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Modelling the Effects of Changes in the Exchange Rate, Oil Price and Real Wages on the Trade Balance in South Africa.

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Trade, which includes exports and imports, is one of the main engines of economic growth for both developed and developing countries. International trade is however affected and influenced by many factors, such as the exchange rate, commodity prices, production factors, etc. The purpose of this study was to analyse the responsiveness and relationship between the trade balance and factors such as the oil price, the exchange rate and real wage shocks. The study employed quarterly data covering the period from the first quarter of 1994 to the fourth quarter of 2018. The study adopted various statistical and econometric approaches and these approaches included an autoregressive distributed lag (ARDL) model, an error correction model and the Toda-Yamamoto causality test. The results from the ARDL model suggested long-run cointegration amongst the variables. The regression analysis revealed that all explanatory variables negatively impact on the trade balance. However, the magnitude of their effects differs from one variable to the other. Comparing all independent variables, the exchange rate was found to have the strongest long-term effect on the trade balance compared to the effect of both crude oil price and real wages. Interestingly, the error correction model (ECM) results indicated that the exchange rate can positively affect the trade balance. Additionally, the Toda-Yamamoto results demonstrated that both the exchange rate and oil price shocks can assist in forecasting trade balance fluctuations in the short-term. Based on these findings, and since South Africa has no control over the oil price, it is imperative that the South African Reserve Bank implement strategies that may stabilise the exchange rate, in an attempt to increase opportunities that facilitate a positive trade balance, which is required for economic growth.

Key words: *ARDL model, exchange rate, oil price, real wage shocks, South Africa, trade balance.*

Introduction

International trade with export growth serves as an important engine for economic growth in most of the fast growing economies. The level of a country's trade depends on many factors including the exchange rate, the oil price and real wage rate (Baas & Belke, 2018; Olayungbo, 2019; Zheli, 2017). The exchange rate refers to the price of one country's currency expressed in terms of other countries' currency (Yang & Zeng, 2014). The exchange rate plays a significant role within developing countries in terms of international trade and a country's trade balance (Obansa, Okoroafor, Aluko & Millicent, 2013). In South Africa, the currency has been facing high levels of instability due to exchange rate volatility (Fowkes, Loewald & Marinkov, 2016). This instability affects not only trade activities but also the international investment position. For instance, in 2018 between June and September, the market value of South Africa's foreign assets declined from R7 369 billion to R7 247 billion, due to currency fluctuations. Additionally, during this period the country also experienced a decline in direct investment resulting from the lower value of the local currency (South African Reserve Bank, 2019).

South Africa has a flexible exchange rate regime which is determined by factors of demand and supply (Mtonga, 2011). Following a large number of international market activities, the flexible exchange rate regime creates a significant change within the exchange rate of the local currency (Mtonga, 2011). Consequently, forecasting the path towards exchange rate stability and its impact on the trade balance becomes challenging. This situation created a gap for interested scholars and researchers to investigate the relationship between the exchange rate and the balance trade. Although the theory of international trade suggests that currency depreciation leads to more exports, while its appreciation results in demand for more imports, it is not always an automatic cause-effect system, as there are some other factors that influence the relationship between the exchange rate and exports dynamism (Shahbaz, 2012).

Moreover, crude oil is one of the most traded commodities that also impacts on the trade of other commodities and products. A high level of dependency on oil could be a source of a trade deficit within developing countries (Taghizadeh-Hesary,Yoshino, Rasoulinezhad, & Chang, 2019). The exchange rate and oil price are not the only factors that influence a country's trade balance. Given that the balance trade, as a component of international trade, depends on the level of exports, a close interrelationship exists between real wages and total exports (Deardorff & Hakura, 1993). High levels of exports can lead to wage increases as the latter can serve as motivation to increase labour productivity. Thus, a bilateral relationship is expected between trade and real wages (Du Caju, Rycx, & Tojerow, 2011).

According to the South African Reserve Bank (SARB) reports (2019), in the last quarter of 2018, the country experienced a trade surplus due the rise of exports from manufacturing and mining merchandise and a decline in the volume of domestic imports. Between the third and fourth quarter of 2018 the trade balance widened from R10.2 billion to R71.8 billion, respectively. However, between 2017 and 2018, the oil price increased from \$54.2 to \$71.2 dollars per barrel, while the currency weakened from R13.73 per US dollar (on the first day of

2017) to R14.4 per US dollar (on the last day of 2018) (SARB, 2019). Furthermore, since 1994, real wages have been a source of dispute between labour unions and employers. From this scenario, one could ask what effect should the exchange rate, oil price and real wages have on the South African trade balance.

The aim of this paper is therefore to assess the effect of alterations in the exchange rate, global oil prices and real wages on the South African trade balance. The analysis of the impact of these variables on the trade balance invites attention, due to their influence on a country's effective economy (Chen, Kuo & Chen, 2010; Corsetti *et al.* 2007; Leamer, 1994). The study outline is organised of follows: the first section is dedicated to an introduction to the study, the second section focuses on the literature review, the third section illustrates and elucidates approaches and procedures used to assess the relationship among the variables, the fourth section presents and discusses the empirical findings and lastly, the fifth section provides the conclusion and recommendations in line with the findings.

Literature review

As mentioned before, international trade theory suggests that a country's state of trade balance depends on its levels of imports and exports. In other words, a country that exports more than it imports, experiences a positive balance and vice versa (Bonga, 2018). The trade balance, which is the difference between a country's exports and imports, depends on various economic variables (Romero, 2012). The subsequent paragraphs represent a review of the relationship between the exchange rate, the oil price, real wages and the trade balance.

Exchange rate and trade balance

Various factors play significant roles in the relationship between international trade, the trade balance and the exchange rate. Such factors may include geographic proximity, language and culture, trade agreements, income and prices (Tadesse, 2009). Shocks in the exchange rate can originate from three main factors, namely: fluctuations in basic issues such as consumer purchasing power; fluctuations in the basic characteristics of foreign exchange market such as an excess of rumours, portfolio changes, noise traders and cause-effects system; and the signals of expected changes in future policy such as the inflation rate, money supply, interest rates and output growth (Tadesse, 2009). Most empirical studies conducted to analyse the effect of exchange rate volatility on international trade found that shocks on exchange rates negatively impact on the trade balance (Bahmani-Oskooee, 2002; Doroodian, 1999 Schnabl, 2008; Sukar & Hassan, 2001). In support of these studies' findings, the study conducted by Onafowor and Owoye (2008) attests that exchange rate shocks significantly impact on exports levels in both the short and long term.
Regardless though what previous studies have found, which mostly suggests an inverse relationship between international trade and exchange rate volatility, De Grauwe (1988), Giovannini (1988), and Peree and Steinherr (1989) argue that exchange rate volatility

stimulates exports of risk-neutral firms. Consequently, volatility in the exchange rate is expected to precede growth in international trade. De Grauwe (1988) specifically maintains that the influence of exchange rate shocks depends on a firm's level of risk aversion. Therefore, while a risk-averse exporter is more likely to worry about a decrease in export revenue as a result of taking high risks, a risk-loving or a risk-taking agent does not act based on speculations and as a result their trade decisions are not affected by exchange rate volatility.

Contrary to those mentioned studies whose findings suggest that exchange rate volatility results either in a decline or a decrease of trade volume (especially exports level), the third group of findings assert that exchange rate shocks do not always result in a rise or fall in trade volume. Gagnon (1993), Koray and Lastrpe (1989), and Medhora (1990), for instance, found that volatility of the exchange rate does not unavoidably lead to a decline in trade volume. Additionally, Bacchetta and van Wincoop (2000) argue that trade is independent from exchange rate volatility. The Bacchetta and van Wincoop finding is supported by Doyle (2001), who assessed the effect of exchange rate volatility on trade and found inconclusive results. Based on these conflicting findings, one can conclude that the effect of exchange rate might differ from one country to the other.

Oil price and the trade balance

Oil price fluctuations and / or shocks may impact on the external economic accounts through two distinct channels, namely the financial channel and the trade channel (Le & Chang, 2013). The financial transmission channel operates through alterations within asset prices and external portfolio positions. The trade transmission channel operates through alterations within prices and quantities of tradable goods and services. Nonetheless, following the aim of this study, the main focus here is the trade transmission channel. Changes in the oil price is more likely to have both direct and indirect effects on both oil importing and oil exporting economies (Le & Chang, 2013). According to Backus and Crucini (2000), for an oil importing country, an increase in the oil price is considered as a negative term-of-trade shock, as it curtails the production and productivity capacity. They argue that oil is regarded as a production input for oil importing countries. Accordingly, oil price increases result in a higher cost of production and consequently the country or firm experiences a decline in total output. Lower levels of output cause a reduction in exports and an increase in imports and as result, a negative trade balance. Various studies were conducted in distinct areas within distinguished periods; they all found that the trade balance within an oil importing country is negatively affected by oil price increases and volatility (Backus & Crucini, 2000; Bodenstein et al., 2011; Hassan & Zaman, 2012; Kilian et al., 2009; Le & Chang, 2013). Nonetheless, rising oil prices is more beneficial to oil-exporting countries as it results in more revenue (Le & Chang, 2013). For oil importing countries such as South Africa, rising oil prices appear to seriously reduce total production and exports, which is expected to result in a trade deficit.

Real wages and trade Nexus

Real wage is another macroeconomic variable that plays an important role regarding international trade and the trade balance (Krugman & Lawrence 1993). Since international trade involves the total output of tradeable products and that production involves labour capital, real wage is supposed to have at least an indirect effect on trade balance, and the latter determines the number of workers needed for production (Taylor, 2008). In addition, and keeping all other factors constant, an increase in real wages could lead to higher cost of production, resulting in high prices of goods and services in the global market or a reduction in total output (Martins & Opromolla. 2009). Either way, high increases in real wages will most probably impact negatively on the trade balance. On the other hand, improvement in the trade balance, which means more exports, is more likely to positively impact on real wages (Duda-Nyczak & Viegelahn, 2018). Nonetheless, the effect of trade on real wages does not only depend on the domestic economy but also on the global economy (Deardorff & Hakura, 1993). Growth in domestic demand could lead to an increase in real wages with increasing production and could create equilibrium between foreign demand and domestic supply (Duda-Nyczak & Viegelahn, 2018).

Methodology

This paper employed quarterly time series variables that include the trade balance, effective exchange rate, crude oil prices and real wages. Data for crude oil prices and the effective exchange rate were sourced from the Quantec Easy Data website and the trade balance (total export minus total imports) and real wages were acquired from the South African Reserve Bank website. The time period is from 1994Q1 to 2018Q4. There were two reasons guiding the choice of this timeframe. Firstly, the selection of post 1994 period in South Africa is the period after the end of Apartheid; and the second reason was the availability of data. Generally, shocks in the trade balance would depend to a large extent on the exchange rate. However, since export levels play an important role and exports depend on other factors such as crude oil prices and labour wages, these two variables were also included in the model. In order to estimate the elasticity or responsiveness of the dependent on independent variables, all variables are expressed in natural logarithms.

In the study field of econometrics, a number of cointegration approaches could be utilised to establish a long term and short term relationship between variables. However, traditional approaches such as the Johanson Cointegration and vector error correction model (VECM) suffer from some flaws (Pesaran *et al.,* 2001), and in this paper the autoregressive distributed lag (ARDL) model introduced by Pesaran and Shin (1995) and revised by Pesaran *et al.* (2001) is utilised. The ARDL model yields robust and consistent results for both or the long and short-term relationship among variables. Among numerous advantages, this approaches allows the simultaneous establishment of both short and long term relationships, it can be applied on regressors irrespective of their order of integration (whether they are purely I(0), I(1) or a mixture of the two), provided that none of series is I(2). Additionally, the ARDL model allows the establishment of long term and short term dynamics without causing any loss of long term information. The following ARDL equation is estimated to establish a long term relationship between the selected variables:

$$\Delta lnTB_t = \propto_0 + \sum_{i=1}^{n} \beta_i \Delta \ln TB_{t-i} + \sum_{i=0}^{n} \delta_i \Delta \ln EXR_{t-i} + \sum_{i=0}^{n} \eta_i \Delta \ln COP_{t-i} + \sum_{i=1}^{n} \psi_i \Delta \ln RWAG_{t-i} + \lambda_1 lnTB_t + \lambda_2 lnEXR_t + \lambda_3 lnCOP_t + \lambda_4 lnRWAG_t + e_t \quad (1)$$

Where TB denotes the trade balance, EXR is represents the exchange rate, COP is the crude oil price and the RWAG symbolises real wages. The sign Δ and ln denote changes and natural logarithm respectively. The short-term dynamics are represented by the first part of the equation with β_i , δ_i , η_i and ψ_i as short-term coefficients. The long term relationship is represented by the second part of the equation with λ_1 , λ_2 , λ_3 and λ_4 as long term parameters. The cointegration among variables is established under the following hypotheses:

$H_0 : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$ (long term relationship does not exist)

$H_1 : \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0$ (long term relationship does exist)

The Bounds test is used to determine whether the null hypothesis is or is not rejected. In this regard, the computed F-statistic is compared to the Pesaran et al. (2001) critical values. The null hypothesis of no cointegration is rejected if the computed F-statistic exceeds the upper bound critical value, and it is not rejected if the computed F- statistic is smaller than the lower bound critical value. Nonetheless, in case the computed F-statistic falls between the two boundaries, the result remains inconclusive. In case the Bound test result evidences the presence of cointegration among variables, Equation 2 is estimated for the short term dynamics.

$$\Delta lnTB_t = \propto_0 + \sum_{i=1}^{n} \beta_i \Delta \ln TB_{t-i} + \sum_{i=0}^{n} \delta_i \Delta \ln EXR_{t-i} + \sum_{i=0}^{n} \eta_i \Delta \ln COP_{t-i} + \sum_{i=1}^{n} \psi_i \Delta \ln RWAG_{t-i} + e_t \quad (2)$$

The presence of cointegration among variables requests also the establishment of an error correction model (ECM) that assists in determining the speed of adjustment towards long-term equilibrium after short-term shocks. The ECM is estimated in Equation 3.

$$\Delta lnTB_t = \propto_0 + \sum_{i=1}^{n} \beta_i \Delta \ln TB_{t-i} + \sum_{i=0}^{n} \delta_i \Delta \ln EXR_{t-i} + \sum_{i=0}^{n} \eta_i \Delta \ln COP_{t-i} + \sum_{i=1}^{n} \psi_i \Delta \ln RWAG_{t-i} + \varphi_i ECM_{t-1} + e_t \quad (3)$$

Where φ_i is the coefficient for the error correction model. To ensure the goodness of fit of the established model (ARDL), stability and diagnostic tests were conducted. Through diagnostic tests, normality, heteroscedasticity and serial correlation associated with the model are determined, and through the structural stability test, the model stability is established.

The most used approach to examine the existence of causal relationship between two variables is the one proposed by Granger (1969). This test is based on vector Autoregressions (VAR) and it is estimated as follow:

$$X_t = \sum_{i=1}^{n} \propto_i Y_{t-i} + \sum_{j=1}^{n} \beta_j X_{t-j} + u_{1t} \quad (4)$$

$$Y_t = \sum_{i=1}^{m} \lambda_i X_{t-i} + \sum_{j=1}^{m} \delta_j Y_{t-j} + u_{2t} \quad (5)$$

Where u_{1t} and u_{1t} are assumed to be uncorrected. In equation 4, variable X is predicted by the lagged variable Y and in equation 5, is considered to be a predictor of variable Y. Following Equation 4 and 5, the researches can examine if the coefficients $\propto_i$ and λ_i are jointly different from zero with F-statistic. It is confirmed that a causal relationship exists between variable X and Y, if both null hypothesises suggesting that coefficients $\propto_i$ and λ_i are jointly equal to zero are rejected. Although the Granger causality is easy to conduct and applicable to various types of empirical study, it has its own limitations. As it estimates the causal relationship between two variables without considering the effect of one variable with the other, the Grange causality test is subjected to specification bias. Given that the Granger causality test is sensitive to lag selection, it is also likely to produce different results depending on the number of lags included in the model (Gujarati, 2006). Due to these mentioned and unmentioned shortcomings of Granger causality, Toda and Yamamoto (1995) introduced a robust procedure that can assist in testing causation between variables. The procedure also uses bivariate VAR and it adds an extra lag (*m* + *dmax*). The subsequent equations (6 and 7) follow Yamada's (1998) procedure.

$$X_t = \omega + \sum_{i=1}^{m} \theta_i X_{t-i} + \sum_{i=m+1}^{m+dmax} \theta_i X_{t-i} + \sum_{i=1}^{m} \delta_i Y_{t-i} + \sum_{i=m+1}^{m+dmax} \delta_i Y_{t-i} + v_{1t} \quad (6)$$

$$Y_t = \psi + \sum_{i=1}^{m} \phi_i Y_{t-i} + \sum_{i=m+1}^{m+dmax} \phi_i Y_{t-i} + \sum_{i=1}^{m} \beta_i X_{t-i} + \sum_{i=m+1}^{m+dmax} \beta_i X_{t-i} + v_{2t} \quad (7)$$

Where X denotes independent variables (exchange rate, crude oil price and real wages) and Y is the dependent variable (trade balance). The model parameters are represented by ω, θ_s , δ_s,

ψ , ϕ_s and β_s. The maximum order of integration is represented by *dmax*. v_{1t}~*N(0,* Σ_{v1}) and v_{1t}~*N(0,* Σ_{v2}) represent the models residuals ; while Σ_{v1} and Σ_{v2} are the covariance metric of v_{1t} and v_{2t} respectively. The null hypothesis for no causal relationship is written as H_0 : $\delta_i = 0$, ∀ i=1, 2, ..., m. The procedure follows two steps. The first is to determine the lag length (*m*) and the second is to determine the maximum order of integration (*dmax*) for a series in the model. The study used Schwarz Information Criterion (SC) to determine the optimal lag for VAR, and the Augmented Dickey-Fuller (ADF) Phillip-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are used to establish the order of integration.

Empirical findings and interpretation

Stationarity and unit root tests

Although the ARDL model does not require the pre-testing of variables, it is important to establish the order of integration for each variable before testing for cointegration. This is needed to ensure that none of the variable are integrated at second difference or beyond. The unit root tests are conducted using the Augmented Dickey-Fuller (ADF), Phillips Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin test statistic (KPSS) tests. The results from these tests, as listed in Table 1, suggest that the variables comprise of a mixture of I(1) and I(0). While the exchange rate (EXR) is stationary at levels, the trade balance (TB), crude oil price (COP) and real wages (RWAG) are integrated at first difference. Therefore, it is advisable to proceed with the ARDL model.

Table 1: Unit root and stationarity results

Variables	Test inclusion	Levels			1st Difference		
		ADF	PP	KPSS	ADF	PP	KPSS
TB	Constant	0.9903	0.9945	1.1230	0.0001*	0.0001*	0.3756*
	Constant & trend	0.5142	0.5735	0.2743	0.0000*	0.0000*	0.0391*
EXR	intercept	0.0688	0.0599	0.4160*	0.0000*	0.0000*	0.0634*
	Constant & trend	0.1860	0.1520	0.0829*	0.0000*	0.0000*	0.0398*
COP	intercept	0.4826	0.4295	0.8187	0.0000*	0.0000*	0.0876*
	Constant & trend	0.6753	0.5642	0.1520	0.0000	0.0000*	0.0614*
RWAG	Constant	1.0000	1.0000	1.1835	0.0635	0.0000*	1.2062
	Constant& trend	0.9050	0.9285	0.3095	0.0000*	0.0000*	0.1093*

Note: * denotes stationary variable at 5 % significant level.

Bounds testing

Since the integration order for each of the variables is established, the next step will be to determine whether variables cointegrate in the long term or not. The conclusion is made based on the result from the Bounds test. Since the ARDL model is used, the amount of lag is selected automatically, and each variable can use its own optimal lag length. The Schwarz-Bayesian criteria (SBC) is used for lag selection. The best selected model is ARDL (2, 0, 2, 0). The maximum number of lags selected is 3. Looking at the results exhibited in Table 2, the calculated F-statistic is 5.2447, which is greater than the Pesaran *et al.* (2001) upper bound critical value of 3.67 at a 5 percent level of significance. This result infers the rejection of the null hypothesis. In conclusion, it could be concluded that a long term relationship exists between the exchange rate, the crude oil price, real wages and the trade balance.

Table 2: Bounds test results

Test Statistic	**Value**	**K**
F-statistic	5.2447	3
Critical Value Bounds		
Significance	**I (0) Bounds**	**I(1) Bounds**
10%	2.37	3.2
5%	2.79	3.67
2.5%	3.15	4.08
1%	3.65	4.66

Long term elasticities

Table 3 displays the long term coefficients assessed by means of the ARDL approach. The results of the model ARDL (2, 0, 2, 0) suggest that all explanatory variables (crude oil price, exchange rate and real wages) possess a negative long term impact on the South African trade balance. While a one percent increase in crude oil prices causes the trade balance to decrease by almost 1.7 percent; a one percent increase in real wages results in approximately 1.58 percent decline in the trade balance. The reason for the inverse relationship with the trade balance might be that the high price of crude oil and increasing real wages may lead to a high cost of inputs, production and transport and subsequently cause a decline in total outputs (exportable products). This is in line with the findings of Fueki, Higashi, Higashio, Nakajima, Ohyama and Tamanyu (2018); Ghosh, Varvares and Morley (2009); and Malik, Ahmed and Ali (2000). Additionally, this study also found a negative relationship exists between the exchange rate and the trade balance. Interestingly, a one percent increase in the exchange rate (appreciation of the domestic currency) leads to a 2.7 percent decrease in the trade balance. This negative relationship between the exchange rate and the trade balance is supported by economic theories and empirical findings (Akorli, 2017; Chowdhury, 2014; Haberler, 1936). However, the relationship between the balance trade and the exchange rate is not always clear or predictable. For instance, the studies of Fountas and Aristotelous (2005) and Zakaria (2013) found the effect of exchange rate fluctuations on trade or total exports to be ambiguous, as it differs from country to country. The overall findings of the current study's model infer that the exchange rate has a dominant effect on the trade balance compared to other explanatory variables.

Table 3: Long Term Coefficients

Variable	Coefficient	Std. Error	T-Statistic	Prob.
LNCOP	-1.6676	5.9403	-0.2807	0.7796
LNEXR	-2.7055	9.3073	-0.2906	0.7720
LNRWAG	-1.5845	3.2047	-0.4944	0.6222
C	37.5263	69.2187	0.5421	0.5891

Error correction and short term relationship

Table 4 exhibits the short term coefficients and error correction coefficient estimated from the ARDL (2, 0, 2, 0) model. Both crude oil price and real wages are not statistically significant to impact upon the trade balance. However, the lagged value of the trade balance and the exchange rate are statistically significant enough, at 5 percent, to affect the trade balance. Contrary to the long term effect, domestic currency (Rand) appreciation can result in a short term trade surplus. The error correction term for cointegration equation is, as expected and required, negative and statistically significant, meaning that a long term relationship exists amongst the selected variables and that part of short-term disturbances is corrected in each quarter. The value of -0.009438 suggests that in every quarter only 0.9 percent of shocks is corrected. This shows that if new policies and serious measures are not taken in account it will take approximately 26 quarters years for the model to come back to a long term equilibrium.

Table 4: Error correction term and short term coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNTB(-1))	-0.3562	0.0986	-3.6102	0.0005*
D(LNCOP)	-0.0428	0.0272	-1.5694	0.1201
D(LNEXR)	0.2632	0.0799	3.2951	0.0014*
D(LNEXR(-1))	0.2097	0.0815	2.5732	0.0117*
D(LNRWAG)	-0.0019	0.1700	-0.0113	0.9909
CointEq(-1)	-0.0094	0.0020	-4.5026	0.0000*

Note: * denotes stationary variable at 5 % significant level.

Diagnostic and Stability Tests

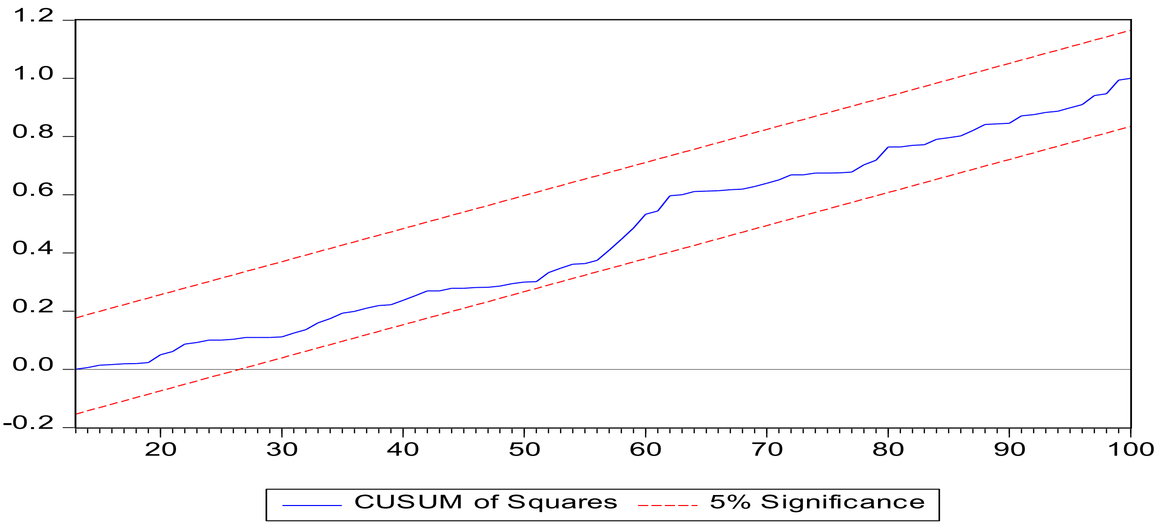
Four tests were conducted to determine the accuracy of the ARDL (2, 0, 2, 0) model. These tests include the CUSUM of square test for stability, the Jarque-Bera for normality, the Breusch-Godfrey LM Test for serial correlation and the White test for heteroscedasticity. The results displayed in Table 5 infer that the series are normally distributed, homoscedastic and serially uncorrelated. Additionally, the CUSUMSQ statistic plot (figure 1) shows that the blue line falls within the critical bands (the red lines) with a 95% confidence interval. Therefore, the ARDL (2, 0, 2, 0) model is stable.

Table 5: Diagnostic and Stability results

Test Statistics	Probability (P-value)	Decision
Normality	0.6258*	Residuals are normally distributed
Serial correlation	0.4009*	Residuals are serially uncorrelated
Heteroscedasticity	0.6068*	Residuals are homoscedastic
Stability		The model is stable

Note: * denotes failure to reject the null hypothesis at 5 % significance level

Figure 1: CUSUMSQ statistic plot



Toda-Yamamoto Granger Causality Test

Having established the long term and short term relationships between the variables, it is important to investigate the causal relationships between the variables. The causation between variables is assessed based on the Toda-Yamamoto (1995) approach and estimated through the MWALD test. The results in Table 7 suggest a bi-directional causality between the exchange rate and the trade balance (at 10% significance level) and a uni-directional causality between the crude oil price and the trade balance. In other words, both the exchange rate and oil price are predictors of short-term behaviour of the trade balance, while the trade balance can be used to predict oil price behaviour.

Table 7: Toda-Yamamoto causality test two-variate VAR model results

Variables	Lag(m)	Lag (m+dmax)	Chi-sq	Prob.	Direction of causality
LnEXR vs LnTB	2	2+1	10.7315	**0.0047***	LnEXR ↔ LnTB
BT vs LEXCH	2	2+1	4.7603	**0.0425***	
LnCOP vs LnTB	0	0+1	8.7146	**0.0128***	LnOILP → LnTB
LnTB vs LnCOP	2	2+1	1.9938	0.3690	LnTB Ø LnCOP
LWAGE vs TB	0	0+1	0.6468	0.7237	LnWAG Ø LnTB
LnTB vs LnWAG	2	2+1	2.5060	0.2856	LnTB Ø LnWAG

Note: * rejection of null hypothesis at 5 percent level. The (k+dmax) denotes VAR order. →Denotes a causality direction. Ø denotes absence of causation.

Conclusion

This study analysed the effect of the exchange rate, crude oil price and real wages on the South African trade balance for the period 1994 – 2018. The ARDL model was employed as developed by Pasaran *et al.* (2001) to determine the long term and short term relationships, and the Toda-Yamamoto (1995) causality tests to determine the causal relationships between the variables. The main objective was achieved via the econometric analysis and the relationships between the variables were determined. Unit root tests were conducted to establish the order of integration for the underlined variables. The outcome from these (unit root) tests suggested a mixture of I (0) and (1). The findings from the cointegration test infer that a long term relationship exists between the exchange rate, crude oil price, real wages and the trade balance. All explanatory variables, namely the exchange rate, the crude oil price and real wages were found to have a negative impact on the trade balance. The analysis revealed that the exchange rate impacts more on the trade balance compared with other variables under study. Contrary to long term results, the short-term findings indicate that domestic currency appreciation leads to a positive effect on the short-term trade balance, while both crude oil price and real wages are not statistically significant enough to affect the balance trade in the short term. The study has a relatively long time series of 25 years of quarterly data. Limitations of the study could include the restricted number of independent variables, though more variables could make the model unstable. Future studies will include additional economic variables such as trade openness, inflation and interest rates. Other studies could also include an assessment of a range of developing countries regarding the impact of the volatility of the exchange rate.

The relevance of the study is that the results and findings could be applicable to other oil-importing developing countries. The implications of the study are that the exchange rate, especially if the exchange rate shows evidence of high levels of volatility, has a significantly negative impact on trade and the trade balance, and that both the price of crude oil and wages do impact on the trade balance. Based on these findings, and since South Africa is not an oil producing country and thus has no control over the oil price, it is imperative for the South

African Reserve Bank to implement strategies that stabilise the exchange rate for the country to enjoy a trade surplus. Moreover, increasing stocks of imported oil can assist in delaying the effect of oil price fluctuations on the trade balance.

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