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DETERMINANTS OF REAL EFFECTIVE EXCHANGE RATE IN BOTSWANA

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ABSTRACT

This paper identifies the determinants of the Real Effective Exchange Rate (REER) in Botswana for the period 1992Q1 to 2016Q2. The paper employs the Behavioral Equilibrium Exchange Rate (BEER) approach to analyse the behaviour of the real effective exchange rate. The paper employs the Vector Autoregressive (VAR) model to estimate the determinants of the REER. The VAR model results show that variables from the financial and fiscal sectors do not affect the REER. Coefficients are statistically insignificant and have the wrong signs. These findings are in contrast with those found in the literature (Iimi (2006), De Jager (2012) and Kiptui et.al (2013)). However, from the Variance Decomposition (VD), we find that the same endogenous variables explain approximately 9.1 percent of the variation on the REER, while 91 percent of the variation of the REER is explained by itself. Additionally, the Impulse Response Function (IRF) reveals that the REER responds to all individual-instantaneous shock for a certain period. Furthermore, the model proves to be stable. It can be argued that, from the VD, IRF and Stability tests, the findings corroborate those found by Iimi (2006), De Jager (2012) and Kiptui et.al (2013). i.e., through the BEER approach the; Prime Rate, Headline Inflation, Government Expenditure and Bank of Botswana Certificates partially influence the Real Effective Exchange Rate in Botswana.

Keywords*: Real Effective Exchange Rate, Behavioral Equilibrium Exchange Rate Approach, Impulse Response Function, Financial and Fiscal sectors, Botswana*

JEL Classification*: F31; F41*

I. INTRODUCTION

This paper identifies the determinants of the Real Effective Exchange Rate (REER) in Botswana from the financial and fiscal sectors. It covers the period 1992Q1 to 2016Q2. A stable Real Effective Exchange Rate is important in achieving macroeconomic stability and sustained diversified development.

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Therefore, there is a need to know how to control the REER by influencing certain sectors of the economy. i.e., what are the macroeconomic fundamentals that policymakers may influence or monitor to affect the REER? The study of the real effective exchange rates is an important part of overall macroeconomic analysis. A large body of evidence indicates that exchange rates can get seriously misaligned with economic fundamentals (Iimi, 2006). These create substantial macroeconomic imbalances. Moreover, exchange rate misalignments can be a consequence of inappropriate macroeconomic policies and indicate the necessity of a shift in monetary or fiscal policy. Exchange rate and competitiveness surveillance is particularly important in an open economy like Botswana. This is because adjustment mechanisms have to be employed in order to manage competitiveness problems and maintain internal and external balance (Edwards, 1988, Motlaleng, 2009).

The exchange rate is one of the most important economic indicators which show the relative price of one currency in terms of the other. It determines the trading price, making the exchange rate a very sensitive price responding rapidly to any changes in the economy. The main purpose of exchange rate policy in Botswana is achieving price stability and relative competitiveness of a country's exports against the rest of the world. In addition, an important matter is the REER depicts the levels, trends and the extent to which the REER is aligned to its equilibrium level. It is important to have the REER aligned to its equilibrium level since deviations of it lead to distortions in the economy. Its level and stability has been shown to influence exports and private investment. Most studies in developing countries indicate that the volatility and fluctuations of exchange rates contribute towards a deficit or a surplus in their balance of payments. Bank of Botswana (2015) highlights that, a stronger currency makes a country's exports more expensive and imports cheaper. This lowers revenue generated into the economy. A weaker currency on the other hand, makes a country's exports cheaper and imports expensive, resulting in a positive balance of payments. The paper proceeds as follows: Section II gives an overview on the evolution of exchange rate in Botswana. Section III focuses on literature review. The methodology employed is outlined in Section IV. Section V presents empirical results. Lastly, Section VI comprises of conclusions of the paper.

II. EVOLUTION OF EXCHANGE RATE IN BOTSWANA

Botswana maintained its membership to the Rand Monetary Area (RMA) until 1976. The RMA was a regional monetary union which comprised of Botswana, South Africa, Lesotho, Swaziland and Namibia (Bank of Botswana, 2007). All these countries used the Rand as a common currency and the Rand was pegged to the US dollar. South Africa as the largest economy of all the member states had decisive influence on the exchange rate policy of the RMA. In 1976 Botswana withdrew from the RMA and introduced her own currency, the Pula. The Pula was pegged to the US dollar. This maintained parity with the Rand. Bank of Botswana (2007, (2014)) accentuates that, the Pula was revalued by 5 percent against the Rand in April 1977. This was done with the aim of reducing imported inflationary pressures and to demonstrate independence of the new currency.

In 1980 South Africa withdrew from the US dollar peg and introduced a managed float exchange rate regime. The Rand started to further appreciate against the US dollar due to the increase in gold prices. This necessitated a change in strategy for Botswana as the Pula depreciated against the Rand, causing inflation in Botswana to accelerate. The Pula was pegged to a basket of currencies comprising of the Special Drawing Rights (SDR) and the South African Rand. This was done in order to moderate and influence the developments taking place in South Africa and to achieve a more stable relationship between the Rand and Pula. The fixed peg was considered to be appropriate because Botswana was relatively small and undiversified and was unlikely to sustain a floating currency.

From 1980 the exchange rate was adjusted intermittently, as both an anti-inflation tool and to promote domestic industry competitiveness. However, from the early 1990s, the export competitiveness objective became more dominant. This was also against the background of an enhanced monetary policy framework that increasingly became more effective in mitigating inflationary pressures (Bank of Botswana, 2007).

The first major Pula devaluation of 10 percent, took place in May 1982 to alleviate the impact of the oil shock that precipitated a global recession in 1981 and subsequent collapse of demand for diamonds (Bank of Botswana, 2007). The depressed diamond market led to the imposition of a quota on Botswana's diamond sales, resulting in a sharp decrease in exports and a balance of payments crisis. This also resulted in a significant decline in foreign exchange reserves to only 3.5 months of import cover in March 1982.

The collapse of the Rand due to economic sanctions and disinvestment in protest over the apartheid regime resulted in further devaluations of the Pula by 5 percent in July 1984 and 15 percent in January 1985. This was done to maintain viability and competitiveness of local producers. In addition to this objective, the central bank also motivated the former devaluations of 5 percent in each instance, in 1990 and 1991. In between, the Pula had been revalued by 5 percent in June 1989 (Bank of Botswana, 2007). This was done to mitigate inflationary pressures as the sharp depreciation against the major currencies threatened high inflation in South Africa and in turn imported inflation into Botswana.

In May 2005 Botswana introduced a major change in exchange rate policy that entailed the adoption of the current framework. It is based on a crawling band mechanism where the rate of crawl is based on the differential between the Bank of Botswana's inflation objective and forecast inflation in trading partner countries. Motlaleng (2009) and Bank of Botswana, 2007 argue that the exchange rate has a significant role in achieving monetary stability and for supporting the economic activities such as; price stability, preventing hyperinflation and having sustainable economic growth (Bank of Botswana, 2016).

The crawling band exchange rate regime is implemented through continuous adjustment of the trade-weighted Nominal Equilibrium Exchange Rate (NEER) of the Pula. The crawl is at a rate based on the differential between the Bank's inflation objective and the forecast inflation of trading partner countries (Bank of Botswana, 2014). The rate of crawl is thus determined using a forward-looking approach and is revised on a regular basis. In this forward-looking scheme, the authorities periodically determine the rate of crawl for the subsequent period. For example, in the next six or twelve months. Since the introduction of the crawl, Botswana's inflation has generally been higher than the average inflation of its trading partners and this has necessitated a downward crawl. However, if inflation differentials were to be reversed such that the domestic inflation objective fell below expected inflation in trading partner countries, then an upward crawl could be introduced. The stability of the exchange rate is required to achieve a conducive environment which encourages business activities. Exchange rate policy contributes to macroeconomic stability as it impacts the external sector, fiscal developments and financial stability of the country.

III. REVIEW OF PREVIOUS STUDIES

Numerous studies have used the Purchasing Power Parity (PPP) in different facets of exchange rate mechanisms. Nonetheless, it has been shown not to be an appropriate model for the determination of equilibrium exchange rate (MacDonald & Ricci, 2003). This is because of the slow mean reversion of real exchange rates to a constant level, which is the long equilibrium by the PPP assumption. MacDonald and Ricci (2003) conclude that this has resulted in the shift away from PPP based measures of the equilibrium exchange rate. The shift has been to ones which focus on the link between the real exchange rate and various real determinants such as productivity and net foreign assets.

A study conducted by Edwards (1988) was done to analyse real exchange rate behaviour in developing countries. The results obtained was that; expansive and inconsistent macroeconomic policies have inevitably generated forces towards real overvaluation. The estimation also indicates that the autonomous forces that move the real exchange rate back to equilibrium operate very slowly. They maintained the country out of equilibrium for a long period. In addition, the results indicate that if a country is in disequilibrium, nominal devaluations can greatly help to speed up the real exchange rate realignment. Asari et al. (2011) used a VECM approach of stationarity test, cointegration test, stability test and Granger causality test analyse real exchange rate behaviour in Malaysia. The results reported that in the long run, interest rates moves positively and inflation rate moves negatively towards exchange rate volatility in Malaysia. This comes to a conclusion that, increasing the interest rate can be efficient in restraining exchange rate volatility.

Cahyono (2008) focused on the determinants of equilibrium real exchange rate and its misalignment in Indonesia. Economic fundamental of net foreign asset, terms of trade, non-traded goods and inflation targeting framework were used and were all statistically significant. The results showed patterns of misalignment of the rupiah over a six year period. When the real exchange rate appreciates or is overvalued, the trade balance shows high surplus. Cahyono further concludes that, other variables can determine the equilibrium RER and its misalignment which are not included in the model but give effect on the RER. For example; interest rate, government expenditure, oil price and money supply. Zardad *et al.* (2013) conducted a study in Pakistan over a thirty year time period (1980-2010). The results indicate that the real effective exchange rate has been volatile around its equilibrium level. The VECM results confirmed that long term parameters are statistically significant and consistent with previous literatures. The relative productivity and terms of trade are related with more appreciation in RER. In contrast the government expenditure and trade openness, being associated with depreciation in RER. The Error Correction The speed of adjustments towards equilibrium is statistically significant with the correct negative sign. It indicates that RER will quickly adjust to the equilibrium level at a speed of 87 percent.

Using a two structural model, Imam and Minou (2011) analysed the equilibrium exchange rate in Mauritius over the medium term. Results showed that positive terms of trade shock improved trade balance. It resulted in an increase in domestic demand causing higher prices of non-tradable and hence an appreciation of the RER. Increases openness leads to lower domestic prices which depreciate the RER. An increase in government consumption appreciates the RER since much of this consumption is non-tradable. In a nutshell, the RER was found to be closer to its equilibrium level. Kiptui et.al (2013) determined the extent of misalignment of the real exchange rate in Kenya over a fourteen year period (1998-2012). Adopting the Behavioural Equilibrium Exchange Rate (BEER), estimation is carried out using a Vector Error Correction Model (VECM) framework. The results reported the significant role played by real incomes, money supply and government expenditures in influencing the magnitude of the real exchange rate changes. During the fourteen year period, the real exchange rate was not seriously misaligned.

In South Africa De Jager (2012) modelled equilibrium real effective exchange rate and investigated the various factors that may have an impact on the level of exchange rate using a VECM approach. The results from the model suggests that the equilibrium level may be determined by the effects of key economic fundamentals being interest rate differential, a suitable productivity measure, commodity prices, the fiscal balance and capital flows. All of the variables had a positive effect. i.e., an increase in one of the variable caused an appreciation of the exchange rate. The fiscal balance had a negative effect implying that an increase in the fiscal balance lead to a depreciation in the equilibrium exchange rate. It was found that the actual level of the REER was close to its equilibrium in the last quarter of 2011. Iimi (2006) conducted a study on exchange rate misalignment in Botswana. He applied the behavioral equilibrium exchange rate (BEER) approach for the period 1985-2004. The paper estimated a reduced-form single-equation model, using the vector error correction mechanism (VECM). The findings were that, the Botswana Pula seemed to have been undervalued in the late 1980s and overvalued by 5 to 10 percent in the more recent years. The misalignment in the 1990s seemed to have been very marginal. The results also revealed; a positive relationship between the equilibrium RER with the domestic interest rates and the terms of trade. A negative relationship was found between the equilibrium RER with the risk premium (associated with a fiscal deficit). An unexpected negative relationship was found between equilibrium RER and the net foreign assets.

This paper contributes to the literature by first including a dummy variable as one of the independent variables in the model employed. The inclusion of this binary variable is to capture the period before and after Botswana adopted the crawling peg exchange rate regime prior to the fixed exchange rate regime. This makes it clearer if Botswana's real effective exchange rate (REER) has been influenced by the crawling peg regime. Secondly, the paper uses the real effective exchange rate index computed by the Bank of Botswana. In contrast, Iimi (2006) used the REER index as calculated by the International Monetary Fund (IMF). The REER index is computed differently across central banks and is prone to give varying results. Iimi (2006) elaborates that even using a conventional measurement, there are many conceptual and calculation ambiguities in REER. Thirdly, the study uses different variables across sectors in order to capture a variety of broader macroeconomic variables. This is associated with the behavioral equilibrium exchange rate (BEER) approach. Finally, the time period used in this paper is a longer time period of twenty-four years (1992Q1 to 2016Q2).

IV. METHODOLOGY

It is clear from the above reviewed literature that the real exchange rate is not determined by only the domestic and foreign prices as suggested by the PPP theory but by other variables or fundamentals in different sectors of the economy (see for instance, Iimi (2006), De Jager (2012), Kiptui et.al (2013) and Kiptui and Ndirangu (2015)). They argue that sources of long-run RER variability can be emphasised as follows.

$$\underset{}{RER} = f(\underset{(-)}{y}, \underset{(+)}{M3}, \underset{(-)}{G\,exp}, \underset{(-)}{CABr}, \underset{(-)}{NFA}, \underset{(-)}{OPEN}, \underset{(-)}{capf}, \underset{(+/-)}{TOT}) \tag{4.1}$$

Where: RER is the real exchange rate, y is output, M3 is money supply, Gexp is government expenditure, CABr is the current account balance as a percentage of nominal GDP, NFA is net foreign assets, OPEN is the openness to trade, capf is capital formation and TOT is the terms to trade. Equation (4.1) indicates the RER is not only determined by nominal exchange rate, domestic price and foreign price as proposed by the PPP theory but by other aspects in the economy as proposed by the Behavioral Equilibrium Exchange Rate (BEER) approach. This approach quantifies the fundamental determinants of the real effective exchange rate (REER) through econometric estimation with an extended version of the uncovered interest parity (UIP) as a theoretical background. BEER focuses on the dynamic behaviour of the interest rate, short run movement and deviations and taking macroeconomic conditions into account. Using the BEER in calculating the REER is consistent with the concept of economic equilibrium which is in connection with macroeconomic fundamentals. The model used in this paper can be formally represented as:

$$REER = f(PR, HI, GE, BOBCS, D) \tag{4.2}$$

Where:

- REER is the Real Effective Exchange Rate index
- The Financial sector: Prime rate (PR), Headline inflation (HI) and Bank of Botswana Certificates (BOBCs)
- Fiscal sector: Government expenditure (GE)
- D is the dummy variable.

The model is expressed in log-linear form to measure elasticities. Lower case letters denote logarithms of the variables:

$$reer_t = \alpha_1 + \alpha_2 pr_t + \alpha_3 hi_t + \alpha_4 ge_t + \alpha_5 bobcs_t + d_t + \varepsilon_t \tag{4.3}$$

Where: α is the model parameters, d_t as explained before is a dummy variable for the crawling peg exchange rate (where $d_t = 1$ is the exchange rate during the crawling peg regime and when $d_t = 0$ otherwise), ε_t is the disturbance term and all other variables as explained before.

4.1.1. Explanation of Variables and Expected Signs

i) *The Financial Sector*- the relative interest rate differential between domestic and foreign real interest rates (rirrus) reflects the uncovered interest rate parity (UIP). It states that the domestic interest rate must be higher than the foreign interest rate by an amount equal to the expected depreciation of the domestic currency (MacDonald & Ricci, 2003). According to economic theory, the interest rate differential should tend to equalise across countries in the long run. However, the empirical evidence suggests that this is not necessarily the case. On the assumption that the UIP holds and that all other factors (such as a risk premium) are constant, an increase in the domestic interest rate relative to other countries would tend to attract foreign capital. This would cause an appreciation of the domestic currency. Due to this, there is a negative relationship between the financial sector and the real exchange rate.

ii) *The Fiscal Sector*- an improved fiscal position, caused by either a reduction in government expenditure or an increase in government revenues, essentially leads to more funds flowing to the public sector (MacDonald, 1997). The reallocation of resources from the private sector would cause a decline in domestic demand, and ensuring reduced demand pull pressures will generally lead to lower domestic prices (declining inflation). It is largely this price effect that induces a depreciation of the real exchange rate (Iimi, 2006).

4.2. Vector Autoregressive (VAR)

Estimation is done using the Johansen cointegration approach. Application of this approach starts with the unrestricted vector autoregressive (VAR) model.

$$Y_t = C + \varphi_1 Y_{t-1} + \varphi_2 Y_{t-2} + \cdots + \varphi_k Y_{t-p} + \varepsilon t \tag{4.4}$$

For $t = 1, 2\ldots$ T is a vector of k variables, φ_i are $k\times k$ coefficient matrices, and ε_t is IID N-dimensional vector ($k\times 1$) with zero mean and covariance Ω. This is a VAR (p) process since the number of lags is p. A VAR is a system in which each variable is regressed on a constant and a k of its own lags as well as on k lags of each of the other variables in the model (Enders, 2015). To build relationships among variables, VAR treats every variable as endogenous in the system and as a function of lagged values of all endogenous variables in the system. The VAR facilitates to capture both the dynamic and interdependent relationships of the REER and its factors. We do not interpret estimates; we only interpret the inter-relationships among the variables. This is done through the Impulse Response Function and the Variance Decomposition tests.

In formulating the VAR matrix, equation (4.3) is expressed as:

$$\begin{pmatrix} reer_t \\ pr_t \\ hi_t \\ ge_t \\ bobcs_t \end{pmatrix} =$$

$$\begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \end{pmatrix} + \begin{pmatrix} A^1{}_{11} & \cdots & A^1{}_{15} \\ \vdots & \ddots & \vdots \\ A^1{}_{51} & \cdots & A^1{}_{55} \end{pmatrix} \begin{pmatrix} reer_{t-1} \\ pr_{t-1} \\ hi_{t-1} \\ ge_{t-1} \\ bobcs_{t-1} \end{pmatrix} + \cdots + \begin{pmatrix} A^p{}_{11} & \cdots & A^p{}_{15} \\ \vdots & \ddots & \vdots \\ A^p{}_{51} & \cdots & A^p{}_{55} \end{pmatrix} \begin{pmatrix} reer_{t-p} \\ pr_{t-p} \\ hi_{t-p} \\ ge_{t-p} \\ bobcs_{t-p} \end{pmatrix} +$$

$$\Gamma_d \begin{pmatrix} d_{1t} \\ d_{2t} \\ d_{3t} \\ d_{4t} \\ d_{5t} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{pmatrix} \tag{4.5}$$

Where Ai is a (k×k) matrix of coefficients, p is the lag length of the VAR and ε_t is a (k×1) column vector of random stochastic terms. A critical element in the specification of a VAR model is the determination of lag length. The appropriate lag length must be determined by allowing a different lag length for each set of equations at each point in time. The Akaike Information Criterion (AIK) and Schwartz Information Criterion (SC) are used to estimate the optimal lag length, which minimizes information criteria (Enders, 2015). If the lag length is too short, the model is misspecified and if too long the degrees of freedom are lost.

4.3. Type and Sources of Data

Quarterly time series data is used for the years 1992Q1 to 2016Q2. This twenty-four year period is chosen mainly on the availability of data and to capture a high-frequency-large-sample-size to avoid associated problems related with small samples and yielding robust results. The real effective exchange rates data are collected from Bank of Botswana (BOB), as they calculate it using their own formula. This paper use secondary data published from; the Bank of Botswana Annual Reports, Botswana Financial Statistics, International Monetary Fund

Table 1
ADF and PP Unit Root Tests

Variables	*ADF*			*PP*		
	Levels	*1st Difference*	*Order of integration*	*Levels*	*1st Difference*	*Order of integration*
With intercept						
reer	-2.01561	-10.2635*	I(1)	-1.9917	-10.3402*	I(1)
	(0.2798)	(0.0000)		(0.2901)	(0.0000)	
pr	0.8615	-7.6977*	I(1)	1.0096	-7.7571*	I (1)
	(0.9946)	(0.0000)		(0.9965)	(0.0000)	
hi	0.8803	-8.1746*	I(1)	-1.6894	-8.5424*	I (1)
	(0.9948)	(0.0000)		(0.4334)	(0.0000)	
ge	-1.2621	-10.5416*	I(1)	-0.9596	-39.1045*	I (1)
	(0.6444)	(0.0000)		(0.7649)	(0.0001)	
bobcs	-3.1261*	-13.7087*	I(0)	-3.2741*	-15.8877*	I(0)
	(0.0279)	(0.0001)		(0.0188)	(0.0001)	
With trend and intercept						
reer	-1.9714	-10.2998*	I(1)	-1.9630	-10.3807*	I (1)
	(0.6092)	(0.0000)		(0.6137)	(0.0000)	
pr	-0.4268	-8.0886*	I(1)	-0.6265	-8.0808*	I (1)
	(0.9852)	(0.0000)		(0.9750)	(0.0000)	
hi	0.1120	-6.6609*	I(1)	-2.6703	-8.5039*	I (1)
	(0.9970)	(0.0000)		(0.2512)	(0.0000)	
ge	-1.4325	-10.6020*	I(1)	-5.3985*	-71.7565*	I (0)
	(0.8450)	(0.0000)		(0.0001)	(0.0001)	
bobcs	-3.1117	-13.7562*	I(1)	-3.6915*	-18.6216*	I (0)
	(0.1095)	(0.0000)		(0.0276)	(0.0000)	

Critical values	*ADF with intercept*	*ADF with trend and intercept*	*PP with intercept*	*PP with trend and intercept*
1%	-3.4992	-4.0554	-3.4992	-4.0554
5%	-2.8916	-3.4568	-2.8916	-3.4568
10%	-2.5828	-3.1543	-2.5828	-3.1543

Where ADF is the Augmented Dickey-Fuller test and PP is the Phillips-Perron test. The results record the t-statistics and the probability values. An * indicate stationarity at the 5% level of significance.
Source: Eviews Simulations

website and Statistics Botswana publications. Estimation procedures and tests are carried out using Eviews 8 software package.

V. EMPIRICAL RESULTS

5.1. Unit Root Test

The Augmented Dickey-Fuller (ADF) and the Phillips Perron (PP) tests are used for testing stationarity in the series. The interpretations in the paper are highly based on the PP test, as it is a higher hierarchy from the ADF. The tests are undertaken with trend specification and with trend and intercept specification.

From the unit root test Table 1, we can conclude that government expenditure and Bank of Botswana certificates are stationary at levels I(0) and consequently the real effective exchange rate, prime rate and headline inflation variables are stationary at first difference I(1).

5.2. Cointegration Test

The Johansen cointegration test is employed to test for the long-run movement of the variables.

Table 2
No Deterministic Trend, No Intercept and No Trend in the VAR Model

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	*Eigenvalue*	*Trace Statistic*	*0.05 Critical Value*	*Prob.***
None	0.124165	18.25283	24.27596	0.2378
At most 1	0.036856	5.525395	12.32090	0.4962
At most 2	0.019805	1.920353	4.129906	0.1952

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
** MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	*Eigenvalue*	*Max-Eigen Statistic*	*0.05 Critical Value*	*Prob.***
None	0.124165	12.72743	17.79730	0.2459
At most 1	0.036856	3.605043	11.22480	0.6917
At most 2	0.019805	1.920353	4.129906	0.1952

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
** MacKinnon-Haug-Michelis (1999) p-values
Source: Eviews Simulations

From the above cointegration test results in Table 2, both Trace and maximum Eigenvalue tests report no existence of cointegration among the variables. The null hypothesis is specified as no cointegration among the variables, while the alternative hypothesis specifies cointegration within the variables. Focusing on the probability values; the Trace test p-values are statistically insignificant at 5 percent level. This implies failure to reject the null hypothesis and concludes that there is no cointegrating vectors among the variables. In accordance, the Maximum Eigenvalue test p-values are statistically insignificant at 5 percent level, indicating failure to reject the null hypothesis and concluding no cointegrating equations among the variables. Both tests conclude that there is no cointegration among the series in the study.

5.4. Vector Autoregressive Model

From the Johansen cointegration test, it has been established that there is no cointegration among the I (1) variables. From the methodology, no cointegration implies running an unrestricted VAR (VAR) and presence of cointegration implies running a restricted VAR (VECM) (Rubinfeld, 1991). Therefore, an unrestricted VAR model results are presented in Table 5.3 below. It should be noted that, VAR's are analysed based on their Impulse Response function (IRF) test, Variance Decomposition (VD) test and Stability test and not their lag coefficients. Impulse responses generally tend to converge to zero, implying that the model depicted stability overtime. The IRF helps to discover the effects of unanticipated shocks on the stability of Botswana's real effective exchange rate. In addition, the VD is conducted to assess the extent to which the variables used in the VAR affect the real effective exchange rate over-time (See, for instance Sims 1980; Sims *et al.* 1990; Marcet, 2004).

Table 3
VAR Estimates

Vector Autoregression Estimates
Date: 04/30/17 Time: 06:00
Sample (adjusted): 1992Q3 2016Q2
Included observations: 96 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	Equation 1 *D(REER)*	*Equation 2* *D(PR)*	*Equation 3* *D(HI)*	*Equation 4* *GE*	*Equation 5* *BOBCS*
D(REER(-1))	-0.071561	-0.028453	-1.087106	0.865933	5.007107
	(0.10757)	(0.15886)	(0.81546)	(0.76950)	(2.84279)
	[-0.66524]	[-0.17911]	[-1.33312]	[1.12532]	[1.76133]
D(PR(-1))	0.038363	-0.010680	-0.135461	-0.242230	4.420166
	(0.07512)	(0.11093)	(0.56943)	(0.53733)	(1.98509)
	[0.51072]	[-0.09628]	[-0.23789]	[-0.45080]	[2.22668]*
D(HI(-1))	0.015912	0.079898	0.171113	-0.017716	-0.746416
	(0.01599)	(0.02361)	(0.12121)	(0.11438)	(0.42255)
	[0.99516]	[3.38365]*	[1.41173]	[-0.15490]	[-1.76647]
GE(-1)	-0.002286	-0.011391	-0.017329	0.899004	0.113639
	(0.00503)	(0.00743)	(0.03815)	(0.03600)	(0.13299)
	[-0.45430]	[-1.53272]	[-0.45426]	[24.9741]*	[0.85451]
BOBCS(-1)	0.000815	0.004896	0.014186	0.020425	0.722745
	(0.00274)	(0.00405)	(0.02077)	(0.01960)	(0.07241)
	[0.29743]	[1.20981]	[0.68296]	[1.04203]	[9.98097]*

contd. table 3

	Equation 1 D(REER)	*Equation 2 D(PR)*	*Equation 3 D(HI)*	*Equation 4 GE*	*Equation 5 BOBCS*
C	0.015407	0.064425	0.032852	0.773594	1.386174
	(0.04330)	(0.06394)	(0.32821)	(0.30971)	(1.14419)
	[0.35586]	[1.00758]	[0.10009]	[2.49778]	[1.21149]
DUMMY	0.000341	-0.002992	-0.001472	0.054303	0.066321
	(0.00338)	(0.00500)	(0.02565)	(0.02420)	(0.08942)
	[0.10075]	[-0.59885]	[-0.05739]	[2.24353]*	[0.74168]
R-squared	0.036380	0.235026	0.049342	0.971000	0.688806
Adj. R-squared	-0.028583	0.183454	-0.014747	0.969045	0.667826
Sum sq. resids	0.007083	0.015448	0.407034	0.362445	4.946719
S.E. equation	0.008921	0.013175	0.067627	0.063816	0.235756
F-statistic	0.560006	4.557292	0.769896	496.6647	32.83250
Log likelihood	320.4734	283.0436	126.0159	131.5849	6.131835
Akaike AIC	-6.530696	-5.750908	-2.479497	-2.595520	0.018087
Schwarz SC	-6.343712	-5.563924	-2.292513	-2.408536	0.205070
Mean dependent	0.000643	-0.002982	-0.008506	9.628001	9.010767
S.D. dependent	0.008796	0.014580	0.067134	0.362712	0.409054

Determinant resid covariance (dof adj.)	9.75E-15
Determinant resid covariance	6.68E-15
Log likelihood	885.6485
Akaike information criterion	-17.72184
Schwarz criterion	-16.78692

An * is the statistically significant coefficients, according to the t-statistic.
Source: Eviews Simulations

As per the Table 3, the equation of interest is Equation 1, where R-squared records the lowest value of 0.0364. This indicates that approximately 3.6 percent of the variation in REER in Botswana is explained by the explanatory variables. The statistical inference shows us these factors have a low impact in affecting REER in Botswana. This is also accounted by an insignificant dummy variable affecting the REER model. The t-statistics of the dummy variable is 0.1008 which is less than 2 for it to be statistically significant. Inclusion of the dummy variable to capture the period before the crawling peg exchange rate regime (1992Q1-2005Q2) and after the crawling peg exchange rate regime (2005Q3-2016Q2) did not have any significance. In addition, the joint explanatory power of the F-statistic recorded the lowest value of 0.560006. Implying that, jointly, the independent variables do not well explain the REER variable. The overall model does don't perform well as explained by the F-statistic.

These results are in contrast with those found by Iimi (2006). The author found all variables being non-stationary at levels but stationary after first differencing. This led to testing for the presence of cointegration, further leading to a VECM model. The author was able to find Botswana's exchange rate misalignment with its economic fundamentals through its long-run cointegrating equation. The results are inconsistent with Iimi's (2006) results, probably due to the sample size used. The author's model was estimated using annual data from 1985 to 2004 which does not include the year of the crawling exchange rate regime. Additionally, Iimi (2006) uses the REER calculated by the International Monetary Fund facility database which is most likely to be different from that of Bank of Botswana's REER used in this paper.

Our findings are also in contrast with those of De Jager (2012) and Kiptui *et al.* (2013). For example, Kiptui *et al.* (2013) in the case of Kenya using a Behavioural Equilibrium Exchange Rate approach and VECM model found the following. The real effective exchange rate is largely driven by real incomes, money supply and government expenditures. In addition, the REER is aligned to its long-run equilibrium level in Kenya. These differences in results might be accounted by the sample size. Kiptui *et al.* (2013) uses quarterly data from 1998 to 2012. Compared to our findings, their smaller sample size of fifty-six observation rate may lead to cointegration and hence a VECM approach. It is also important to note that Kenya uses a floating exchange rate regime which may greatly explain their results.

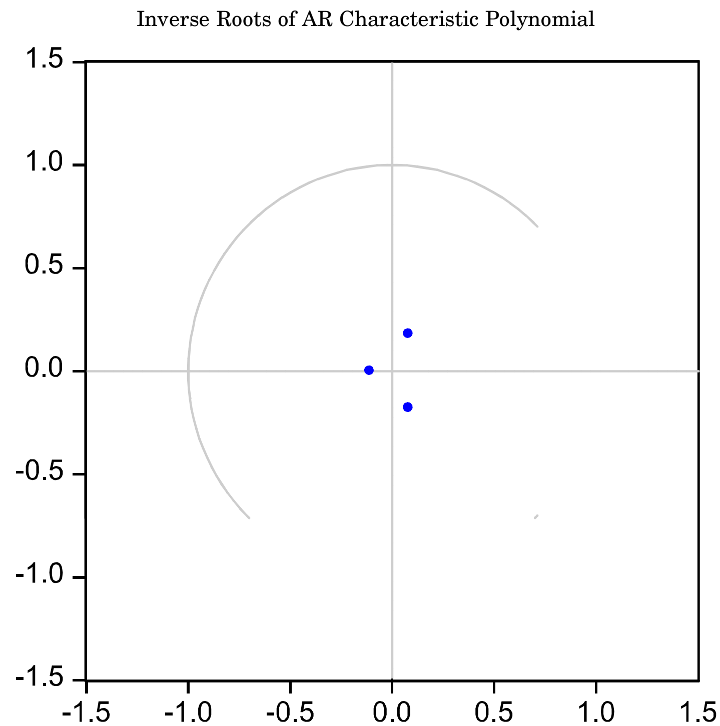
Equation 4 recorded the highest R-squared of 0.971. A 97 percent of the variation in government expenditure in Botswana is explained by the explanatory variables in the model. This implies that all these variables are important factors which affect the government expenditure in Botswana. The dummy variable is statistically significant at the GE variable recording t-statistic of 2.24. The dummy variable played a significant part in GE variable. In addition, the F-statistic recorded the highest value of 496.7, implying that all the independent variables jointly-well explains the government expenditure.

Considering the inter-relationships in the VAR matrix in Table 3 above, in Equation 1, the REER is not explained by other variables or its own lagged variable. All the coefficients as explained by the t-statistic are statistically insignificant. In addition, the coefficients do not follow economic theory as stated in the methodology. The financial sector, that is; the prime rate, headline inflation and Bank of Botswana certificates all have incorrect positive coefficients (recording; 0.038363, 0.015912 and 0.000815 respectively). The implication is that, an increase in one of the financial sector-variables means a real depreciation in the REER. This does not conform to economic theory. The fiscal sector, i.e. government expenditure coefficient has a negative coefficient of -0.002286. This implies an increase in GE will appreciate the REER. As stated above in the methodology, an improved fiscal position, caused by either a reduction in government expenditure or an increase in government revenues, essentially leads to more funds flowing to the public sector (Taye, 2012). The reallocation of resources from the private sector would cause a decline in domestic demand, and ensuring reduced demand pull pressures will generally lead to lower domestic prices (declining inflation). It is largely this price effect that induces a depreciation of the real exchange rate (Iimi, 2006).

5.3. Stability Condition

The null hypothesis is, the model is stable while, the alternative hypothesis is that the model is not stable. The results in Figure 1 below show that all the AR roots lie within the unit-root circle. This implies that the null hypothesis of stability is not rejected and we conclude that the unrestricted VAR model is stable (Gujarati and Porter (2009); Enders 2015)).

Figure 1: AR Roots Graph



Source: Eviews Simulations

Table 4
Roots of Characteristic Polynomial

Root	*Modulus*
0.906017	0.906017
0.749883	0.749883
0.081588 - 0.179628i	0.197289
0.081588 + 0.179628i	0.197289
-0.108457	0.108457

No root lies outside the unit circle.
VAR satisfies the stability condition.
Source: Eviews Simulations

The stability condition can also be shown by the Modulus values in Table 4 above. The Modulus values show that characteristic AR polynomial has absolute values less than one (recording from 0.906017 to 0.108457). This should be the case. This implies failing to reject the null hypothesis of stability of the model and concluding that the VAR model satisfies the stability condition. This is a very crucial key result for our model.

5.4. Impulse Response Function (IRF)

Impulse response functions are used to trace the effect of a shock in one of the variables to all the variables in the model (Enders, 2015). The impulse response analysis shows how modelled variables respond to any innovations in the economy. The impulse responses generally tend to converge to zero, implying that the model depicted stability overtime. The IRF helps to discover the effects of unanticipated shocks on the stability of Botswana's real effective exchange rate. Figure 2 shows that a shock to the real effective exchange rate on itself results in an appreciation of the REER until the second Quarter. It depreciates again between the second and third Quarter where it finally reaches zero (has no effect) on the entire horizon. Implying the model depicted stability overtime. A contemporaneous shock on the D (REER) on itself responds by appreciating then depreciating within the nine month period of time and becomes stable through-out as this variable is constantly monitored by the central bank.

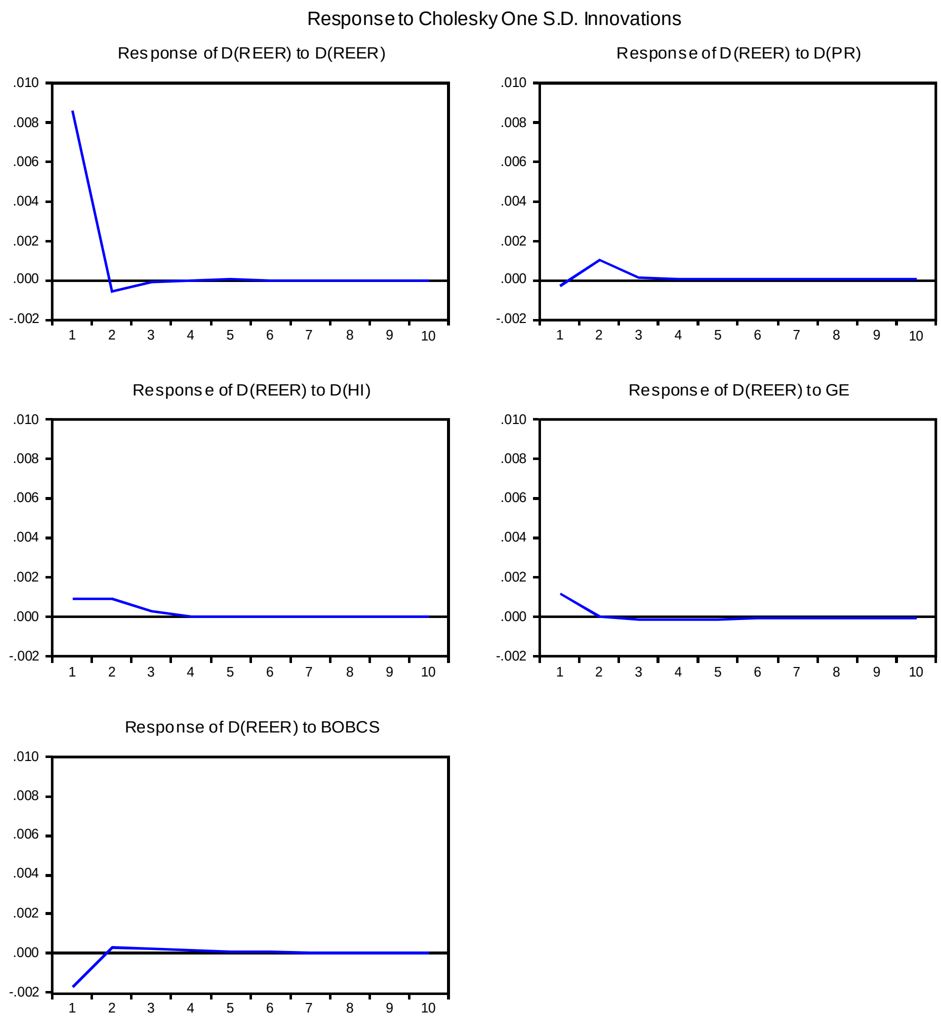
A shock to the prime rates causes depreciation on the real effective exchange rate until the second Quarter. Between the second and third Quarter the REER has an appreciating effect. Then, from Quarter three onwards, there is no effect from the shock, until the entire horizon.

Shocking headline inflation on D (REER) starts off by having a constant effect from the first Quarter to the second Quarter. Then D (REER) responds by having an appreciation effect- response from Quarter two until Quarter four. From Quarter four onwards, the REER depicts no effect lasting the entire horizon '!implying stability. A shock from government expenditure has an appreciation effect on the first two Quarters then depicts no effect from Quarter two to the entire period. Lastly, a shock from the Bank of Botswana certificates causes depreciation to the REER which lasts up to Quarter two. The REER then slowly appreciates from Quarter two until Quarter six, finally reaching stability the entire horizon. The real effective exchange rate responds to all the shocks made by the endogenous variables. The response of the D (REER) from the instantaneous shocks from all the variables lasts for an evident period of time. These responses range from six month period to eighteen months period, before the REER returning to stability throughout the horizon. The stability at each end period is due to Bank of Botswana (BOB) constantly estimating and monitoring the real effective exchange rate in Botswana. There is prudent evidence for these variables from the fiscal and financial sectors having an impact on and determining the REER.

5.5. Variance Decomposition (VD)

The variance decomposition gives information about the relative importance of each random innovation affecting the variables in the VAR. VD is conducted to assess the extent to which the variables (prime rate, headline inflation, government expenditure and Bank of Botswana certificates) used in the VAR affect the real effective exchange rate over-time. Table 5 presents results of VD of Botswana's real effective exchange rate. Own shocks account for between 93 percent and 91 percent of the forecast errors in Botswana's real effective exchange rate, over the period. The results indicate that fluctuation in the REER is explained mostly by itself in the long run at approximately 91 percent. BOBCs explain about 3.8 percent of the variation in the REER. GE comes in third at the beginning of Quarter 1 in explaining the fluctuations in the REER at 1.8 percent. It reduces marginally from Quarter 2, while D (HI) increases significantly from 1.1 percent to 2 percent in the 2nd Quarter. Leading D (HI) accounting for 2.1 percent in the fluctuations of the REER at the end of the period, while GE accounting for 1.8 percent. Lastly, D (PR) explains 1.4 percent of the variation in the REER. The total 9.1 percent signify that these are important sources of the forecast error variance in Botswana's real effective exchange rate.

Figure 2: Impulse Responses to the D (REER)



Source: Eviews Simulations

Table 5
Variance Decomposition of D (REER)

Period	*S.E.*	*D(REER)*	*D(PR)*	*D(HI)*	*GE*	*BOBCS*
1	0.008921	93.41616	0.118687	1.055670	1.768898	3.640581
		(4.96168)	(1.82729)	(2.35758)	(3.04079)	(3.73857)
2	0.009049	91.26507	1.345800	2.012400	1.719809	3.656925
		(5.38997)	(2.43205)	(3.16666)	(2.93471)	(3.61611)
3	0.009057	91.10889	1.355271	2.089684	1.732783	3.713371
		(5.48123)	(2.44025)	(3.12015)	(2.94762)	(3.65409)
4	0.009059	91.06502	1.355692	2.088724	1.751179	3.739381
		(5.55282)	(2.43869)	(3.12227)	(2.98885)	(3.68333)
5	0.009060	91.04006	1.356299	2.088152	1.765484	3.750008
		(5.60232)	(2.43602)	(3.11535)	(3.02881)	(3.70389)
6	0.009061	91.02330	1.356823	2.087827	1.777447	3.754608
		(5.64118)	(2.43342)	(3.11019)	(3.06422)	(3.71796)
7	0.009062	91.01133	1.357088	2.087598	1.787613	3.756370
		(5.67095)	(2.43138)	(3.10557)	(3.09510)	(3.72735)
8	0.009062	91.00235	1.357197	2.087414	1.796199	3.756844
		(5.69480)	(2.42983)	(3.10174)	(3.12198)	(3.73347)
9	0.009063	90.99531	1.357225	2.087263	1.803403	3.756803
		(5.71421)	(2.42854)	(3.09838)	(3.14546)	(3.73740)
10	0.009063	90.98962	1.357213	2.087136	1.809420	3.756608
		(5.73041)	(2.42741)	(3.09542)	(3.16618)	(3.73987)

Source: Eviews Simulations

Statistically from the VAR coefficients in the VAR model, REER is not determined by these factors. Therefore, the results are contrast with those from Iimi (2006). This is mainly because Botswana does not operate in the floating exchange rate regime. It operates in a fixed, crawling peg exchange rate regime. Not surprisingly, the par value of the Pula is determined by Bank of Botswana which is allowed to float at a certain band. However, from the Variance Decomposition we find that the same variables explain approximately 9.1 percent on the variation on the REER, while 91 percent of the variation of the REER is explained by itself. From the VD results, in addition to the Impulse Response Function and Stability results, we can conclude by saying the results in this paper corroborate the findings of Iimi (2006), De Jager (2012) and Kiptui (2013). Through the Behavioural Equilibrium Exchange Rate approach the; Prime Rate, Headline Inflation, Government Expenditure and Bank of Botswana Certificates partially influence the Real Effective Exchange Rate in Botswana.

VI. CONCLUSIONS

This paper established the determinants of the real effective exchange rate (REER) in Botswana from the financial and fiscal sectors. A VAR model was used to identify the determinants of real effective exchange rate in Botswana. From the analysis, all endogenous variables, including the dummy variable, were statistically insignificant. This suggests that the REER is not explained by these variables or its own lagged value. The coefficients of the variables reported to have incorrect signs. i.e., the financial sector coefficients having incorrect positive coefficients, while the fiscal sector having an incorrect negative coefficient. The results obtained are in contrast and differ from the studies used in the literature review (e.g., Iimi 2006). One can further imply that the results are different from those of the studies in the literature review because Botswana's REER is estimated by Bank of Botswana through crawling peg exchange rate regime. The REER in South Africa (De Jager, 2012) and Kenya (Kiptui *et al.*, 2013) are determined by market forces in the economy by the floating exchange rate regimes. Even though the VAR model indicates that REER is not determined by the fiscal and the financial sectors the Variance Decomposition test found that 9.1 percent of the variation on the REER is explained by the above-mentioned variables. Additionally, when Real Effective Exchange Rate is shocked using the Impulse Response Function test, the REER responds to all the instantaneous shocks made by all the endogenous variables. These responses last for an evident time period, ranging from six months to eighteen months period, before the REER returning to stability throughout the horizon. Furthermore, the model proved to be stable through the stability test. Therefore, policy makers need to analyse these variables (Fiscal and financial) as they partially determine the REER which is needed for the conducive investment climate of a country like Botswana.

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