products, we observe 4 commodities which, on average, have exports which are greater than their imports due to possible comparative advantages in production (i.e. Primary commodities, precious stones and non-monetary gold; Agriculture raw materials; Ores and metal; Crude materials, inedible except fuels). We note the remaining 15 trade commodities produce negative trade balance averages which may signify comparative disadvantages in production in commodities such as electronics as well as their parts and components;

TABLE 2 Unit Root Test Results

Variable	Levin, Lin, and Chu				Im, Pesaran, and Shin			
	Int	Trend	Int	Trend	Int	Trend	Int	Trend
dgdp	−1.07*	0.59	−4.88***	−4.28***	0.99	−0.14	−3.57***	−1.87**
wgdp	−0.74	1.11	−3.12***	−2.33***	1.97	0.61	−2.71***	−2.84***
reer	−1.49*	−0.35	−4.73***	−3.88***	−1.89**	−1.17	−4.15***	−2.52***
ALL	−1.53*	0.14	−2.86***	−1.46*	−1.23	0.08	−4.64***	−3.23***
AFI	−1.38*	0.00	−4.06***	−2.30***	−0.66	−0.50	−5.63***	−4.08***
ARM	−2.03**	−2.40***	−8.81***	−7.20***	−1.73**	−2.21***	−8.33***	−6.83***
BNT	−0.44	0.58	−4.61***	−3.25***	−0.34	0.03	−5.57***	−4.58***
C	−1.99**	−1.68**	−6.18***	−5.24***	−1.16	−0.08	−6.78***	−6.02***
CI	−1.05	−0.95	−6.78***	−5.50***	−0.61	−0.83	−6.86***	−5.39***
CNT	−0.51	−0.43	−5.03***	−3.61***	−0.46	−0.45	−4.98***	−3.42***
E	−0.57	−1.35*	−6.16***	−5.18***	−1.13	−1.14	−6.46***	−5.28***
F	−2.20**	−1.44*	−5.09***	−3.43***	−1.52*	−0.72	−5.86***	−4.43***
FNL	−1.59*	−0.30	−3.62***	−1.56*	−0.77	−0.77	−6.66***	−5.21***
INS	−0.76	0.04	−4.29***	−2.94***	−1.94**	−0.75	−4.96***	−3.51***
MG	−2.07**	−0.58	−3.77***	−2.61***	−1.63*	−0.14	−5.25***	−4.01***
MLNR	−2.20**	−1.44*	−5.09***	−3.43***	−1.52*	−0.72	−5.86***	−4−43***
MMA	0.06	−0.36	−5.47***	−4.38***	−0.28	0.38	−5.38***	−4.26***
MNT	−1.01	−1.87**	−2.99***	−2.42***	−0.72	−1.78**	−5.96***	−4.46***
ONM	−0.82	−0.29	−3.24***	−1.58**	−0.97	−1.01	−7.25***	−5.84***
PC	−0.39	1.59	−2.94***	−2.06**	0.20	0.98	−5.13***	−3.97***
PNC	−0.30	−0.37	−2.78***	−2.71***	0.21	−0.73	−5.24***	−3.59***
PPN	0.96	1.38	−1.53*	0.16	0.96	0.03	−4.06***	−2.59***
TYFC	0.45	0.82	−3.87***	−3.11***	0.38	0.94	−3.55***	−2.37***

NOTES ***, **, * indicate significance at the 1%, 5% and 10% levels.

and in manufactured goods as well as in machinery and transport equipment.

Table 2 presents the findings from Levin, Lin, and Chu (2002) (hereafter LLC) and Im, Pesaran, and Shin (2003) (hereafter IPS) panel unit root tests performed with (i) an intercept and (ii) an intercept and trend, on our empirical series. Whereas the LLC tests the null hypothesis that each individual time series contains a unit root against the alternative that each series is I(0) stationary, the IPS tests the null hypothesis of a unit root against the alternative hypothesis that some of the individual series do not contain unit roots. The reported findings in table 2 are ambiguous when both tests are performed on the levels of the variables, regardless of whether an intercept or a trend is included. However, in their first differences all test statistics manage to reject the respective unit root hypotheses in both tests, hence rendering the series to be generally first-difference stationary variables. All in all, we render the series compatible with the proposed PMG estimators as none of the series is integrated of an order higher than I(1).

Empirical Results and Discussions

We begin our empirical analysis by reporting the panel cointegration tests on the estimated panel ARDL regressions for each of the 19 industries. The computed within-statistics (pooled statistics) and the between-statistics (pooled-mean group statistics) for all industries are reported in table 3. The within-statistics, which test the null of no cointegration against the alternative 'homogenous' cointegration effects, reject the null hypothesis in 32 out of the 80 tested cases (i.e. Panel v-statistics with 4 out of 20 cases; Panel ρ-statistics with 5 out of 20 cases; Panel ADF-statistics with 9 out of 20 cases; and Panel PP-statistics with 14 out of 20 cases). Collectively, we note that for 4 industries the null hypotheses cannot be rejected in all 'within-statistics' (i.e. All allocated products; Iron and Steel; Miscellaneous manufactured articles; and Primary commodities, precious stones and non-monetary gold). On the other hand, the between statistics, which test the null of no cointegration against the alternative 'heterogenous' cointegration effects, offer more optimistic results as they reject the null hypothesis in 38 out of the 60 tested cases (i.e. mean-group ρ-statistics with 8 out of 20 cases; mean-group ADF-statistics with 10 out of 20 cases; and mean-group PP-statistics with 20 out of 20 cases). Note that at least one of the mean group statistics mange to reject the no cointegration null hypothesis for all trade industries which we treat as sufficient evidence in favour of cointegration effects in all selected industries. We hence proceed to our main PMG estimates.

The PMG estimates of the PARDL model are reported in table 4 for the short-run dynamics and in table 5 for the long-run. From the short-run estimates, we firstly note that 9 trade commodities produce their expected negative and statistically significant estimates on at least one of the two lags on the real exchange rate variable (i.e. Beverages and tobacco; Commodities and transactions; Fuels; Iron and steel; Manufactured goods;

TABLE 3 Panel Cointegration Test Results

Industry	Within-statistics				Between-statistics		
	Panel v-Statistic	Panel -Statistic	Panel ADF-Statistic	Panel PP-Statistic	Group -statistic	Group PP-statistic	Group ADF-statistic
ALL	−0.39 (0.65)	0.37 (0.39)	0.38 (0.65)	−0.10 (0.46)	0.15 (0.56)	−0.72 (0.23)	−1.14 (0.09)*
AFI	−0.61 (0.73)	0.63 (0.73)	−0.00 (0.50)	−0.59 (0.28)	−0.11 (0.46)	−0.66 (0.26)	−1.45 (0.07)*
ARM	−1.32 (0.91)	−1.43 (0.07)*	−4.71 (0.00)***	−3.40(0.00)***	−1.99 (0.02)**	−3.72 (0.00)***	−3.72 (0.00)***
BNT	0.65 (0.26)	−1.74(0.04)*	−2.59 (0.00)***	−4.91(0.00)***	0.19 (0.57)	−7.74 (0.00)***	−5.29 (0.00)***
C	0.30 (0.30)	−0.32 (0.37)	−0.05 (0.48)	−2.51(0.01)***	−2.98 (0.00)***	−2.28 (0.01)***	−9.12 (0.00)***
CI	−0.96 (0.83)	−0.66 (0.25)	−2.02 (0.02)**	−2.23 (0.01)*	−2.25 (0.01)***	−3.04 (0.00)***	−9.99 (0.00)***
CNT	0.18 (0.43)	−0.49 (0.31)	−3.51 (0.00)***	−3.99 0.00)***	0.04 (0.51)	−3.33 (0.00)***	−2.93 (0.00)***
E	−0.04 (0.51)	−0.92 (0.10)*	−4.36 (0.00)***	−3.77(0.00)***	−1.01 (0.10)*	−3.72 (0.00)***	−5.56 (0.00)***
F	0.15 (0.44)	0.14 (0.56)	0.04 (0.52)	−1.75 (0.04)**	−0.76 (0.22)	−0.78 (0.22)	−2.39 (0.01)***
FNL	−0.79 (0.79)	0.68 (0.75)	−0.72 (0.23)	−0.98 (0.09)*	−0.52 (0.30)	−0.59 (0.28)	−2.04 (0.02)**
INS	0.16 (0.44)	0.75 (0.77)	1.01 (0.84)	−0.20 (0.42)	−2.11 (0.02)**	−2.88 (0.00)***	−9.29 (0.00)***
MG	−0.88 (0.81)	−1.01 (0.10)*	−1.54 (0.06)*	−2.72 0.00)***	0.13 (0.55)	−0.37 (0.35)	−1.18 (0.09)*
MLNR	0.15 (0.44)	0.14 (0.56)	0.04 ((0.52)	−1.75 (0.04)**	−0.76 (0.22)	−0.78 (0.22)	−2.39 (0.01)***
MMA	0.01 (0.49)	0.42 (0.66)	0.52 (0.70)	−0.81 (0.21)	−0.94 (0.10)*	−2.72 (0.00)***	−5.21 (0.00)***
MNT	0.01 (0.50)	−0.63 (0.27)	−4.80(0.00)***	−4.60 (0.00)***	−0.10 (0.46)	−1.46 (0.07)*	−1.40 (0.03)*
ONM	1.31 (0.09)*	0.01 (0.51)	−1.23 (0.09)*	−1.91 (0.03)**	−0.87 (0.10)*	−0.32 (0.37)	−2.62 (0.00)***
PC	−0.14 (0.55)	0.70 (0.76)	0.81 (0.79)	0.05 ((0.52)	0.18 (0.57)	−0.37 (0.35)	−0.97 (0.09)*
PNC	1.34 (0.09)*	−1.99(0.02)**	−1.99 (0.02)**	−8.96 0.00)***	−1.57 (0.05)**	−1.20 (0.10)*	−3.67 (0.00)***
PPN	1.25 (0.10)*	−0.79 (0.22)	−0.12 (0.45)	−2.55(0.01)***	−0.31 (0.38)	0.82 (0.79)	−3.54 (0.00)***
TYFC	1.02 (0.10)*	0.05 (0.52)	−0.41 (0.34)	−0.77 (0.22)	0.37 (0.65)	−0.47 (0.32)	−1.97 (0.02)**

NOTES Numbers inside the parentheses next to coefficient estimates are *t*-ratios. The numbers inside the parentheses next to coefficient estimates of the normality are the probability. The numbers inside the parentheses next to coefficient estimates of the LM and heteroskedacity are the probability (Chi-square). ***, **, * indicate significance at the 1%, 5% and 10% levels. The numbers inside the parentheses next to coefficient estimates of the reset are the probability of the *t*-statistic.

TABLE 4 Summary for Short-Run Results

Industry	Short Run Estimates										
	Δtb_{t-1}	Δtb_{t-2}	$\Delta dgdp$	$\Delta dgdp_{t-1}$	$\Delta dgdp_{t-2}$	$wgdp$	$wgdp_{t-1}$	$wgdp_{t-2}$	$\Delta reer$	$\Delta reer_{t-1}$	$\Delta reer_{t-2}$	ect_{t-1}
ALL	0.01 (0.96)	0.24 (0.35)	0.03 (0.94)	0.30 0.73)	1.13 (0.21)	0.50 (0.39)	−0.69 (0.52)	−1.16 (0.10)*	0.19 (0.78)	−0.07 (0.95)	−0.88 (0.52)	−0.64 (0.01)**
AFI	−0.68 (0.05)**	−0.33 (0.04)**	2.03 (0.10)*	2.86 (0.26)	0.27 (0.86)	−1.25 (0.45)	−2.99 (0.10)*	1.47 (0.33)	−1.85 (0.26)	−2.49 (0.30)	−0.84 (0.61)	−0.46 (0.02)**
ARM	−0.65 (0.00)***	−0.49 (0.00)***	−3.39 (0.06)*	−3.27 0.05)**	−1.01 (0.67)	1.96 (0.05)**	4.49 (0.02)**	2.71 (0.03)**	3.62 (0.01)***	3.45 (0.05)**	2.53 (0.55)	−0.11 (0.00)***
BNT	0.10 (0.83)	0.02 (0.95)	6.51 (0.09)*	10.04 (0.09)*	4.17 (0.45)	−2.65 (0.21)	−12.00 (0.10)*	1.81 (0.61)	−4.70 (0.09)*	−10.53 (0.10)*	−2.82 (0.44)	−0.68 (0.01)**
C	−0.47 (0.09)*	−0.44 (0.02)**	−1.85 (0.03)**	−1.36 (0.44)	−1.59 (0.09)*	4.25 (0.09)*	2.06 (0.58)	4.79 (0.02)**	1.70 (0.30)	−0.15 (0.97)	0.94 (0.69)	−0.65 (0.01)**
CI	0.38 (0.09)*	0.19 (0.14)	4.17 (0.32)	−2.05 (0.41)	2.80 (0.55)	−2.27 (0.39)	6.82 (0.01)***	1.23 (0.69)	−4.42 (0.26)	3.90 (0.01)***	−1.90 (0.75)	−1.07 (0.06)*
CNT	−0.68 (0.00)***	−0.31 (0.39)	12.08 (0.41)	2.21 (0.54)	−4.69 (0.66)	−15.78 (0.25)	2.32 (0.82)	6.29 (0.49)	−12.33 (0.46)	−7.06 (0.09)*	−5.70 (0.63)	−0.36 (0.00)***
E	0.01 (0.98)	0.08 (0.70)	1.47 (0.58)	−0.67 (0.84)	2.32 (0.35)	−2.29 (0.45)	3.07 (0.65)	1.00 (0.52)	7.29 (0.23)	2.70 (0.32)	−1.40 (0.63)	−0.66 (0.01)**
F	−0.52 (0.01)*	−0.43 (0.07)*	7.82 (0.01)***	6.96 (0.04)**	7.82 (0.04)**	−3.39 (0.04)**	−6.05 (0.01)***	−5.63 (0.28)	−3.14 (0.37)	−5.89 (0.09)*	−9.35 (0.02)**	−0.98 (0.00)***
FNL	−0.68 (0.02)**	−0.40 0.02)**	1.18 (0.23)	2.76 (0.16)*	0.06 (0.96)	−0.64 (0.78)	−2.91 (0.09)*	1.45 (0.42)	−1.57 (0.34)	−2.59 (0.22)	−0.85 (0.63)	−0.44 (0.02)**
INS	0.64 (0.08)*	0.39 (0.33)	−2.45 (0.27)	1.06 (0.44)	−1.94 (0.33)	5.79 (0.05)**	−2.58 (0.09)*	4.13 (0.27)	3.99 (0.09)*	−3.93 (0.04)**	−1.55 (0.71)	−1.29 (0.01)***
MG	0.12 (0.60)	0.06 (0.70)	−0.15 (0.86)	1.31 (0.10)*	−0.00 (0.99)	0.78 (0.41)	−0.88 (0.30)	0.96 (0.32)	0.89 (0.31)	−2.05 (0.10)*	−0.75 (0.57)	−0.95 (0.01)***
MLNR	−0.29 (0.02)**	−0.56 (0.23)	7.82 (0.01)***	6.96 (0.04)**	7.82 (0.04)**	−3.39 (0.04)**	−6.05 (0.01)***	−5.63 (0.28)	−3.14 (0.37)	−5.89 (0.09)*	−9.35 (0.02)**	−0.98 (0.00)***
MMA	−0.39 (0.00)***	−0.18 (0.06)*	0.60 (0.91)	4.43 (0.09)*	2.56 (0.40)	0.42 (0.95)	−6.23 (0.10)*	−2.38 (0.62)	2.48 (0.65)	−5.43 (0.04)**	−2.08 (0.59)	−0.19 (0.02)**
MNT	0.89 (0.56)	0.53 (0.82)	1.70 (0.10)*	−0.09 (0.93)	−1.11 (0.04)**	−1.72 (0.10)*	0.18 (0.66)	2.94 (0.00)***	−1.17 (0.64)	0.45 (0.82)	1.37 (0.41)	−0.75 (0.00)***
ONM	0.13 (0.71)	0.20 (0.47)	6.45 (0.00)***	0.41 (0.89)	−0.30 (0.94)	−4.00 (0.26)	5.61 (0.09)*	2.29 (0.67)	−8.53 (0.00)***	1.06 (0.74)	2.46 (0.66)	−1.03 (0.09)*
PC	−0.57 (0.00)***	−0.12 (0.65)	0.68 (0.52)	0.49 (0.80)	1.63 (0.32)	0.40 (0.77)	0.50 (0.59)	−0.67 (0.63)	0.44 (0.69)	0.20 (0.92)	−0.35 (0.81)	−0.10 (0.02)**
PNC	−0.49 (0.10)*	−0.03 (0.91)	−1.83 (0.42)	−2.75 (0.12)*	−4.73 (0.08)*	0.10 (0.95)	4.34 (0.08)*	5.09 (0.09)*	1.09 (0.77)	1.00 (0.63)	4.18 (0.10)*	−0.36 (0.15)
PPN	−0.38 (0.09)*	−0.06 (0.68)	−2.37 (0.48)	2.99 (0.69)	1.53 (0.49)	−5.56 (0.01)***	−2.07 (0.77)	−0.99 (0.86)	2.28 (0.61)	−1.94 (0.87)	4.44 (0.55)	−0.22 (0.01)**
TYFC	−0.82 (0.01)**	−0.56 (0.02)**	2.20 (0.24)	1.64 (0.23)	−0.42 (0.69)	−1.26 (0.59)	0.60 (0.55)	−0.30 (0.82)	−4.12 (0.02)**	−3.23 (0.07)*	−0.21 (0.86)	−0.43 (0.02)**

NOTES Numbers inside the parentheses next to coefficient estimates are *t*-ratios. The numbers inside the parentheses next to coefficient estimates of the normality are the probability. The numbers inside the parentheses next to coefficient estimates of the LM and heteroskedacity are the probability (Chi-square). ***, **, * indicate significance at the 1%, 5% and 10% levels. The numbers inside the parentheses next to coefficient estimates of the reset are the probability of the *t*-statistic.

TABLE 5 Summary of Long-Run Results

Industry	Long Run Estimates		
	dgdp	*wgdp*	*reer*
ALL	−1.51 (0.00)***	1.72 (0.00)***	0.58 (0.00)***
AFI	2.36 (0.00)***	−3.02 (0.00)***	−1.63 (0.00)***
ARM	32.05 (0.00)***	−36.48 (0.00)***	−29.16 (0.00)***
BNT	−4.10 (0.00)***	3.26 (0.00)***	7.36 0.00)***
C	3.95 (0.00)***	−4.92 (0.00)***	−3.91 (0.00)***
CI	0.15 (0.75)	0.41 (0.43)	−2.53 (0.00)***
CNT	−69.41 (0.00)***	86.96 (0.00)***	81.99 (0.00)***
E	−4.69 (0.00)***	5.60 (0.00)***	−6.12 (0.00)***
F	−6.55 (0.00)***	7.41 (0.00)***	5.22 (0.00)***
FNL	2.99 (0.00)***	−3.77 (0.00)***	−2.16 (0.00)***
INS	0.65 (0.00)***	−1.23 (0.00)***	−0.03 (0.89)
MG	−1.83 (0.00)***	2.18 (0.00)***	1.39 (0.00)***
MLNR	−6.55 (0.00)***	7.41 (0.00)***	5.22 (0.00)***
MMA	−25.68 (0.00)***	29.33 (0.00)***	12.12 (0.00)***
MNT	−0.54 (0.10)*	0.76 (0.05)**	−0.46 (0.10)*
ONM	0.00 (0.99)	0.47 (0.33)	−2.43 (0.00)***
PC	10.32 (0.01)***	−13.26 (0.01)***	−17.86 (0.00)***
PNC	3.35 (0.01)***	−3.77 (0.01)***	−3.15 (0.00)***
PPN	5.74 (0.40)	−4.89 (0.55)	−2.53 (0.71)
TYFC	−4.70 (0.00)***	3.58 (0.00)***	7.02 (0.00)***

NOTES Numbers inside the parentheses next to coefficient estimates are *t*-ratios. The numbers inside the parentheses next to coefficient estimates of the normality are the probability. The numbers inside the parentheses next to coefficient estimates of the LM and heteroskedacity are the probability (Chi-square). ***, **, * indicate significance at the 1%, 5% and 10% levels. The numbers inside the parentheses next to coefficient estimates of the reset are the probability of the *t*-statistic.

Mineral fuels, lubricants and related materials; Miscellaneous manufactured articles; Ores and metals; and Textile fibres, yarn, fabrics and clothing). Furthermore, we note that for these industries, the short-run coefficients on the lags for domestic GDP produces expected negative and statistically significant estimates, whereas concerning the world GDP variables, the estimates are significantly positive as expected.

On the other hand, 3 trade commodities produce positive and statistically significant short-run estimates on the real exchange rate variables (i.e. Agricultural raw materials; Crude materials, inedible, except fuels; Parts and components for electrical and electronic goods).

We also note 'reverse' signs on the coefficient estimates for the domestic and world GDP variables which produce positive and negative estimates, respectively, and these estimates are statistically significant. All remaining trade commodities that are not mentioned above do not find any statistically significant estimates on the real exchange rate variable. Nevertheless, the error correction terms associated with all trade commodities produce their 'correct' negative and significant estimates, implying that the observed short-run dynamics transition into their steady-state long-run equilibriums.

Focusing on our long-run estimates reported in table 4, we note that 8 industries produce their expected positive and statistically significant estimate on the real exchange rate variable (i.e. All allocated products; Beverages and tobacco; Commodities and transactions; Fuels; Manufactured goods; Mineral fuels, lubricants and related materials; Miscellaneous manufactured articles; and Textile fibres, yarn, fabrics and clothing). According to the 'new definition' (Bahmani-Oskooee and Ratha 2004) of the J-curve (under the traditional definition, the J-curve is confirmed solely when exchange rate depreciations boast trade balance over the long-run whereas under the new definition, the currency depreciation harms trade balance in the short-run whilst improving it only in the long-run), these 8 industries would benefit from long-run real exchange rate depreciations. Ten of the remaining 12 commodity groups produce negative and statistically significant estimates on the real exchange rate variable (All food items; Chemical products; Crude materials, inedibles except fuels; Electronic excluding parts and components; Food and live animals; Machinery and transport equipment; Ores and metals; Primary commodities; as well as Parts and components for electrical and electronic goods). Finally, only Pearls, precious stones and non-monetary gold items produce insignificant long-run coefficients on the real exchange rate variable.

In knitting together our results obtained from both the short-run and the long-run estimates in tables 4 and 5, we conclude on the 'traditional definition' (Rose and Yellen 1989) of the J-curve holding for 7 industries (i.e. Beverages and tobacco; Commodities and transactions; Fuels; Manufactured goods; Mineral fuels, lubricants and related materials; Miscellaneous manufactured articles, Textile fibres, yarn, fabrics and clothing). We note that our overall findings of industry-specific J-curve dynamics are comparable to those previously found for other emerging economies such as in Bahmani-Oskooee and Harvey (2015), who find similar evidence for manufactured articles and special transactions in US–Indonesia trade; Bahmani-Oskooee and Mitra (2009) for similar evidence on textile yarn and thread, tubes and manufactures of metal, and other crude minerals, soaps in US–India trade; as well as Bahmani-Oskooee, Huseynov, and Jamilov (2013) for similar evidence on polymer, rubber and plastics for trade between Azerbaijan and the world.

Conclusion

Economic theory suggests a 'J-curve' relationship between real exchange rates and the trade balance, initially being negative related over the short-run and subsequently turning positive in the long-run. Our study examined this relationship for the 5 SACU countries which are considered as one of the oldest customs unions in the world, with South Africa being the trade 'hub' of the group and the exchange rates of the 4 smaller nations (Botswana, Lesotho, Namibia and Eswatini) being closely linked with South Africa's free-floating Rand currency. In differing from previous related literature, we disaggregate the trade balance according to 19 industries which form the core of SACU's trade activities, hence reducing susceptibility to the 'aggregation bias' described in Rose and Yellen (1989) and Bahmani-Oskooee and Ardalani (2006). In applying PMG estimators to Panel ARDL econometric models for annual data spanning over 1995 to 2020, our empirical findings can be summarized as follows.

Firstly, we find exchange rate devaluations harming long-run trade balance in 10 industries (All food items; Chemical products; Crude materials, inedibles except fuels; Electronic excluding parts and components; Food and live animals; Machinery and transport equipment; Ores and metals; Primary commodities, Pearls, precious stones and non-monetary gold; and Parts and components for electrical and electronic goods). Secondly, exchange rate devaluations boost long-run trade balance in the remaining 8 industries (i.e. All allocated products; Beverages and tobacco; Commodities and transactions; Fuels; Manufactured goods; Mineral fuels, lubricants and related materials; Miscellaneous manufactured articles; and Textile fibres, yarn, fabrics and clothing). Thirdly, in further using the strict definition of J-curve effects in which the short-run exchange rate depreciations adversely influence the trade balance before exerting positive long-run effects, we note that only 7 industries fit the definition (i.e. Beverages and tobacco; Commodities and transactions; Fuels; Manufactured goods; Mineral fuels, lubricants and related materials; Miscellaneous manufactured articles; Textile fibres, yarn, fabrics and clothing). Lastly, only Pearls, precious stones and non-monetary gold items are irresponsive to exchange rate fluctuations over the long-run.

Considering that South Africa's currency has been on a deteriorating path over the last 4 years or so, there are some important policy implications which can be drawn from our study. For instance, current exchange rate depreciations will assist in strengthening the trade balance of the textile and clothing industry which is considered a sectoral priority regarding industrial development in the smaller member states (especially Lesotho) as is demonstrable by the establishment of the Textile and Clothing Industry Development Programme (TCIDP). SACU policymakers must take advantage of currency depreciations as a means of diversifying into other manufacturing sectors which enjoy dynamic economies of scale and present opportunities for innovation technology. For the other sectors, such as food, precious metals, electronics, and machinery, whose trade balance will be adversely affected by currency depreciations, firms in these sectors need to engage in currency risk mitigation strategies such as forward contracts and currency options. Moreover, these sectors should further consider import substitution industrialization policies as a means of boosting domestic production, relying less on expensive imports and consequentially strengthening the trade balance of these sectors over the long-run. Nonetheless, seeing that our study is conducted at industry-level using linear cointegration analysis, we recommend that future studies can be further undertaken at firm-level using more advanced econometric tools which can account for time-variation and cyclical asymmetries.

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