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The influence of the real effective exchange rate and relative prices on South Africa's import demand function: An ARDL approach

Tony Nchokoe Matlasedi[1*]

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*Corresponding author: Tony Nchokoe Matlasedi, Department of Economics, University of Limpopo, Private Bag, X1106, Sovenga 0727, South Africa
E-mail: tonymatlasedi@yahoo.com

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Abstract: This paper analyses the influence of the real effective exchange rate (REER) and relative prices on South Africa's import demand function both in the long run and the short run. The ARDL bounds testing approach is employed to test the long-run relationship hypothesis. The estimation of both the long-run and short-run import demand models is based on the ARDL error correction methodology. All the tests are applied to South Africa's secondary quarterly data covering the period 1980Q1–2014Q4. Real GDP and Foreign reserves were also added to the models as control variables. The Bounds test proved cointegration and the results show that in the long run, South Africa's import demand is negatively related to the REER, while being positively related to Real GDP (used as a proxy for national income) and relative prices. The coefficient of the relative price variable is greater than 1 in absolute terms, thus also confirming the Marshal Lerner condition. In the short run, import demand is found to be negatively related to the REER, while being positively related to Real GDP, relative prices and the stock of foreign reserves. The result gives hope that a policy aimed at depreciating the currency may help bring down the surge in import demand.

Subjects: Mathematical Modeling; Economics; Macroeconomics; Econometrics; International Economics

ABOUT THE AUTHOR

Tony Nchokoe Matlasedi is a Master of Commerce graduate (**Obtained Cum Laude) and a lecturer of International Economics, Monetary Economics and Mathematical Economics at the University of Limpopo, South Africa. His research interests are in the areas of Monetary Economics, International trade, International Finance, Foreign Direct Investment, Geopolitics and Macroeconomics.

PUBLIC INTEREST STATEMENT

In South Africa, the period after the world financial crisis of 2007–2008 has been characterised by, among other things, the relative weakness of the South African Rand (ZAR) against all major currencies as well as an upward trend in imports. Thus, this paper explores whether the real effective exchange rate as well as the relative price of imports, have impacted South Africa's merchandise import demand function. Results from the study confirm that a depreciation of the currency as well as the increase in relative prices, halt the flow of imports in the long run, while increases in Real GDP increase imports. Therefore, a policy aimed at carefully depreciating the currency is recommended. The paper further calls for the proper implementation of two important bills which were promulgated into law in 2015 and 2016, respectively, namely, the Protection of Investment Act No. 22 of 2015 and the Expropriation Bill.

Keywords: import demand; foreign exchange; depreciation; auto regressive distributed lag model (ARDL); commercial policy; Marshall–Lerner condition

JEL codes: C32; F13; F31

1. Introduction

South Africa has been confronted with a bulging current account deficit for some time now and since the world financial crises of 2007–2008, this deficit could be attributed in part, to the rising trend in imports expenditures from 2009. Gumede (2000) estimated South Africa's import demand function and concentrated on the influence of national income and relative prices but did not include the exchange rate. Likewise, Ziramba (2008) also estimated the import demand function, albeit with a better methodology, and focused solely on national income and relative prices as explanatory variables. There are also a number of other studies which have followed the same trend, see (Erasmus, 1978; Kahn, 1987; Lawrence & van der Westhuizen, 1990, 1994; Truett & Truett, 2003; Woods, 1958). Also, most of the other studies which do incorporate the exchange rate in the import function, do so using bilateral exchange rates (e.g. ZAR/US$). However, as countries engage in trade in a multilateral environment, hence using a number of currencies, it therefore becomes inappropriate to use a chosen bilateral exchange rate (e.g. ZAR/US$) for the analysis in this paper. Thus, a multilateral exchange rate has been chosen. A multilateral exchange rate is defined by Dornbusch and Fischer (2010) as the price of a representative basket of foreign currencies with each currency weighted by its importance to the country in terms of international trade. But in order to ascertain whether goods are becoming cheaper or more expensive in international markets, we have to consider the real effective exchange rate (REER), which is just a Nominal effective exchange rate (multilateral exchange rate) adjusted for domestic and foreign inflation differentials. Also, it is well established that a country pays for its imports from the quantity of foreign reserves it has at its disposal. Hence, the paper aims to fill the gap in the literature by incorporating the REER as well as foreign reserves into the augmented import demand model as postulated by Bahmani-Oskooee and Kara (2003). This, it is hoped, will influence policy-makers to take proactive steps to reverse this trend of increasing imports and try to reduce the current account deficit.

Apart from the introduction, the rest of the paper is structured as follows: Section 2 briefly looks at the trends of the REER as well as total merchandise imports. Section 3 reviews South Africa's main import sources and proceeds to outline some empirical literature on exchange rate—import demand relationships both from South Africa and abroad. Section 4 introduces the methodology to be used in this paper. Section 5 proceeds with the analysis of results based on the methodology discussed in Section 4. Section 6 gives the summary of findings and recommendations.

2. Trends of the REER and total merchandise imports

2.1. Trend of the REER

Figure 1 shows the trend and behaviour of the REER for the period 1980Q1 to 2014Q4. It is clear from the figure that the Rand was at its strongest levels during the period 1980 to 1984 and then weakened sharply in the mid-1980s, reaching its lowest level on 28 February 1985 when it depreciated to R2.23 against the dollar (Bronkhorst, 2012). From 1985, it appreciated steadily against most major currencies until the crash of 2002 where the Rand reached its lowest levels in history. It recovered after that until it depreciated sharply in 2008 and again in 2014.

2.2. Trend of merchandise imports

Figure 2 shows the trend of merchandise imports for the period 1980Q1 to 2014Q4. The figure shows an increasing trend from 1980Q1 until around 1999. During the mid-/late 2000s, South Africa experienced a surge in imports reaching a peak of R785.72 billion in 2008Q3. Imports declined sharply during 2008–2009 due to the world financial crisis, but started picking up again in 2009Q4 and peaking at R1.09 trillion in 2014Q1.

Figure 1. The trend of the real effective exchange rate during 1980Q1–2014Q4.

Source: Computation based on data obtained from the South African Revenue Services (SARS).

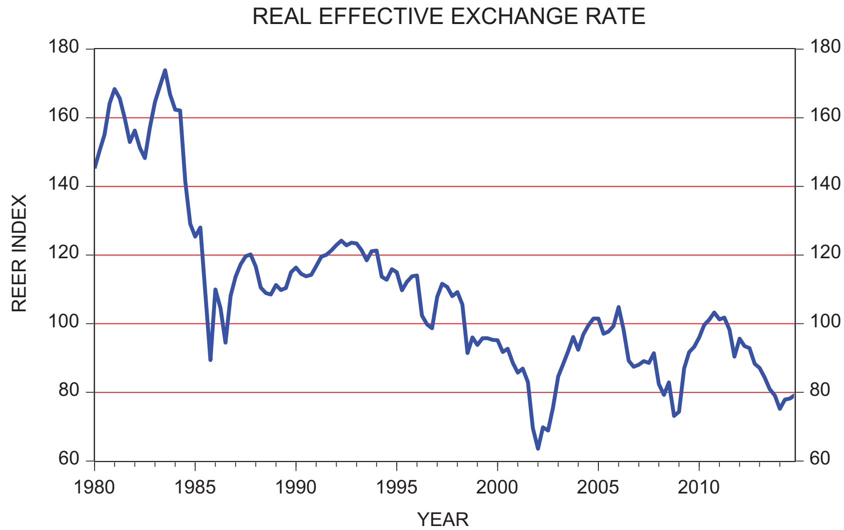
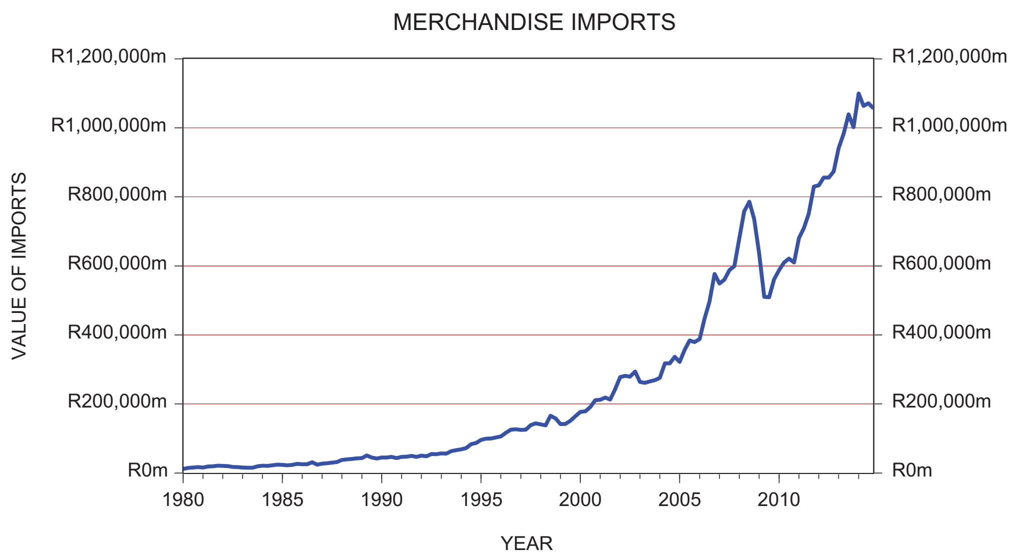


Figure 2. The trend of Merchandise Imports during 1980Q1–2014Q4.

Source: Computation based on data obtained from the South African Revenue Services (SARS).



2.3. RSA top 10 imports by commodity

Table 1 and Figure 3 show South Africa's top 10 imports by commodity during the period 2010–2014. Perhaps noteworthy is that in 2010, 25.22% of total imports were made up of machinery, including mechanical appliances. There was a decline thereafter until 2014. Mineral imports have actually caught up with imports of machinery as they both accounted for about 46.73% of all total imports at the end of 2014. Interestingly, exports of goods such as vehicles, aircraft and vessels have increased while imports have decreased during the period which augurs well for the trade balance. Fluctuations have been recorded in the other commodities during the period.

3. South Africa's main import sources for the period 2010–2014

3.1. RSA top 10 world import sources

Source: Computation based on data obtained from the South African Revenue Services (SARS).

Figure 4 and Tables 2(a) and 2(b) present South Africa's top 10 import sources from around the world, with panel (a) in Figure 4 showing the main import sources during 2010–2014 and panel (b)

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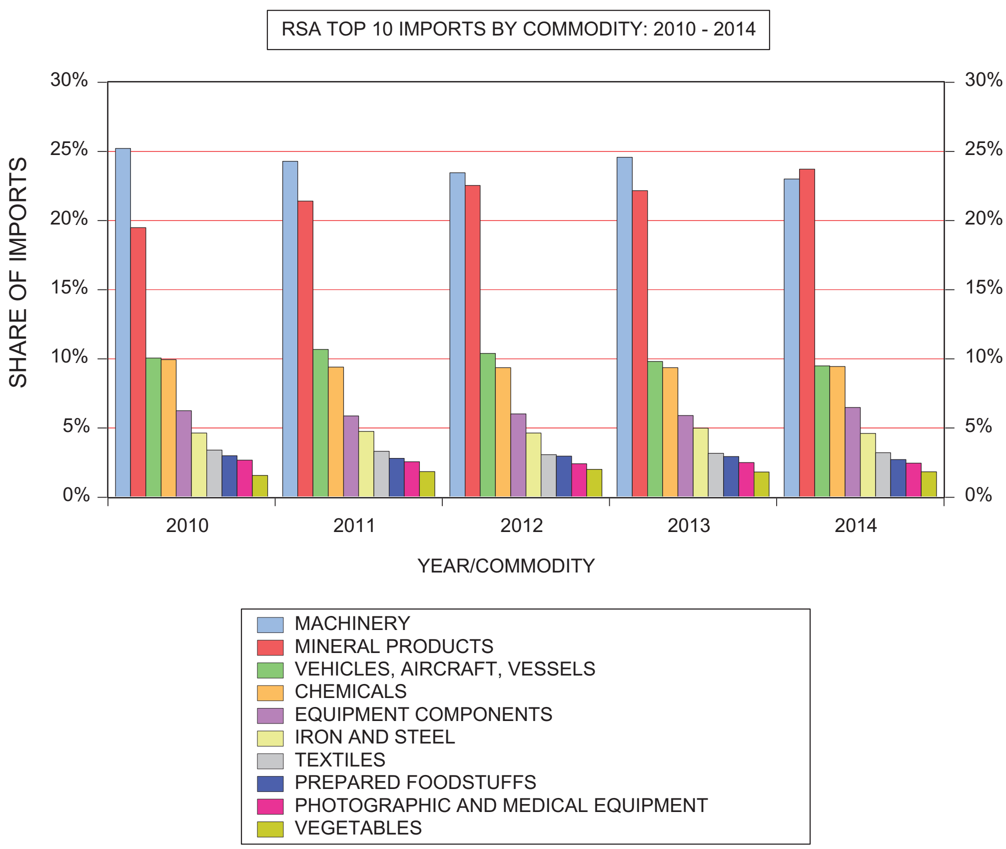
Table 1. RSA top 10 imports by commodity, 2010–2014 with percentage shares

Commodity	2010	2011	2012	2013	2014
Mineral products	19.49	21.41	22.54	22.16	23.72
Machinery	25.22	24.28	23.46	24.58	23.01
Vehicles, aircraft, vessels	10.06	10.68	10.39	9.82	9.49
Chemicals	9.94	9.4	9.36	9.37	9.45
Equipment components	6.26	5.87	6.02	5.91	6.48
Iron and steel	4.64	4.76	4.64	4.99	4.61
Textiles	3.41	3.32	3.07	3.18	3.22
Prepared foodstuffs	3	2.81	2.97	2.94	2.72
Photographic and medical equipment	2.68	2.57	2.42	2.51	2.46
Vegetables	1.58	1.85	2.01	1.83	1.84

Source: The South African Revenue Services (SARS).

Figure 3. RSA top 10 imports by commodity, 2010–2014.

Source: Computation based on data obtained from the South African Revenue Services (SARS).



showing the total share. China continues to underline its importance to South Africa with R167.6 billion of South African imports at the end of 2014 coming from that country, representing a 17.6% share, a 99.8% nominal and 60.6% real growth rates during the period. Germany also underlines its position as South Africa's largest trading partner in Europe with imports from that country reaching R108.59 billion in 2014 from R66.29 billion in 2010, representing a nominal growth rate of 66.8% and a real growth rate of 31.6% during the period accounting for an 11.5% share of all imports from the rest of the world for South Africa. Overall, imports from South Africa's major trading partners increased during the period, especially Saudi Arabia, which had nominal and real growth rates of 226.6

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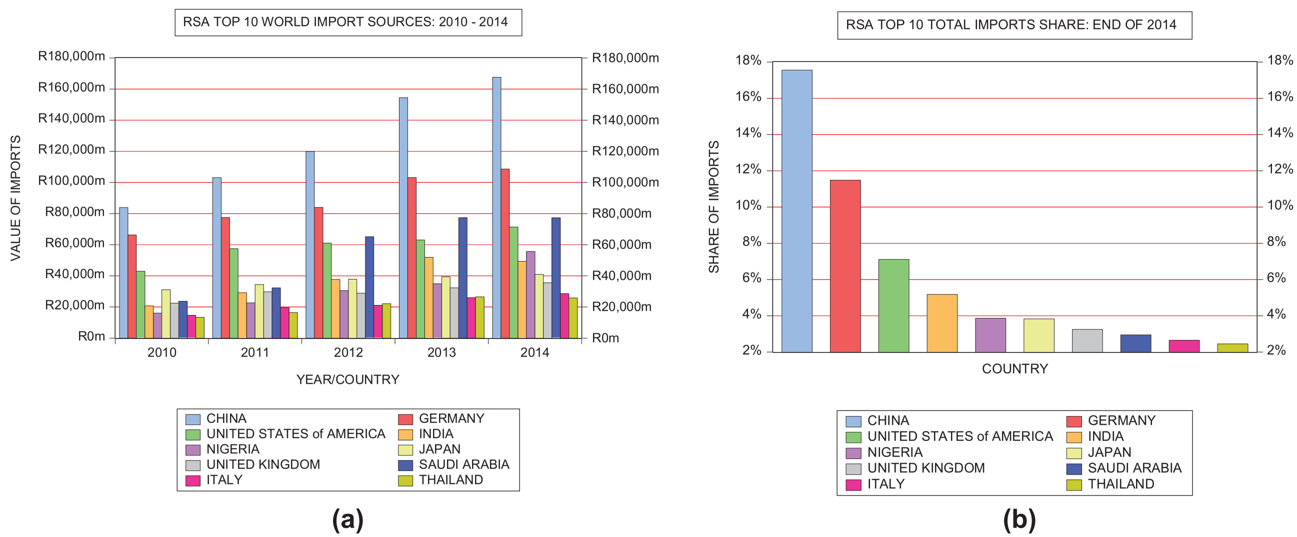

Figure 4. RSA top 10 world import sources.

Source: Computation based on data obtained from the South African Revenue Services (SARS).

Table 2a. RSA top 10 world import sources and nominal import values

Country	2010	2011	2012	2013	2014	Share of imports (%)	Nominal import growth (%)
China	83,894	103,143	119,945	154,445	167,600	17.6	99.8
Germany	66,293	77,469	83,962	103,227	108,591	11.5	63.8
United States of America	43,015	57,438	61,047	63,032	71,391	7.1	66.0
India	20,762	29,172	37,700	51,894	49,368	5.2	137.8
Nigeria	16,080	22,660	30,550	34,898	55,704	3.9	246.4
Japan	31,033	34,377	37,815	39,393	40,967	3.8	32.0
United Kingdom	22,443	29,711	28,834	32,283	35,493	3.2	58.1
Saudi Arabia	23,674	32,295	65,148	77,440	77,327	2.9	226.6
Italy	14,696	19,595	21,086	25,975	28,652	2.6	95.0
Thailand	13,373	16,450	22,137	26,537	25,775	2.4	92.7

Source: The South African Revenue Services (SARS). All data is in millions of ZAR and stated in current South African prices.

Table 2b. RSA top 10 world import sources with real import values

Country	2010	2011	2012	2013	2014	Real import growth: 2010–2014 (%)
China	83,894	98,236	108,125	132,036	134,695	60.6
Germany	66,293	73,783	75,688	88,249	87,271	31.6
United States of America	43,015	54,705	55,031	53,886	57,375	33.4
India	20,762	27,784	33,985	44,364	39,676	91.1
Nigeria	16,080	21,582	27,540	29,834	44,768	178.4
Japan	31,033	32,741	34,089	33,677	32,924	6.1
United Kingdom	22,443	28,297	25,993	27,599	28,525	27.1
Saudi Arabia	23,674	30,758	58,728	66,204	62,145	162.5
Italy	14,696	18,663	19,008	22,206	23,027	56.7
Thailand	13,373	15,667	19,956	22,687	20,715	54.9

Source: The South African Revenue Services (SARS). All data are in millions of ZAR and are stated in constant 2010 prices.

and 162.5%, respectively, between 2010 and 2014. Nigeria also showed its importance as RSA's top import source on the African continent which will be discussed in the next section.

3.2. Empirical literature review

3.2.1. Selected import demand studies from South Africa

As previously mentioned, Gumede (2000) estimated South Africa's import demand function and the results showed that the demand for imports was significantly income elastic both in the short-run and in the long-run. On a disaggregated scale, short-term import demand was found to be less elastic to changes in income levels compared to the long run. For both the mining and agricultural sectors, the income elasticities were found to be non-significant. For the manufacturing sector, import demand was found to only respond to changes in income and not to price changes. Price elasticity is only significant in the cases of both the paper and transport sectors. The study concluded that, overall it is mainly income which drives imports.

A study conducted by Erasmus (1978) employing the OLS methodology found that import demand is highly correlated with income whereas the results for price elasticity were mixed. Kahn (1987) estimated import demand functions for four different manufacturing sectors and found results similar to those by Erasmus (1978). Kahn (1987) confirmed that relative prices and real income are significant explanatory variables of the behaviour of import demand. Lawrence and van der Westhuizen (1990, 1994) using a GNP Function Framework got the result that is in line with economic theory and similar to that of other studies. They found that import demand is generally inelastic to relative price changes, (Ziramba, 2008).

3.2.2. Selected import demand studies from abroad

At industrial level for the USA economy, Bahmani-Oskooee and Ardalani (2006) employing an Autoregressive distributed lag (ARDL) approach to cointegration analysis developed by Pesaran, Shin, and Smith (2001) show that in half of the 66 estimated export functions for US industries, the coefficient on exchange rate is significantly negative as expected. However, in the case of import functions only in 13 out of 66 cases estimated coefficients on exchange rate have the correct, positive sign. Thus this study confirms the observation that if aggregated data are used, significant exchange rate coefficients in some sectors could be offset by insignificant ones in other sectors and could lead to the wrong conclusion that exchange rate has no impact on trade flows (Petrović & Gligorić, 2009).

In Africa, import and export demand functions for Madagascar and Mauritius have also been examined by Razafimahefa and Hamori (2005) and the existence of a cointegrating relationship found between import, income and exchange rate for both countries. The long-run income elasticities estimated were 0.86 and 0.67 and price elasticities −0.49 and −0.64 for Madagascar and Mauritius, respectively. After estimating export demand functions, they concluded that Marshall–Lerner condition is fulfilled only in Mauritius. Oyinlola, Adeniyi, and Omisakin (2010) employed the ARDL bounds testing and error correction model to estimate Nigeria's import demand model and the results showed that import demand chiefly responds to changes in domestic income, relative prices, nominal effective exchange rates and the stock of external reserves.

4. Data, methodology and model specification

4.1. Data collection

The paper relies on quarterly secondary data. The data span the period 1980Q1–2014Q4. The data for the following variables: merchandise imports, South African foreign reserves, REER and South African GDP in Rands and Consumer Price Index is obtained from the South African Reserve Bank (SARB) online statistical query. Data for the following indices: domestic import price is sourced from Quantec, and data for the domestic (consumer) price index is sourced from Statistics South Africa.

4.2. Data analysis

In this section, all the econometric methods used in the paper are explained. These include unit root tests, and the ARDL bounds test.

4.2.1. Unit root tests

One of the first steps in econometric analysis is to test for the unit roots of the series, for which different tests are described in the literature. For the purposes of this paper, the standard version of the Augmented Dickey–Fuller (ADF) (Dickey, 1976; Dickey & Fuller, 1979) unit root test will be employed to check the non-stationary assumption.

4.2.2. Model specifications

4.2.2.1. Import demand model. The Import demand function in Equation (1) is derived from the augmented version as postulated by Bahmani-Oskooee and Kara (2003).

$$\mathrm{LnIM}_t = \theta_0 + \theta_1 \mathrm{LnGDP}_t + \theta_2 \mathrm{Ln}\left[\frac{\mathrm{PM}}{\mathrm{PD}}\right]_t + \theta_3 \mathrm{LnREER}_t + \theta_4 \mathrm{LnFR}_t + \varepsilon_t \tag{1}$$

4.2.2.2. Priory expectation: Import demand function.

$\theta 1 > 0; \theta 2 < 0; \theta 3 < 0; \theta 4 > 0$

where,

[LnIM_t] = the log of Merchandise Imports in South African Rands.

[LnGDP_t] = the log of the country's Real Gross Domestic Product denominated in South African Rands, which is used as a proxy for national income. The elasticity is expected to be positive as a rise in domestic income levels will result in an increase in demand for foreign produced goods.

$\mathrm{Ln}\left[\frac{\mathrm{PM}}{\mathrm{PD}}\right]_t$ = the log of the Import Price Index divided by the (Domestic) Consumer Price Index. The relative price of imports to domestic prices is expected to be negative as a rise in the price of imports, *ceteris paribus* will lead to a decrease in import demand and *vice versa*.

[LnREER_t] = the log of the Real Effective Exchange Rate, which is calculated by the SARB based on the flow of trade between South Africa and 20 of its major trading partners. Wang (2009) states that when the exchange rate is directly quoted, an increase in the REER index is equivalent to an appreciation of the local currency or a depreciation of the foreign currency and a decrease in the REER index is considered depreciation of the domestic currency or an appreciation of the foreign currency. Chiloane (2012) notes that South Africa indirectly quotes the exchange rate, hence an increase in the REER index is considered an appreciation and a decrease in the index is considered depreciation. The elasticity of the REER index is expected to be negative as a depreciation of the domestic currency makes domestic goods more desirable (cheap) and foreign goods (denominated in foreign currency) more expensive, thus, likely to lead to a decrease in import demand.

LnFR_t = the log of South Africa's Real Foreign Exchange Reserves denominated in Rands. The elasticity is expected to be positive.

[ε] = Error term.

4.2.2.3. Auto-regressive distributed lag approach (ARDL). Pesaran and Shin (1999) proposed an approach that has really gained traction in recent times called the auto regressive distributed lag approach (ARDL). This approach was further expounded by Pesaran et al. (2001) and it is also known as bound testing approach and it is used to investigate the existence of cointegration relationships among variables. When compared to other cointegration procedures like the Engle and Granger (1987) and Johansen and Juselius (1990) approaches, the bounds testing approach (ARDL) is favoured based on the fact that both the long-and short-run parameters of the model specified can be estimated simultaneously. This approach is applicable irrespective of the order of integration whether the variables under consideration are purely $I(0)$ (i.e. the variables are stationary at level form) or purely $I(1)$ (i.e. the variables become stationary at first difference). Thus, this paper will use the ARDL method to estimate the long- and short-run parameters of the import demand model.

4.2.3. ARDL specification for the import demand model

$$\Delta \mathrm{LnIM}_t = \theta_0 + \theta_1 \mathrm{IM} + \theta_2 \mathrm{LnGDP}_{t-1} + \theta_3 \mathrm{Ln}\left[\frac{\mathrm{PM}}{\mathrm{PD}}\right]_{t-1} + \theta_4 \mathrm{LnREER}_{t-1} + \theta_5 \mathrm{LnFR}_{t-1} + \sum_{i=1}^{p} \theta_6 i \Delta \mathrm{LnIM}_{t-i} + \sum_{i=1}^{q} \theta_7 i \Delta \mathrm{LnGDP}_{t-i} + \sum_{i=1}^{r} \theta_8 i \Delta \mathrm{Ln}\left[\frac{\mathrm{PM}}{\mathrm{PD}}\right]_{t-i} + \sum_{i=1}^{s} \theta_9 i \Delta \mathrm{LnREER}_{t-i} + \sum_{i=1}^{t} \theta_{10} i \Delta \mathrm{LnFR}_{t-1} + \varepsilon_t \quad (2)$$

Where,

Δ denotes the first difference operator [i.e. D(LnIM)],

θ_0 is the drift component,

ε_t is the white noise residuals.

The left-hand side in Equation (2) represents import demand. The first until fifth expressions (θ_1–θ_5) on the right-hand side correspond to the long-run relationship between the variables. The remaining expressions with the summation sign (θ_6–θ_{10}) represent the short-run dynamics of the model.

4.2.4. ARDL cointegration test

The ARDL bound test for cointegration is based on the Wald-test (*F*-statistic). Two critical values are given by Pesaran et al. (2001) for the cointegration test. The lower critical bound assumes all the variables are $I(0)$ meaning that there is no cointegration relationship between the examined variables. The upper bound assumes that all the variables are $I(1)$, meaning that there is cointegration among the variables. When the computed *F*-statistic is greater than the upper bound critical value, then the H_0 is rejected, meaning that the variables in the model are cointegrated). If the *F*-statistic is below the lower bound critical value, then the H_0 cannot be rejected (meaning that there is no cointegration among the variables). When the computed Wald-test *F*-statistic falls between the lower and upper bound, then the results are inconclusive, meaning that the relationship between the variables cannot be ascertained

The null hypothesis of no cointegration (H_0) and the alternative hypothesis (H_1) of cointegration amongst the variables in Equation (2) are shown in the table below.

Model	**Null hypothesis [H_0]**	**Alt hypothesis [H_1]**	**Function**
Equation (2)	$\theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5$	$\theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5$	$F_{\text{LnIM (LnIm} \mid \text{LnGDP, Ln[PM/PD], LnREER, LnFR}}$

The *F*-test is simply a test of the hypothesis of no cointegration among the variables against the existence of cointegration among the variables, denoted as:

$$H_0{:}\theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = 0 \tag{3}$$

When the situation in Equation (3) exists, there is NO cointegration among the variables.

$$H_1{:}\theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5 \neq 0 \tag{4}$$

Should Equation (4) persist, then there is cointegration among the variables in the model.

4.2.5. ARDL error correction model (ECM)

This paper also develops the ECM in order to test for the speed of adjustment and how the variables in the data-set converge towards equilibrium in the long run. Therefore, the ARDL version of the ECM for the import Demand model can be expressed as Equation (5) below. The error correction version of the ARDL model relating to the variables in Equation (1) is as follows, where λ explains the speed of adjustment and **ECT** is the Error Correction Term, and is derived from the residuals obtained in Equation (2).

The unrestricted error correction version of the ARDL model concerning the variables in Equation (1) is as follows:

$$\Delta \text{LnIM}_t = \theta_0 + \sum_{i=1}^{p} \theta_1 i \Delta \text{LnIM}_{t-i} + \sum_{i=1}^{q} \theta_2 i \Delta \text{LnGDP}_{t-i} + \sum_{i=1}^{r} \theta_3 i \Delta \text{Ln}\left[\frac{\text{PM}}{\text{PD}}\right]_{t-i} + \sum_{i=1}^{s} \theta_4 i \Delta \text{LnREER}_{t-i} + \sum_{i=1}^{t} \theta_5 i \Delta \text{LnFR}_{t-1} + \lambda \text{ECT} + \varepsilon_t \tag{5}$$

4.2.5.1. Stability test and diagnostic tests. This paper also adopts the RAMSEY RESET to test for the stability of the estimated ARDL long-run model and the ECM. Residuals diagnostic tests are also performed to test for serial correlation, normal distribution of the residuals and problems of heteroscedastricity.

Table 3. Unit root tests (Augmented Dickey–Fuller test)

Variable	Intercept	Intercept & trend	None	Order of integration
LNIM	−0.132 (0.9426)	−4.267(0.0048)***	3.302(0.9997)	I(1)
ΔLNIM	−5.227(0.0000)***	−5.212(0.0002)***	−3.839(0.0002)***	I(1)
LNGDP	1.126(0.9976)	−1.627(0.7770)	3.586(0.9999)	I(1)
ΔLNGDP	−6.325(0.0000)***	−6.548(0.0000)***	−3.991(0.0001)***	I(1)
LNREER	−2.822(0.0578)*	−3.569(0.0364)**	−0.555(0.4748)	I(1)
ΔLNREER	−5.818(0.0000)***	−5.793(0.0000)***	−5.786(0.0000)***	I(1)
$LN\frac{PM}{PD}$	−1.411(0.5753)	−1.442(0.8441)	−1.072(0.2556)	I(1)
$\Delta LN\frac{PM}{PD}$	−10.558(0.0000)***	−10.670(0.0000)***	−10.598(0.0000)***	I(1)
LNFR	−0.230(0.9304)	−3.447(0.0494)**	2.510(0.9971)	I(1)
ΔLNFR	−13.213(0.0000)***	−13.176(0.0000)***	−12.525(0.0000)***	I(1)

Note: *P*-values are in parentheses.

Source: Author's calculations.

*Represent the rejection of the null hypothesis at 10%.

**Represent the rejection of the null hypothesis at 5%.

***Represent the rejection of the null hypothesis at 1%.

5. Discussion of findings

5.1. Unit root tests

Table 3 summarises the results of the unit root tests from the ADF test.

Merchandise imports, REER and Foreign reserves appear to have some form of stationarity at either intercept or intercept and trend. The other variables, all display non stationary properties; hence the null hypothesis of non-stationarity cannot be rejected at their level form. When the ADF test is applied to the first difference of the variables, they all become stationary. Thus, the variables in the import demand model are integrated of both order 0 and order 1 [i.e. (I0) and (I1)] and thus applicable for the ARDL method of analysis as they are integrated of different orders.

5.2. ARDL cointegration test

Tables 4 and 5 present results of the bounds test. The Akaike information criterion was used to select the best model out of several other ones evaluated. The number of regressors in the model are four, hence $K = 4$. All the lower bound and upper bound critical values are obtained from Table CI (iii) Case III: Unrestricted intercept and no trend (Pesaran et al., 2001). The calculated Wald F-statistic = 5.02 and is greater than the lower bound critical value of 2.86 and the upper bound critical value of 4.01 at the 5% level of significance. Therefore, we reject the null hypothesis of no long-run relationship. Therefore, the conclusion is that there is cointegration or a long-run relationship between the variables in the import demand model.

The bounds testing approach has provided evidence of a long-run relationship between the variables in the model. Now the paper proceeds to estimate the long-run cointegrating equation and the coefficients of the model specified.

5.3. Long-run Import demand equation

Long-run Import demand equation

$$\text{Cointeq} = \text{LNIM} - \left(5.21\text{LNGDP} - 1.54\text{LNREER} - 0.05\text{LNFR} - 2.32\text{LN}\frac{\text{PM}}{\text{PD}} - 57.08\right) \quad (6)$$

Table 6 and Equation (6) summarise the results of the long-run ARDL model for the import demand model. All the variables in the model are statistically significant at 1% bar the foreign reserves

Table 4. Bounds test

Equation	Wald *F*-statistic	Lower bound I0	Upper bound I1	Outcome
Import demand	5.02	2.86	4.01	Cointegrated

Source: Author's calculations.

Table 5. Critical value bounds

Significance (%)	I0 bound	I1 bound
10	2.45	3.52
5	2.86	4.01
1	3.74	5.06

Source: Eviews output.

Table 6. ARDL long-run Import demand model

Variable	Coefficient	*t*-Statistic	Probability value
LNGDP	5.211250	4.614644	0.0000*
LNREER	−1.535403	−3.398702	0.0009*
LNFR	−0.054855	−0.397678	0.6916
$\text{LN}\frac{\text{PM}}{\text{PD}}$	−2.316273	−4.692183	0.0000*
Intercept	−57.081557	−4.160125	0.0001*

Source: Author's calculations.

*Denotes a 1% level of significance.

coefficient. The income elasticity of demand for imports is 5.2, suggesting that a 1% increase in real GDP, hence in real income, will lead to an increase of about 5.2% in the demand for imported goods. Gumede (2000) also reported a relatively high income elastic demand for imports in his study on the South African economy.

The exchange rate elasticity of import demand is reported at −1.5, suggesting a negative relationship between merchandise imports and the REER index in the long run. With the knowledge that South Africa indirectly quotes the effective exchange rates (both nominal and real), this means that a 1% increase or appreciation of the ZAR will lead to a 1.5% increase in the demand for imported goods while a 1% depreciation or decrease of the ZAR will lead to a 1.5% decrease in the demand for imported goods.

The relative price elasticity of import demand equals −2.3 and is highly significant at 1%, thus confirming a negative relationship between the variables. This suggests that a 1% increase in relative prices will lead to a 2.3% decrease in the demand for imported goods in South Africa's economy. The reason for this may be that, as the prices of imported goods rise faster than those of domestically produced goods, domestic consumers will shift their consumption patterns towards domestically produced goods, hence the fall in the demand and volumes of imported goods. Although the export supply function was not estimated, the result further confirms the Marshal Lerner condition as the relative price elasticity coefficient equals −2.3 and the sum of the price elasticities will obviously be greater than 1 in absolute terms.

5.4. ARDL import demand ECM

Table 7 presents the short-run parameters of the import demand model. Once again, the elasticities of the model are highly significant at both 1 and 5%, bar the real GDP coefficient which is significant at 10%. The lagged merchandise imports variable is highly significant at 1% and suggests that the current quarter's import volume is directly influenced by the previous quarter's import value.

Table 7. ARDL import demand error correction model

Variable	Coefficient	*t*-statistic	Probability value
$\Delta LNIM_{t-1}$	−0.420275	−4.832854	0.0000***
$\Delta LNREER_{t-1}$	−0.414354	−2.932987	0.0041***
$\Delta LNGDP$	1.635336	1.783612	0.0772*
$\Delta LNFR_{t-2}$	0.068086	2.353898	0.0204**
$\Delta Ln\frac{PM}{PD}_{t-3}$	0.434097	2.297631	0.0235**
ECT_{t-1}	−0.154742	−2.768697	0.0066***

Source: Author's calculations.
*Denotes significance at 10% level.
**Denotes significance at 5% level.
***Denote significance at 1% level.

The results show that import demand is negatively and significantly related to a one quarter lag of REER. The exchange rate elasticity of import demand is −0.41, suggesting that a 1% appreciation of the ZAR will lead to a 0.41% increase in the demand for imported goods and a 1% depreciation will lead to a 0.41% decrease in import demand in the short run. This also reveals that import demand is more responsive to exchange rate variations in the long run than in the short run.

The real GDP variable, with a coefficient of 1.63, shows a positive relationship with import demand, thus meaning that a 1% increase in the level of domestic income will lead to a 1.63% increase in import demand.

The foreign reserves variable is significant at 5% and positively related to merchandise imports in the short run. A 1% increase in FR will lead to a 0.068% increase in the demand for imported goods.

The third quarter lag of the relative price elasticity of demand is positively related to merchandise imports in the short run and with a coefficient of 0.43. This reveals that a 1% increase in relative prices will lead to a 0.43% increase in the demand for imported goods in the short run. Although this may be in contradiction with economic theory (the elasticities approach), Oyinlola et al. (2010) argues that most imported goods may not have competitive domestic substitutes, thus, even with a decline in domestic prices or an increase in import prices, the demand for imports may still increase.

The coefficient of the error correction term, which measures the speed of adjustment is as expected, significantly negative at 1%, suggesting that the series is not explosive and that equilibrium in the long run will be attained. The coefficient of −0.15 reveals that 15% of the disequilibrium in the import demand function for the current period will be corrected in the following quarter.

5.5. Diagnostic and stability tests on the ECM

The validity of the results is dependent on the fit and stability of the model, hence table 8 summarises the results of the various stability checks.

Table 8 reports the residual diagnostics of the import demand model. The residuals are normally distributed in the model as evidenced by the non-rejection of the null hypothesis using the Jarque–Bera test. The Ljung–Box Q statistic also reports that there is no auto correlation in the model. The Lagrange Multiplier serial correlation test also confirms that there is no serial correlation in the model. The model also appears not be heteroscedastic as it passes all the heteroscedastricity tests.

The Ramsey RESET test results shown in Table 9 suggest that the model is correctly specified as evidenced by a probability value of 94.62%, which is greater than the 5% level of significance. Therefore, we do not reject the null hypotheses that the model is correctly specified.

Table 8. Stability diagnostic checks

Test	Null hypothesis	Test statistic	*P*-value	Conclusions
Jarque–Bera	Residuals are normally distributed	1.49	0.48	Do not reject Ho as PV is greater than the L.O.S at 5%, therefore the residuals of the model are normally distributed
Ljung–Box Q	No autocorrelation	9.43	0.31	Do not reject Ho as PV is greater than the L.O.S at 5%, therefore the model does not suffer from autocorrelation
Lagrange multiplier test	No serial correlation	13.68	0.09	Do not reject Ho as PV is greater than the L.O.S at 5%, therefore, therefore there is no serial correlation in the model
Breusch–Pagan–Godfrey	No heteroscedastricity	22.69	0.36	Do not reject Ho as PV is greater than the L.O.S at 5%, therefore there is no Heteroscedastricity in the model
Harvey	No heteroscedastricity	25.19	0.24	Do not reject Ho as PV is greater than the L.O.S at 5%, therefore there is no Heteroscedastricity in the model
Glejser	No heteroscedastricity	22.49	0.13	Do not reject Ho as PV is greater than the L.O.S at 5%, therefore there is no Heteroscedastricity in the model
Arch	No arch heteroscedastricity	0.24	0.63	Do not reject Ho as PV is greater than the L.O.S at 5%, therefore there is no Heteroscedastricity in the model
White	No heteroscedastricity	20.53	0.49	Do not reject Ho as PV is greater than the L.O.S at 5%, therefore there is no Heteroscedastricity in the model

Note: L.O.S denotes level of significance.

Source: Author's calculations.

Table 9. Ramsey RESET test

Test	Ho	Test statistic	*P*-Value	Conclusion
Ramsey RESET	The model is correctly specified	0.004582	0.9462	Do not reject Ho because the *P*-Value is greater than the level of significance at 5%

Source: Author's calculations.

Figure 5. Model criteria graph.

Source: Author's calculations.

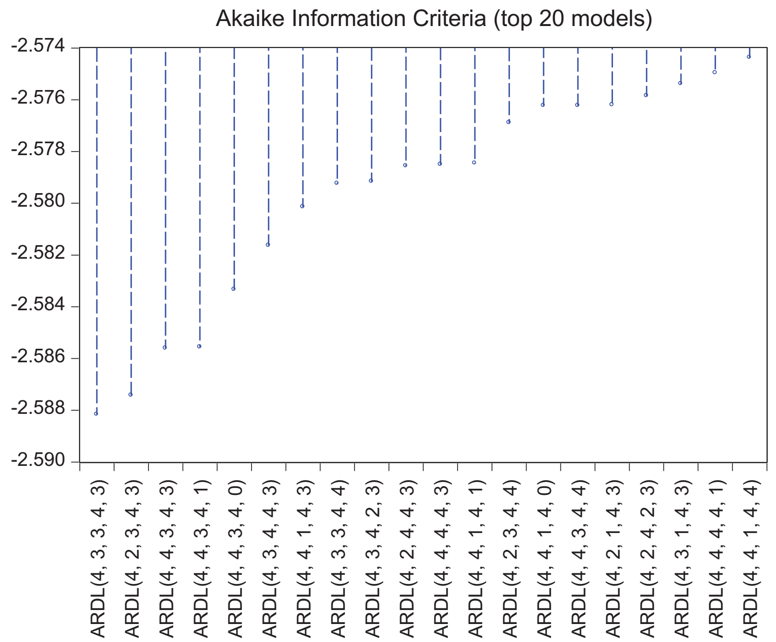

Figure 5 shows the top 20 of the 2500 different ARDL models evaluated by Eviews and the final selected model as chosen by the Akaike Information criterion. The figure shows that the final model used in the paper is an ARDL (4, 3, 3, 4, 3) model. That is, four lags of the dependant variable (imports), three lags of real GDP, three lags of the REER, four lags of relative prices and three lags of foreign reserves.

6. Summary of findings and recommendations

The paper discussed the influence of the REER and relative prices on South Africa's import demand function. The results from the analysis showed that in the long run, the import demand function is influenced by the exchange rate, domestic GDP and relative prices with foreign reserves statistically insignificant. On the variables of interest, the depreciation of the South African Rand (ZAR) was found to lead to a decrease in the demand for foreign produced goods, which is consistent with economic theory. The relative price elasticity of demand revealed that as import prices rise or domestic prices for the same goods fall, domestic consumers will shift their consumption patterns towards domestically produced goods, hence the fall in the demand and volumes of imported goods. This further confirmed the Marshal Lerner condition as the relative price elasticity coefficient equalled 2.3 (although the export supply function was not estimated).

For the short run, the results showed that import demand is still influenced by the exchange rate, domestic GDP, relative prices as well as foreign reserves, with it significant at 5% and positively related to merchandise imports.

The results summarised above have certain implications for policy discussions. The results showed that the Marshal Lerner condition holds and that a depreciation of the domestic currency leads to a reduction of imports both in the long run and in the short run. Therefore, a policy aimed at depreciating the ZAR might work well to reduce the flow of imports and thus reduce the trade deficit and current account deficit. However, South African industries are highly dependent on imports of capital goods as well as raw materials. It should be emphasised that the importation of raw materials and capital goods also have positive spill over effects on unemployment and economic growth, therefore, policy-makers have to keep in mind those spillovers before implementing such a policy to depreciate the Rand.

The results further showed that increasing demand for imports is associated with an increase in domestic income levels. This could be a sign that the South African economy is not developing and growing in such a way that more goods (substitutes) can be produced locally instead of the country sourcing high volumes of these goods from abroad. Perhaps, South Africa's National Development Plan (Vision 2030) can address such challenges, especially with regard to rapid industrialisation. Policy-makers also need to create a favourable environment for foreign direct investment into South African industries, and crucial to this is the proper implementation of two important bills which were promulgated into law in 2015 and 2016, respectively, namely, the Protection of Investment Act No. 22 of 2015 and the Expropriation Bill.

Directions for further research into the estimation of import demand functions, especially for South Africa, could include the role of remittances and the level of trade liberalisation (tariffs) in the country and how they could affect the model both in the long run and the short run. Due to the unavailability of data, these variables could not be added to the model adopted in this paper.

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Author details
Tony Nchokoe Matlasedi[1]
E-mail: tonymatlasedi@yahoo.com
ORCID ID: http://orcid.org/0000-0003-2426-0838
[1] Department of Economics, University of Limpopo, Private Bag, X1106, Sovenga 0727, South Africa.

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