I J A B E R, Vol. 14, No. 3, (2016): 1789-1804

TESTING THE EXCHANGE RATE PASS-THROUGH IN BOTSWANA

Mogale M. Ntsosa* and Tlotlo P. Nkwe

Abstract: *This paper explores the impact of exchange rate fluctuations and other macroeconomic variables on inflation in Botswana.It uses vector error correction model and the data is from first quarter of 1998 to last quarter of 2013. The empirical resultsshow that South African CPI, currency depreciations, foreign exchange reserves and financial deepening are the sources of inflation in the long run.For Botswana, the findings corroborate that of Atta et al (1999) who found South African inflation and bilateral Rand-Pula exchange rate to be significant and Taye (2012) who found South African inflation and M2 to be significant.The exchange rate pass through is incomplete with a coefficient of 0.2. In the short-run inflation is determined by its lag and South African inflation.*

1. INTRODUCTION

This paper investigates the extent to which external shocks and policy of currency devaluations contribute to an inflationary environment in Botswana. This is through the measurement of the impact of exchange rate fluctuations and other macroeconomic variables on consumer prices. The interest is on short- and long-run determinants using vector error correction and Johansen's cointegration respectively. As an open economy, Botswana is vulnerable to external shocks that are inflationary. The exchange rate pass-through is likely to be large as imports contribute 70 percent of the country's aggregate consumption and 45 percent of the inflation basket (Republic of Botswana, 2004).Monetary policy objective of low and stable inflation would be difficult to attain if external shocks dominate. The conventional wisdom is that currency devaluations improve international competitiveness by boosting exportsand importsubstituting firms.Ito and Sato (2007) point out that this holds as long as inflation is constant as a rise in inflation will wipe out all the gains.For Botswana, Galebotswe and Andrias (2008) found devaluations to be expansionary in short-run but contractionary in long-run thus recommended devaluations be used sparingly.

* Department of Economics, University of Botswana, Private Bag UB 705, Gaborone, Botswana, Corresponding author's, *E-mail: ntsosamm@mopipi.ub.bw*

According to Kiguel, (1994) exchange rate policy balances two conflicting goals of price stability and export competitiveness. On the one hand, price and macroeconomic stability requires the real exchange rate (RER) to be stable. On the other, pursuit of export competitiveness and import substitution requires frequent devaluation of the RER. Exchange rate policy is effective in the short-run since prices and wages are rigid hence nominal exchange rate can be adjusted to control the RER.However, in the long-run prices and wages are flexible rendering nominal exchange rate changes ineffective. Hence the RER is affected by changes in policies that affect aggregate demand or affect composition of government expenditure, specific taxes, changes in terms of trade and costs of external funding.

Detailed studies on pass-through in Botswana are limited by the absence of data on variables such as import and producer price indices as only CPI data is available. Using the ARDL approach, Atta *et al.* (1999) foundthe nominal exchange rate and South African inflation to determine domestic inflation in the long-run.Short-run determinants are South African prices, nominal exchange rates and US prices. James (2014) studied the exchange pass-through of oil prices to domestic inflation using the Phillips curve. He found the pass through to be low both in short- and long-run. Using annual data from 2003 to 2011 Raboloko *et al.* (2014) using VAR found lagged domestic prices to determine prices in Botswana. Taye (2012) using ARDL found lagged CPI, real GDP, money supply and South African CPI to determine domestic prices both in short- and long-run.

According to Goldberg and Knetter (1996) exchange rate pass-through (ERPT) is the percentage change in the local currency of import prices due to a one percentage change in the exchange rate between exporting and importing countries. ERPT is passed on to domestic prices through direct and indirect channels. The direct channel has two stages of pass through, for which the first one is the changes in exchange rate to changes in imports' prices. The second stage refers to the transmission of changes in import prices to domestic consumer and producer prices (Mishkin, 2008). The indirect channel is to do with manufacturers of exports. Here exchange rate depreciation leads to a rise in price of imported intermediate inputs. This raises costs of manufacturing forcing manufacturers to raise export prices. Finally, a depreciating currency makes domestic goods cheaper to foreigners resulting in anincreased foreign demand that forces a rise in prices. The focus of this study is on the direct channel.

When an exchange rate depreciates, prices of imported commodities rise. If the pass-through occurs frequently and is of a higher magnitude, the price uncertainty results in misallocation of resources. How much of a risk is posed by exchange rate depreciation depends on the extent to which the falling value of the currency is passed through to import prices and then consumer prices. According to Ca'zorzi et al (2007), the entry point of ERPT studies is to assume purchasing power parity. That is, there is a one-to-one relationship between the exchange rate and domestic prices. However, in empirical studies, it was observed that exchange rate depreciationslead to incomplete rise in prices. Further, low exchange rate pass-through has been observed in both developed and developing countries in recent years (Mishkin, 2008, Adam and Frimpong, 2010; Mwase, 2006). This is thought to be due to imperfect information where firms respond to exchange rate depreciation by raising prices including mark ups (Dornbusch, 1987); monetary and fiscal policies' attempts to dampen impact of exchange rate changes on prices (Gagnon and Ihrig, 2004); measurement problems of CPI which fail to account for quality adjustments in exchange rate fluctuations (Burstein *et al.*; 2005).

This study uses vector error correction model for analysis. The study period is from first quarter of 1998 to the last quarter of 2013. Section 2 of the paper is on monetary and exchange rate policies in Botswana. In section 3 the analytical framework is presented while section 4 presents data description and empirical results. Section 5 concludes.

2. PERFORMANCE OF MONETARY AND EXCHANGE RATE POLICIES

Denominated in US dollars, mineral revenues have been mostly higher than the import bill denominated in South African Rand in the past three decades. Coupled with low absorptive capacity of the economy, the current account surpluses that followed diamond discoveries led to high liquidity in the economy (Phetwe, 2014). Monetary and exchange rate policies are largely driven by attempts to limit negative effects of excess liquidity on the economy. To avoid the appreciating currency from crowding out other sectors, the central bank fixed the exchange rateand later allowed it to crawl following multiple devaluations to maintain stable real effective exchange rate (REER). Capital controls were removed inFebruary 1999 to allow liquidity to be drained off the economy and encourage foreign direct investment.

From 1998 when the first monetary policy statement was published, the monetary policy has consistently had its objective as to achieve sustainable, low and predictable level of inflation with positive real interest rates over the medium and long term. Attainment of the former goal contributes to stability of REERand macroeconomic policies. In 2006, Bank of Botswana introduced a medium term inflation objective of 3 to 6 percent.This incorporated some degree of inflation targeting regime to the key elements of Botswana's monetary policy. Inflation targetingis prioritized over output and exchange rate targeting to foster macroeconomic stability. The monetary policy framework uses loans and loanable funds to influence economic activity (Bank of Botswana, 2007).

Figure 1 shows inflation average to have been above 7 percent with large spikes in some quarters during the period. Monetary policy has not been entirely successful in bringing down inflation to the objective range of between 3 and 6 percent until mid-2013. However, the fall in inflation may reflect the sluggish growth of global economy rather than effectiveness of policy.

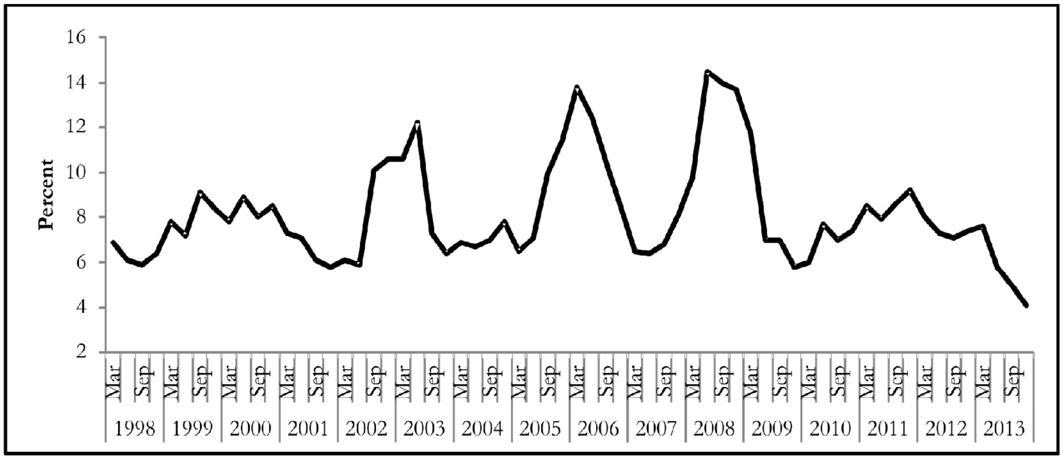

Figure 1: Average Inflation

Source: Statistics Botswana

According to Galebotswe & Andrias (2008) during the period 1990 to 2004 the Pula was frequently devalued mainly to maintain competitiveness of primary exports through stabilization of REER. In 2005 the exchange rate was moved from fixed but adjustable peg to a crawling peg. Based on trade patterns, the weights of the peg are 55 percent to the South African Rand and 45 percent to the IMF's Special Drawing Rights. The rate of crawl is minus 16 percent per annum with an objective of minimizing the impact of exchange rate on inflation (Republic of Botswana, 2013). In 2015 in an effort to cushion the exchange rate against the falling Rand, the weights were adjusted to 50 percent Rand, 50 percent SDR and a zero rate of crawl (Republic of Botswana, 2015). The peg was adopted to reduce or mitigate the dangers of the Pula appreciating especially during periods of high export earnings as it might erode export competitiveness (Masalila & Motshidisi, 2003; Galebotswe & Andrias, 2008). From figure 2, the REER shows rapid appreciations before introduction of the crawling peg. Since then the rate of appreciation hasdeclined considerably.

The pass-through can be approximatedusing purchasing power parity (Atta *et al.*, 1999). The absolute purchasing power parity is represented by equation (1) where P is the domestic price, P^f is the foreign price and E is the nominal exchange rate.

$$P = EP^f \quad (1)$$

$$p = e + p^f \text{ or } e = p - p^f \quad (2)$$

Variables p, e and p^f are natural logs of P, E and P^f respectively. If purchasing power parity holds, then a plot of nominal exchange rate and price differential will track each other closely. Empirically the closeness will be reduced by a lag in the adjustment process. Figure 3 tends to support this assertion especially after the third quarter of 2003.

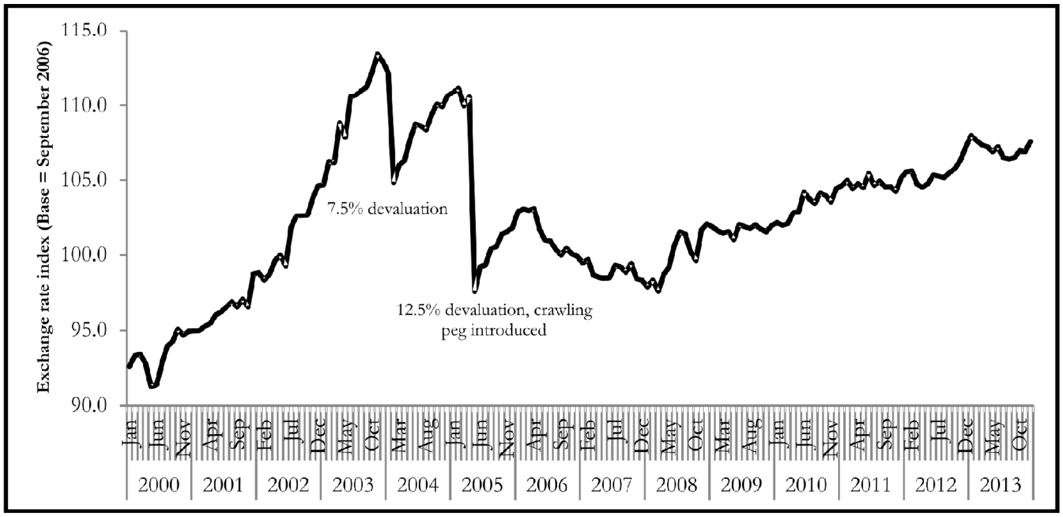

Figure 2: Real effective exchange rate index

Source: authors' calculations based on data from Bank of Botswana

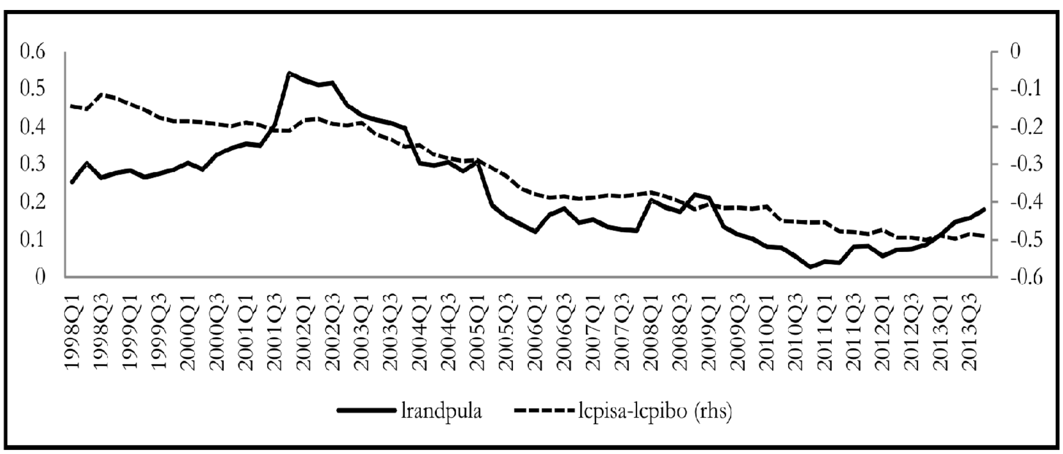

Figure 3: Rand/ Pula exchange rate and Botswana/South Africa inflation differential

Source: authors' calculations based on data from Bank of Botswana

3. EMPIRICAL MODEL

In pass through modeling the impact of exchange rate changes on domestic prices is of major interest. However, domestic price changes have an impact on exchange rates. This endogenous relationship justifies the use of a vector auto-regression (VAR) type model. A major advantage of VAR models is they do not assume any theoretical structure (Sims, 1980). Following Karoro (2007), assume a VAR of order p:

$$y_t = z + \Sigma_{i=1}^{p} \Lambda_i y_{t-i} + \varepsilon_t \tag{3.1}$$

y_t is an n×1 vector of I(1) variables. These are logarithms of GDP gap, CPIs of Botswana and South Africa, M2, Rand-Pula exchange rate and foreign exchange reserves in US dollars. z is an vector of deterministic variables. Λ_i is an $(n\times n)$ coefficient matrix and ε_t is an $(n\times 1)$ vector of white noise error terms.

Augmented Dickey-Fuller and Phillips-Perron methods are used to test for the presence of unit roots in levels and first differences. If the variables are stationary at levels then a VAR in levels will be estimated. If non-stationary, then the variables are differenced to find level of integration. Variables integrated of same order may be cointegrated. A Johansen cointegration test is conducted to establish whether a long-run equilibrium relationship exists among the variables. If the variables are not cointegrated then a VAR in first differences will be estimated. However, if the variables are cointegrated, a vector error correction model (VECM) will be estimated. A VECM is a first-differenced VAR.

Johansen (1988) is used to test for the rank of matrix, r. The likelihood ratio tests used are the trace and maximum Eigenvalue tests. The trace test is specified $\lambda_{trace}(r) = -T\,\Sigma_{i=r+1}^{n} \ln(1-\lambda_i)$. The null hypothesis is that the number of cointegrating vectors is less or equal to r against a specified alternative that there are more than r. The maximum Eigenvalue test is stated as $\lambda_{\max}(r, r+1) = -T\ \ln(1-\lambda_{r+1})$. The null hypothesis is that the number of cointegrating vectors is against the alternative hypothesis of r+1. The null hypothesis of presence of cointegrating relationships is rejected if the test statistic is greater than critical values for both trace and Eigenvalues. The rank of matrix is established by testing trace and Eigenvalue statistics against critical values generated from Osterwald-Lenum (1992) method.

When converted to VECM, equation (3.1) becomes

$$\Delta y_t = z + \Sigma_{i-1}^{p-1} \Gamma_i \Delta y_{t-i} + \Pi y_{t-1} + \varepsilon_t \tag{3.2}$$

Δy_t is the differenced form of hence it will be I(0). Γ_i is an $(n\times n)$ coefficient matrix. Π is an $(n\times n)$ matrix and its rank determines the number of cointegrating relationships. If $r = n$ then Π is of full rank and if $r = 0$, then there are no cointegrating vectors. If $r \leq (n-1)$, then we have $\Pi = \alpha\beta$. Where α is a $n \times r$ matrix represents speed of adjustment towards equilibrium after deviations in the previous period, while β is a $r \times n$ matrix of cointegrating vectors.

The next step is the choice of optimal lag length. The lag length is determined by running an unrestricted VAR. Selection of the optimal lag length is through the use of information criterion. According to Lutkepohl (2007) optimal lag length of a VECM is the optimal lag length of VAR minus one. The aim is to select the number of parameters that minimize the information criterion. If the number of lags is too high then they consume degrees of freedom.Residual tests are conducted to test the robustness of the estimations.

4. DATA DESCRIPTION ANDEMPIRICAL RESULTS

4.1. Data description

A 6-variable VECM model is used with quarterly data from 1998 to 2013. The variables are the logarithms of Consumer Price Indexes (CPI) of Botswana and South Africa, GDP gap, M2/GDP, Rand-Pula exchange rate and foreign exchange reserves in US dollars.

The GDPgap approximates demand conditions in the economy. It is the deviation of the logarithm of real GDP from its Hodrick-Prescott filter.A positive deviation suggests the economy is operating above potential leading to a rise in prices. A positive relationship between domestic CPI and South African CPI is also expected. South Africa is Botswana's major trading partner hence a rise in prices in South Africa is expected to positively impact Botswana prices.

The proxy for financial deepening is M2/GDP (Asteriou and Hall, 2007; Bank of Botswana, 2012). Money supply M2 is defined as M1 plus quasi money.It is expected that a rise in M2/GDP will raise prices. This follows from the classical quantity theory of money that postulates that more money in the economy leads to higher demand for goods and services. A depreciation of the exchange rate is expected to lead to a rise in domestic prices as the cost of imports rise. Also, foreign demand of exports rises adding to the price increase. Hence, a negative relationship between the Rand-Pula exchange rate and CPI is expected. The Rand-Pula exchange rate is used as South Africa is major trading partner.

The relation between CPI and reserves can either be positive or negative. Capital inflows will lead to a rise in both reserves and money supply culminating in a rise in prices.However, if sterilized effectively then the positive relation will not hold. Alternatively, according to the monetary theory of balance of payments, if authorities increase money supply, foreign currency reserves are expected to fall. Hence, a negative relationship is expected between foreign reserves and CPI.

Foreign exchange reserves in US dollarsand South African CPI approximate the influence of external factors on the economy.

4.2. Unit root test results

Graphs of the series show the variables to be non-stationary with trends except for GDP gap which is stationary. Except for the Rand-Pula exchange rate which shows a downward trend, the other series show an upward trend. However, formal tests are conducted to test the presence of unit roots.The tests used are the Augmented Dickey-Fuller (ADF) and Phillips-Perron tests.

From Table 1 the null hypothesis of presence of a unit root is not rejected for all the variables at levels except the GDP gap. GDP is expected to be stationary as it is the difference between actual GDP and its approximated potential.Hence following Asteriou and Hall (2007), it will be included as an exogenous variable.Using the ADF test, Botswana's CPI is I(2) without trend. But using the Phillips-Perron the variable is I(1). The Phillips-Perron is preferred to the ADF as the ADF is weak for small samples.

Table 1
The ADF test and Phillips-Perron test

		ADF Test			
	With Trend and Intercept		*Without Trend*		
Variables	*Level*	*1st Difference*	*Level*	*1st Difference*	*Conclusion*
GDP gap	-6.028*	-8.925*	-6.112*	-9.087*	I(0)
CPI Bots	-1.917	-6.662*	5.749	-1.119	I(2)
CPI SA	-2.244	-8.085*	0.192	-8.183*	I(1)
M2/GDP	-0.231	-7.350*	5.993	-3.106*	I(1)
R/P exchange	-1.778	-7.131*	-0.751	-7.241*	I(1)
Foreign Reserves	-1.111	-6.793*	0.737	-6.840*	I(1)
		Phillips-Perron Test			
	With Trend and Intercept		*Without Trend*		
Variables	*Level*	*1st Difference*	*Level*	*1st Difference*	*Conclusion*
GDP gap	-6.046*	-19.331*	-6.137*	-19.757*	I(0)
CPI Bots	-1.952	-5.441*	13.227	-2.487*	I(1)
CPI SA	-2.250	-8.091*	0.208	-8.190*	I(1)
M2/GDP	-0.374	-7.347*	5.255	-5.089*	I(1)
R/P exchange	-2.022	-7.171*	-0.798	-7.277*	I(1)
Foreign Reserves	-1.505	-6.892*	0.576	-6.937*	I(1)

*, **, *** represent 1%, 5% and 10% level of significance.

4.3. Lag length determination

From Table 2 theSchwarz (SC) and Hannan-Quinn information criterion (HQ) and the final prediction error (FPE) show the optimal lag length of one. The likelihood ratio (LR) predicts the optimal lag length of 4 while the Akaike information criterion (AIC) the optimal lag length is 5. Lag length of at least 4 is preferred since models with lag lengths below 4 will be serially correlated (Sanusi, 2010).In addition Lutkepohl (2007) argues that the optimal length of a VECM is the lag length of a VAR minus one. This suggests the choice should be based on the AIC.

Table 2
Lag length selection results

Lag	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	NA	2.40E-11	-10.26	-9.91	-10.13
1	740.17	3.70E-17*	-23.65	-22.42*	-23.17*
2	28.38	4.84E-17	-23.41	-21.29	-22.58
3	36.79	4.97E-17	-23.44	-20.44	-22.27
4	38.30*	4.57E-17	-23.62	-19.75	-22.11
5	31.36	4.79E-17	-23.76*	-19.00	-21.90

4.4. Cointegration results

All series are I(1) hence a Johansen cointegrationtest was conducted to check if there are any cointegrating relationships. The null hypothesisof no cointegrating relationships is rejected. From table 3, using the trace statistic, there are 3 cointegrating equations at 5% level of significance. The critical values are from

Table 3
Johansen Cointegration Results

Null Hypothesis	*Alternative Hypothesis*	*Eigenvalue*	*Trace Statistic*	*5 Percent Critical Value*	*1 Percent Critical Value*
r = 0	r = 1	0.476	92.973	68.52	76.07
r = 1	r = 2	0.330	54.822	47.21	54.46
r = 2	r = 3	0.239	31.166	29.68	35.65
r = 3	r = 4	0.175	15.071	15.41	20.04
r = 4	r = 5	0.061	3.692	3.76	6.65
Null Hypothesis	*Alternative Hypothesis*	*Eigenvalue*	*Max-Eigen Statistic*	*5 Percent Critical Value*	*1 Percent Critical Value*
r = 0	r > 0	0.476	38.151	33.46	38.77
r ≤ 1	r > 1	0.330	23.657	27.07	32.24
r ≤ 2	r > 2	0.239	16.095	20.97	25.52
r ≤ 3	r > 3	0.175	11.379	14.07	18.63
r ≤ 4	r > 4	0.061	3.692	3.76	6.65

Osterwald-Lenum (1992). This is also confirmed by maximum Eigenvalue test which shows1 cointegrating equation at 5% level of significance. The conclusion is that there is a long-run relationship among the variables. The cointegrating equations are used as error correction terms in the error correction model.

The normalized cointegrating equation with respect to Botswana CPI (CPIB), with t-statistic in brackets is:

$$\begin{aligned} &CPI_t = -1.209 - 0.15\,Reserves_t + 0.133M2_t - 0.208\,Exchange\,rate_t + 1.13SACPI_t \\ &t - statistic \quad [-3.72][3.46] \qquad [-6.27] \qquad [13.76] \end{aligned} \tag{1}$$

From equation (1),in the long-run, CPI is negatively related to reserves and the exchange rate. However, it is positively related toM2 and South African CPI. The strength of relationship between Botswana's and South Africa's CPIs is very strong as an increase in South African CPI leads to a more than one unit rise in Botswana's CPI.

In the short-run, there is inflation persistence as ΔCPI is positively related to its lagged difference in the first quarter at 1 percent significance level. The relationship is also significant at 3 lags. ΔCPI is also significant and positively related to first lag of changes in South African CPI. This is to be expected as most of Botswana's goods and services are imported from South Africa. CPI is also positively related to changes in reserves after three lags and to change in exchange rate after four lags. Changes in M2 are insignificant as determinants of changes in CPI. GDP gap and CPI show an unexpected negative relationship. The model fit is relatively good with R-squared of 60 percent and standard error of 0.008.

Table 4
Estimates of the VECM

	ΔCPI Botswana	*Δ Reserves*	*ΔM2*	*ΔExchange rate*	*ΔCPISA*
t-1	0.427*	0.04	-0.025	0.033	0.362*
t-stat	[2.21]	[1.03]	[-0.91]	[0.62]	[2.29]
t-2	-0.155	0.033	-0.034	0.018	-0.199
t-stat	[-0.82]	[0.87]	[-1.41]	[0.37]	[-1.29]
t-3	0.39*	0.119*	-0.002	0.013813	-0.172
t-stat	[2.22]	[3.60]	[-0.08]	[0.31]	[-1.17]
t-4	-0.033	0.052	-0.009	0.076**	-0.036
t-stat	[-0.20]	[1.59]	[-0.40]	[1.68]	[-0.28]
GDP gap	-0.043*				
t-stat	[-1.18]				
ECT	-0.265				
t-stat	[-2.00]				
R^2	0.60				
Std error	0.008				

Note: *, ** and *** denote 1, 5, 10 percent significance level respectively.

4.5. Residual diagnostic tests

If serial correlation is present, then estimated variables will be efficient. Thiswould make it harder to identify shocks with specific variables. Further, impulse responses will then depend on ordering of equations in the model (Pindyck and Rubinfeld, 1998). From Table 5, using the Lagrange multiplier method, the null hypothesis of no serial correlation is not rejected. Hence, there is no serial correlation in the residuals.

Table 5
Serial correlation test results using Lagrange multiplier

Lags	*LM-Stat*	*Prob.*
1	36.69	0.44
2	31.94	0.66
3	27.14	0.86
4	34.86	0.52
5	33.30	0.60
6	36.69	0.44
7	35.06	0.51
8	38.02	0.38

If there is heteroscedasticity, then error variances are not constant and the estimates will not be efficient. That is, the estimated variances will not be the minimum (Pindyck and Rubinfeld, 1998). A joint Chi-square test was used to test for heteroscedasticity using White's test. The null hypothesis of no heteroscedasticity was not rejected; hence, the model is homoscedastic.

Jarque-Bera was used to test whether the errors are normally distributed. The test shows a rejection of the null hypothesis that residuals are multivariate normal at 5 percent significance level.

Table 6
Tests for normality and heteroscedasticity

	Chi-square	*Deg. of freedom*	*Probability*
Normality (Jarque-Bera)	20.78	12	0.054
White's Heteroscedasticity	1116.56	1092	0.296

The stability of the modeland long-run relationships between the variables was tested using CUSUM and CUSUM of squares(Borensztein, et al.; 1998, Mohsen *et al.;* 2002). The tests are used to detect structural breaks when the researcher is unsure of the date of the break (Brooks, 2008). The tests use recursive estimation. From figure 4, the model is stable as the plots lie within the 5 percent significance level.

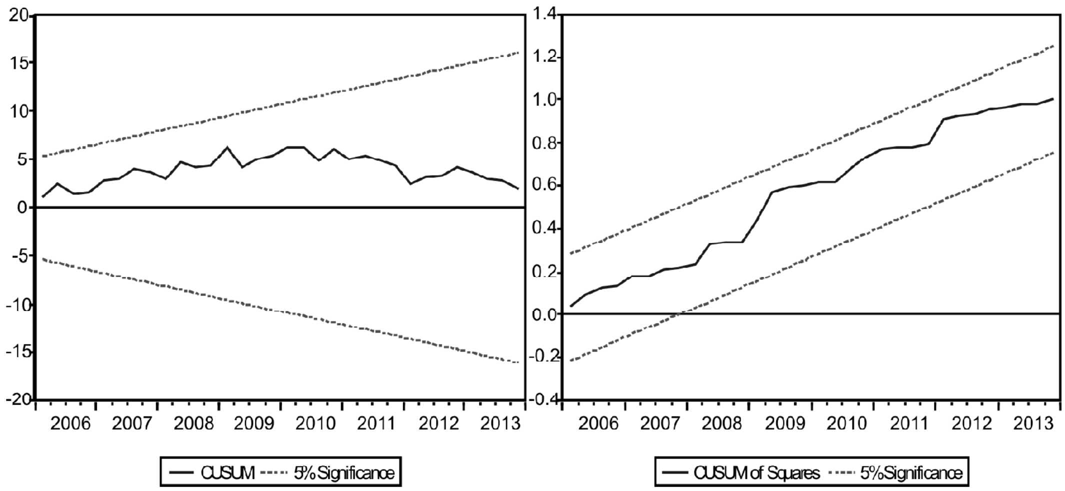

Figure 4: CUSUM and CUSUM of squares stability tests

4.6. Impulse response and variance decompositions

According to Brooks (2008), impulse responses and variance decompositions are important since VECM estimates are difficult to interpret because they are a-theoretical and involve a lot of parameters. Sometimes the difficulty maybe in that coefficients change signs across lags and equations are interconnected. Impulse responses and variance decompositions measure the effect of shocks in one variable on others. The effect is in terms of whether it is negative or positive. Also, they measurethe time each shock takes to work through the system.

Impulse responses identify responsiveness of dependent variables in the system to shocks to each of the variables in the short-run. A shock to each of the error terms is observed over time as it is transmitted throughout the system. In variance decompositions a shock is administered to a variable and the impact of the shock is also observed on other variables.

Figure 5 shows the response of CPI to shocks to different variables. Generalized impulse response analysis developed by Koops et al (1996) and Pesaran and Shin (1998) is employed. Generalized impulse responses do not require orthogonalization of shocks and are invariant to ordering of variables. Because of these, their results are unique and robust (Hurley, 2010). For all the variables shocks are permanent as they settle at a new and higher equilibrium. A shock to domestic CPI and South African CPI results in a positive CPI that rises with fluctuations in the first 5 years and reaches a new and higher equilibrium after 10 years. An innovation to money supply results in a rise in CPI that reaches a new equilibrium after 13.5 years. A shock to the exchange rate results in a negative CPI that continues

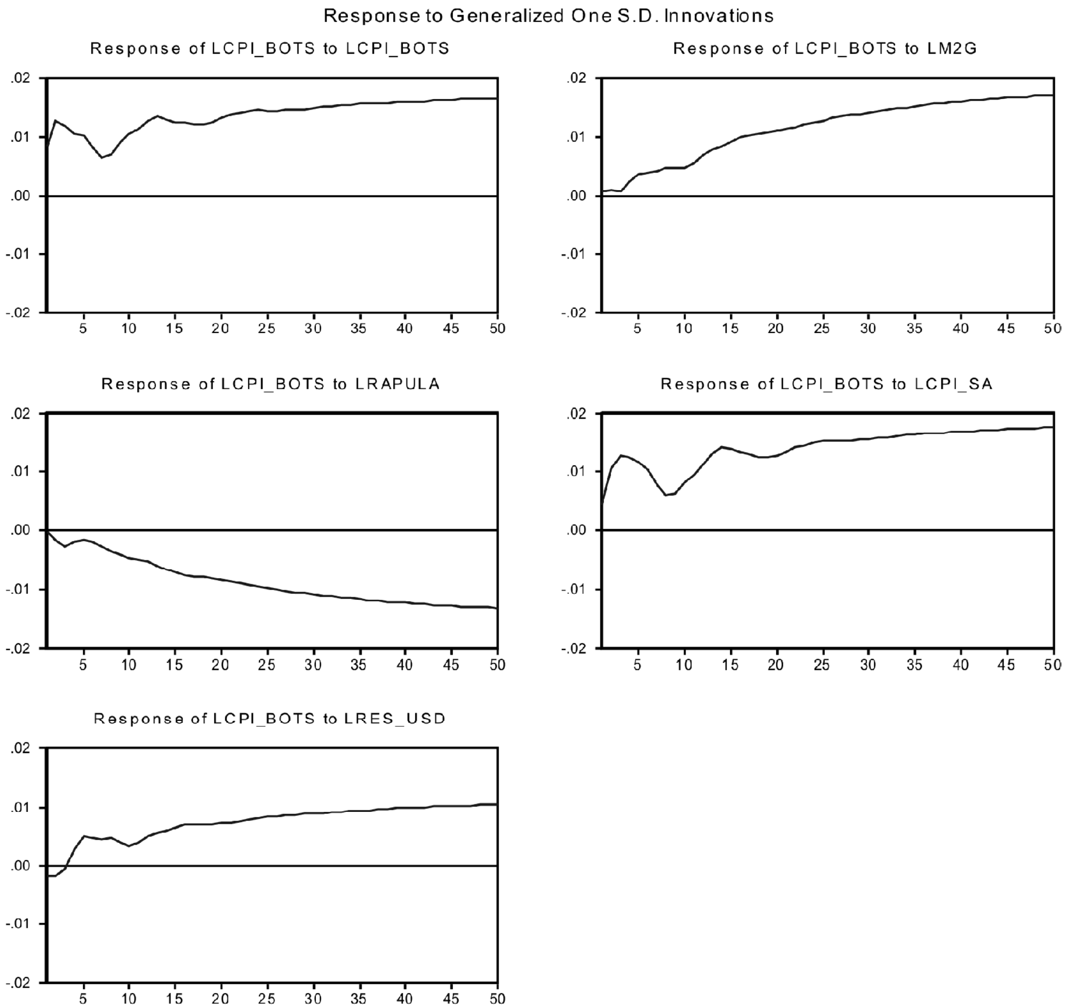

Figure 5: Impulse response functions

falling until a new equilibrium after roughly 13 years. A shock to foreign exchange reserves results in a negative CPI that reaches zero after 3 quarters and remains positive afterwards.

Table 7 shows variance decomposition results. In panel 1, a higher proportion of variation in CPI is from its own innovations. The variances of reserves, South African CPI are also significant demonstrating their contribution to domestic CPI. Shocks to the exchange rate and M2 are insignificant especially in the first few quarters. In addition to its own variance, the variance of reserves is also due to variances of the exchange rate and CPI. The variations in other variables are also relatively significant. This demonstrates that reserves are used to stabilize the economy. Variance of M2 is due to its own, of reserves, CPI and exchange rate. Finally innovations in CPI South Africa, M2 and CPI contribute to the variance of the exchange rate beside itself.

Table 7
Variance decomposition of Botswana CPI

Period	*Botswana CPI*	*Reserves*	*M2*	*SA CPI*	*Rand-Pula exchange rate*
1	100	0	0	0	0
2	88.22	0.48	0.01	6.20	0.01
4	66.11	8.67	0.27	8.65	0.15
6	56.07	16.46	1.25	6.79	0.13
8	50.87	22.78	2.61	5.85	0.37
10	50.62	23.83	3.01	5.28	2.20

5. CONCLUSION

Fighting inflation is a top policy priority for the monetary authorities in Botswana. This is done through controlling the interest rates to affect the cost of money. Yet if inflation is mainly driven by factors external to the economy then using interest rates is inappropriate. This study used VECM to investigate the presence of pass through to the economy of currency depreciation. The VECM is appropriate tool as it caters for endogeneity and cointegration among the variables. The time series data used was from the first quarter of 1998 to the last quarter of 2013.

The results show that the major sources of inflation in the long-run are the South African inflation, the depreciating currency, reserves and M2. The significance of South African inflation and Rand –Pula rate is in line with findings by Atta *et al.* (1999) while Taye (2012) found South African inflation and M2 to be significant.Short-run results show that there is inflation persistence. South African inflation is also a major determinant of inflation while reserves and exchange rate show unexpected signs after three and four quarters, respectively. The GDP gap also is significant but shows an unexpected negative sign in the short-run. The model is stable, has no serial correlation and is homoscedastic.

Impulse responses show the shocks do not settle at zero within the selected period of two and half years. Variance decompositions show that reserves and South African CPI contribute to the variation of domestic CPI. It is notable that, the variances of exchange rate and CPI contribute to that of reserves. This demonstrates that the reserves are used to stabilize the economy.

References

Adam, A. M. & Frimpong. S. (2010), *Exchange rate pass-through in Ghana*. International Business Research, Vol. 3,(2) p. 210-230.

Asteriou and Hall, (2007), Applied Econometrics: A Modern Approach. New York: Palgrave-Macmillan

Andrias, T. & Galebotswe, O. (2012), *Are Devaluations Contractionary in Small Import-dependent Economies? Evidence from Botswana*. Botswana Journal of Economics, Vol. 8(12): pp. 86-98.

Atta, J. K., Jeffries, K. R., and I. Mannathoko, (1999), Exchange rate policy and price determination in Botswana. African Economic Research Consortium.African Research Consortium, Research Paper 93.

Bank of Botswana, (2012), Banking Supervision Annual Report 2012.

Bank of Botswana, (2007), Annual Report, Bank of Botswana, Gaborone, Botswana

Borensztein, E., de Gregorio, J. & Lee, J-W. (1998), How Does Foreign Direct Investment Affect Economic Growth? *Journal of International Economics,* 1 (45), pp. 115–135.

Brooks, C. (2008), Introductory Econometrics for Finance. Cambridge University Press, New York.

Burstein, A., Eichenbaum, M. and Rebelo, S. (2005), Large Devaluations and the Real Exchange Rate, *Journal of Political Economy*, 113, 742-784.

Ca'Zorzi, M; Elke, H. and Marcelo, S., (2007), Exchange Rate Pass-Through in Emerging Markets. European Central Bank Working Paper 739.

Dornbusch (1985), Exchange rates and prices. NBER working paper 1769.

Gagnon and Ihrig (2004), Monetary policy and exchange rate pass-through. *International Journal of Finance & Economics*, Volume 9, Issue 4,pages 315–338, October 2004.

Graubner M, I. Koller, K. Salhofer, A. Balmann (2011), Cooperative versus non-cooperative spatial competition for milk. *European Review of Agricultural Economics*, Vol 38 (1) pp. 99–118.

Hurley, D. T. (2010), A generalized impulse response investigation of U.S. long and short-term interest yields and Asian holdings of U.S. treasuries. *Journal of International and Global Economic Studies,* 3(1), June 2010, 68-86.

Ito and Sato (2007), Exchange Rate Pass-Through and Domestic Inflation: A Comparison between East Asia and Latin American Countries RIETI Discussion Paper Series 07-E-040.

James L. V. (2014), The Pass-Through of World Oil Prices to Botswana Inflation. The Research Bulletin July 2014.

Johansen, S., (1988), Statistical analysis of cointegration vectors. *Journal of EconomicDynamics and Control* 12, 231-54.

Karoro, T.D. (2007), *An analysis of exchange rate pass-through to prices in South Africa. Master* of Commerce Thesis, Rhodes University. Unpublished.

Kiguel, M. A., (1994), Exchange rate policy, real exchange rate and inflation: Lessons from Latin America. Cuadernos de Economia. Vol 31(93), pp. 229-249.

Koops, G., M. H. Pesaran, and S.M. Potter. (1996), "Impulse Response Analysis in Nonlinear Multivariate Models," *Journal of Econometrics,* 74, 119-147.

Lütkepohl, H. (2007), New Introduction to Multiple Time Series Analysis. Berlin: Springer.

Masalila, K. S. and Motshidisi (2003), Botswana's exchange rate policy. May 2003 BIS Papers Number 17.

Masalila, K. S. and Phetwe, M. (2001), "Botswana's monetary policy framework", A paper prepared for the *Conference on Monetary Policy Frameworks in Africa*, Pretoria.

Mishkin, F. S. (2008), *Exchange rate pass-through and monetary policy, A paper prepared for the Norg es Bank Conference on Monetary Policy*, Oslo, Norway.

Mohsen, Bahmani-Oskooee, Ng R.W., (2002), Long Run Demand for Money in Hong Kong: An Application of the ARDL Model. *International Journal of Business and Economics,* Vol. 1, No. 2, pp. 147-155.

Mwase N (2006), An Empirical Investigation of the Exchange Rate Pass-Through to Inflation in Tanzania IMF WP/06/150.

Osterwald-Lenum, M., (1992), "A note with quantiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistics", *Oxford Bulletin of Economics and Statistics* 54, 61-72.

Pesaran and Shin (1998), Generalized impulse response analysis in linear multivariate models Economics Letters 58 (1998) 17–29.

Phetwe, M. (2014), Excess Liquidity and Monetary Policy Strategy in Botswana: An Overview of the Issues. The Research Bulletin July 2014.

Pindyck, R. (1998), Econometric Models and Economic Forecasts. Irwin/McGraw-Hill.

Raboloko, M., G. R. Motlaleng and M. Bakwena (2014), Determinants of Inflation in Botswana: 2003-2011 *Asian-African Journal of Economics and Econometrics,* Vol. 14, No. 2, 2014: 195-210.

Republic of Botswana, (2015), Press Release – January 26, 2015. Ministry of Finance and Development Planning.

Republic of Botswana, (2013), Budget Speech. Gaborone: Ministry of Finance and Development Planning.

Republic of Botswana, (2004), Household Income and Expenditure Survey 2002/03. Gaborone: Central Statistics Office.

Rowland P. (2004), Exchange Rate Pass-Through to Domestic Prices:The Case of Colombia. Central Bank of Colombia.

Sanusi R. A., "ERPT to consumer prices in Ghana: Evidence from SVAR" MPRA, June 2010.

Taye Haile Kebret (2012), The Determinants of Inflation in Botswana and Bank of Botswana's Medium-Term Objective Range Botswana Journal of Economics.