

*Full length research paper*

# Impact of exchange rate volatility on Botswana's imports

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This paper investigates the effects of the Rand/Pula exchange rate volatility on Botswana's disaggregated imports. The VECM framework is selected in order to take into account the possibility of simultaneity between endogenous and exogenous variables. The VECM also allows the use of impulse response functions. The results suggest that exchange rate volatility does have an impact on imports. However, its magnitude, significance and the direction vary substantially across the four groups of imports studied being, Fuel, Textiles, Food and Metals. From the results it is clear that the exchange rate volatility impact has been firmer in the long run than short run. The findings of the study imply that although the Rand/Pula exchange rate volatility affects imports, the effect is not robust. Imports are found to be more responsive to changes in GDP. An almost negligible response of imports to real exchange rate in the overall picture of the results enforces the idea of an inelastic import demand.

**Keywords:** Exchange rate volatility; Botswana's imports; Vector Error correction model

## INTRODUCTION

The aim of this paper is to examine the effect of Rand/Pula (Rand and Pula are South Africa's and Botswana's currencies respectively) exchange rate volatility on imports in Botswana. To achieve this objective we consider disaggregated imports. For the disaggregated imports we choose those that contribute large volumes to Botswana's overall imports. These are Fuel, Food, Beverages & Tobacco, Textiles & Footwear and Metals & metal products. Botswana gets almost 80 percent of these imports from South Africa. This makes the trading relationship between Botswana and South Africa an important one to analyse as it has serious implications on Botswana's economy. The rise in domestic demand due to Botswana's strong economic growth has increased the level of investment in the country. This has gradually increased the country's import demand. As volatility increases importers can no longer be certain of the real prices of the goods.

This increased risk affects their expected profits, and influences their decision to trade. The uncertainty of swings measured by the exchange rate volatility has been a subject of research on many issues. For example, the impact of exchange rate volatility has been studied on foreign direct investment, trade flows, currency crises and debt servicing costs (Esquivel and Larrain (2002)). Botswana is affected by exchange rate volatility matter given instances of the Pula's appreciation followed subsequently by devaluations. The bulk of the empirical literature on the effect of exchange rate volatility on trade volumes has concentrated on exports. Generally there has been little attention devoted to assessing the relationship between exchange rate volatility and import demand. For a country like Botswana, which is highly dependent on international trade a study on imports is as equally important as a study on exports. This study finds it critical to make this analysis given the importance of imports for Botswana's economic growth and development.

Botswana is a highly open economy and has a liberal trade policy. The intended effect of a trade liberalization policy may be negatively affected by a volatile exchange

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rate. A volatile exchange rate can also lead to a balance-of-payment crisis. In practice, there may be a conflict between the two key exchange rate policy objectives in Botswana. The first objective of stable prices requires exchange rate stability. The second objective of maintaining export price competitiveness requires devaluation. Efforts to stimulate the competitiveness of non-traditional exports involve devaluation of the nominal exchange rate. This is in order to alter the real exchange rate and improve the incentive structure facing producers. On the other hand, devaluation increases the price of imports and pushes up domestic inflation. Imports are critical inputs in the production process in Botswana. The effectiveness of any country's international trade policy mostly depends on the magnitude of income and price elasticities of its exports and imports. It also depends on the exchange rate and its volatility. It is against this background that we find it important to study the degree to which the Rand/Pula exchange rate volatility affects the demand for imports in Botswana. The evidence presented in this paper adds a new dimension to this literature and help policymakers to make both exchange rate and trade policies.

The paper proceeds as follows. Section II outlines Botswana's import structure. Review of previous studies is given in section III. Method of analysis is discussed in section IV. Empirical results are outlined in section V, while section VI concludes our paper.

### The import structure in Botswana

The distinguishing feature of Botswana is that her trade relationships are highly concentrated, with respect to both exports and imports. South Africa's dominance of Botswana's import sector reflects not only the geographical proximity of the two countries, but also their common membership of the Southern African Customs Union (SACU). In Botswana principal import commodity groups are driven mainly by five groups. These are Machinery & Electrical Equipment, Food, Beverages & Tobacco, Vehicles & Transport Equipment, Fuel, and Chemical & Rubber Products (C.S.O (2010).

According to the trade report from Central Statistics Office (2010), imports have a similar pattern throughout the years. Machinery & Electrical Equipment contributed 17.7% to total imports. This is followed by Fuel, with 17.0 %. The third most contributing group was Food, Beverages & Tobacco with 12.1%, Vehicles & Transport Equipment was in fourth position with 10.8%. Chemicals & Rubber Products are on fifth position with 10.6%.

Botswana sources most of her imports from South Africa. For example in 2008 imports from South Africa made 77.3% of total imports. Imports from the European Union were 11.3% of total imports. Two countries from the EU supplied imports representing more than 1% of total imports. These are Belgium with 1.9% and UK with

6.0%. Asia as a whole contributes 7.6% of total imports. Asia supply imports representing more than 1.0% of total imports. China supplies 2.9% and Israel 1.6%. Imports from the USA accounts for 1.3% total imports (C.S.O (2010).

### Review of previous studies

Since the collapse of the Bretton Woods system in 1973, real exchange rates began to fluctuate greatly. There has been ongoing research to establish effect of such volatility on international trade. The volatility of exchange rates is an issue of concern for both financial market participants and policymakers. It is evident from the literature that some studies tended to find an insignificant relationship between trade flows and exchange rate volatility. For those studies that a significant relationship was established, it was both negative and positive. For example, Hooper and Khohlagen (1978), Gotour (1985) and Koray and Lastrapes (1990) concluded that exchange rate volatility does not have an effect on the volume of imports and exports traded. Cushman (1983), Akhter and Hilton (1984), Oskooee and Payestech (1993) and Todani and Munyama (2005) established a negative relationship between exchange rate volatility and trade volumes. Furthermore, Arize (1995), Coporale and Doroodian (1994), Arize and Shwiff (1998), Anderson and Skudelnny (2001) and Alam and Ahmed (2010) also found a negative effect of exchange rate volatility on the volume of imports. However, McKenzie and Brook (1997) found exchange rate volatility to be beneficial to imports. The inconclusiveness of the empirical literature is a challenge to policy makers. It is difficult to make appropriate trade decisions from the above different conclusions. In this paper we want to determine the extent to which some of the conclusions reached by previous authors may be confirmed in Botswana

In the case of Botswana, Seleka (2007) estimated horticultural import demand equations. The aim was to capture the impact of import controls on these particular imports. The major findings were that imports of oranges, potatoes, and onions declined by 32%, 29%, and 35%, during the study period respectively. This paper is different from past studies as they have concentrated on the impact of exchange rate volatility on aggregate imports. This investigation examines the behavior of disaggregated imports in Botswana to exchange rate volatility.

### METHODOLOGY

The demand for imports by a consumer is influenced by income, import prices and prices of other commodities. In this paper we follow a model similar to the one used by (Alam and Amehd (2010). They used a traditional import

demand function with an addition of a measure of exchange rate volatility.

$$M_t = (Y_t)^{\alpha_1} \times (RER_t)^{\alpha_2} \times (V_t)^{\alpha_3} \quad (4.1)$$

Where; M is import volume, Y is real gross domestic product, RER represents the real exchange rate and V is the measure of exchange rate volatility

In the area of international trade the two most commonly encountered functional forms for import demand relationships are either linear or log-linear formulations. The logarithm formulation is preferable in modeling import demand for two reasons. First, it gives direct estimation of import elasticity. Secondly, it allows imports to react proportionately to rise and fall in the explanatory variables. The variables used in our study are in natural logarithm form so that the coefficients represent elasticities. The above import demand function in natural logarithm form can be expressed as:

$$\ln M_t = \alpha_1 \ln Y_t + \alpha_2 \ln RER_t + \alpha_3 \ln V_t + \epsilon_t \quad (4.2)$$

To account for the exchange rate policy change in Botswana (shift to crawling peg exchange rate) we make an extension by including a dummy variable (REG) in the model.

$$\ln M_t = \alpha_1 \ln Y_t + \alpha_2 \ln RER_t + \alpha_3 \ln V_t + REG_t + \epsilon_t \quad (4.3)$$

REG<sub>t</sub> is a dummy variable for the change in exchange rate regime. REG=1 during the crawling peg and 0 otherwise and  $\epsilon_t$  is an error term.

Our study uses a Vector Error Correction Model (VECM) to measure the short and long run effects of exchange rate volatility on import volumes in Botswana. A VECM is developed from a VAR model. We follow the VAR as explained by Lutkepohl (1999).

Given a set of k time series variables  $Y_t = (Y_{1t}, \dots, Y_{kt})'$ , the basic VAR model is of the form.

$$Y_t = \beta + A_1 Y_{t-1} + \dots + A_p Y_{t-p} + U_t \quad (4.4)$$

$$Y_t = \beta + \sum_{i=1}^p A_i Y_{t-i} + U_t \quad (4.5)$$

Where,

$\beta$  is a  $(k \times 1)$  vector of intercept

$U_t = (U_{1t}, \dots, U_{kt})'$  is an unobservable zero mean independent white noise process with time invariant positive definite covariance matrix:  $E(U_t U_t') = \Sigma$

$A_i$  are  $(K \times K)$  matrices of coefficients to be estimated

This model is often briefly referred to as Var (p) process because the number of lags is p. Expressing our import demand function in (4.3) as a VAR matrix, we have:

$$\begin{pmatrix} M_t \\ Y_t \\ RER_t \\ V_t \end{pmatrix} = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{pmatrix} + \begin{pmatrix} \alpha_{11}^1 & \dots & \alpha_{14}^1 \\ \vdots & \ddots & \vdots \\ \alpha_{41}^1 & \dots & \alpha_{44}^1 \end{pmatrix} \begin{pmatrix} M_{t-1} \\ Y_{t-1} \\ RER_{t-1} \\ V_{t-1} \end{pmatrix} + \begin{pmatrix} \alpha_{11}^2 & \dots & \alpha_{14}^2 \\ \vdots & \ddots & \vdots \\ \alpha_{51}^2 & \dots & \alpha_{44}^2 \end{pmatrix} \begin{pmatrix} M_{t-2} \\ Y_{t-2} \\ RER_{t-2} \\ V_{t-2} \end{pmatrix} + \dots + \begin{pmatrix} \alpha_{11}^4 & \dots & \alpha_{14}^4 \\ \vdots & \ddots & \vdots \\ \alpha_{41}^5 & \dots & \alpha_{44}^5 \end{pmatrix} \begin{pmatrix} M_{t-4} \\ Y_{t-4} \\ RER_{t-4} \\ V_{t-4} \end{pmatrix} + \begin{pmatrix} D_1 \\ D_1 \\ D_1 \\ D_1 \end{pmatrix} + \begin{pmatrix} U_{1t} \\ U_{2t} \\ U_{3t} \\ U_{4t} \end{pmatrix} \quad (4.6)$$

Where:

$A_i$  is a  $(k \times k)$  matrices of parameters, all of which are non zero.  $U_t$  is a column vector  $(k \times 1)$  of random disturbance values. They maybe contemporaneously correlated with one another but are assumed to be non-auto correlated over time.

P is the lag length of the VAR

D is a column vector  $(k \times 1)$  for the change in exchange rate regime. i.e., dummy variable

The error correction model is obtained by subtracting  $Y_{t-1}$  from both sides of equation (4.4) and then rearranging the terms:

$$\Delta X_t = \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \Gamma_{k-1} \Delta Y_{t-(p-1)} + u_t$$

$$\Delta X_t = \Pi Y_{t-1} + \sum_{j=1}^{p-1} \Gamma_j \Delta Y_{t-j} + u_t$$

In matrix format (4.6) becomes:

$$\begin{pmatrix} \Delta M_t \\ \Delta Y_t \\ \Delta RER_t \\ \Delta V_t \end{pmatrix} = \Pi \begin{pmatrix} M_{t-1} \\ Y_{t-1} \\ RER_{t-1} \\ V_{t-1} \end{pmatrix} + \Gamma_1 \begin{pmatrix} \Delta M_{t-1} \\ \Delta Y_{t-1} \\ \Delta RER_{t-1} \\ \Delta V_{t-1} \end{pmatrix} + \Gamma_2 \begin{pmatrix} \Delta M_{t-2} \\ \Delta Y_{t-2} \\ \Delta RER_{t-2} \\ \Delta V_{t-2} \end{pmatrix} + \dots + \Gamma_{p-1} \begin{pmatrix} \Delta M_{t-(p-1)} \\ \Delta Y_{t-(p-1)} \\ \Delta RER_{t-(p-1)} \\ \Delta V_{t-(p-1)} \end{pmatrix} + \begin{pmatrix} D_1 \\ D_2 \\ D_3 \\ D_4 \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \\ u_{4t} \end{pmatrix} \quad (4.9)$$

Where:

$\Delta$  is the first difference operator.

$$\Pi = -(I - A_1 - \dots - A_p); \quad \Gamma_j$$

$(A_{i+1} + \dots + A_p)$  for  $(i = 1, 2, 3, p-1)$ ;  $\Pi$  and  $\Gamma$

are  $(n \times n)$  coefficient matrices.

$\Pi$  gives information about the long run relationship between  $Y_t$  variables.

**Table 1.** Unit Root Test Results for Variables

Variables	Unit Roots				Order of Integration
With Intercept	Augmented Dickey Fuller				
	Levels	First Difference	Second Difference	0.05 Critical Values	
LnRER	-0.493045	-5.429238**	-9.200179**	-2.905519	I(1)
LnRGDP	-1.535136	-9.117671**	-9.007447**	-2.905519	I(1)
Vol(Garch)	-0.762778	-9.385123**	-12.38061**	-2.905519	I(1)
Vol(Masd)	-3.549329**	-7.478372**	-8.816439**	-2.906210	I(0)
LnRTextiles	-0.374233	-6.896372	-11.08703	-2.906923	I(1)
LnRFood	0.790041	-5.446138	-6.063060	-2.907660	I(1)
LnRFuel	-2.769930	-19.11250**	-11.09414**	-2.905519	I(1)
LnRMetals	-2.899385	-10.75691**	-9.998311**	-2.905519	I(1)
With Intercept and Trend	Augmented Dickey Fuller				
LnRER	-1.446670	-5.441665**	-9.1402929**	-3.478305	I(1)
LnRGDP	-6.234760**	-9.296016**	-8.945440**	-3.478305	I(0)
Vol(Garch)	-2.352987	-9.502720**	-12.30695**	-3.478305	I(1)
Vol(Masd)	-4.585216**	-7.415491**	-8.747083**	-3.478305	I(0)
LnRTextiles	-2.695171	-6.850117	-10.97913	-3.481595	I(1)
LnRFood	-1.761136	-5.861901	-6.089268	-3.478305	I(1)
LnRFuel	-5.845513**	-18.9938**	-10.99772**	-3.478305	I(0)
LnRMetals	-3.946507*	-10.67800**	-9.911977**	-3.478305	I(0)

\*\* indicates stationary at 1%,\* indicates stationarity at 5%

The number of linearly independent combinations of the variables indicates the rank of  $\Pi$ .

## EMPIRICAL RESULTS

This section presents the empirical results. We examine the effect of the exchange rate volatility on disaggregated of imports. Two measures of volatility are employed. These are moving average standard deviation (MASD) and GARCH method. The import functions being considered are as follows. Fuel (LnRFuel), Food, Beverages and Tobacco (LnRFood), Metals and metal products (LnRMetals), and Textiles and Footwear imports (LnRTextiles)

### Unit root test results

We used the Augmented Dickey Fuller (ADF) test for stationarity. When using the ADF technique, the decision rule follows that the calculated ADF statistic should be greater in absolute terms than the ADF critical statistic.

Looking at the results on Table 1, the null hypothesis of non stationarity cannot be rejected at levels for all the variables except for Vol (Masd) .The critical values for these variables are less than the values of the ADF test statistic in absolute terms. At first difference they are stationary I (1).Volatility calculated by the Moving

average standard deviation is the only variable which was found to be stationary at levels.

Conducting the same ADF test but with an intercept and trend, it suggests that most variables are stationary at levels I(0), except LnRER and Vol (Garch). LnRER and Vol(Garch ) are stationary after first differencing, making them I(1).

### Fuel imports

#### Cointegration test

Unit root test results have shown that the variables are not stationary at levels. It is therefore essential to establish whether they have a long term equilibrium relationship. We use the Johansen Cointegration test.

In Table 2, the null hypothesis of no cointegration ( $r = 0$ ) is rejected at 95 % level. The results show that both the maximum eigenvalue and the trace statistic suggest the presence of one cointegrating equation among the four variables. This unveils the existence of a long run equilibrium relationship between Fuel imports, RER, RGDP and Volatility (Masd). Since there is cointegration among the variables in the model, VECM is to be estimated for Fuel Imports. The VECM allows for an analysis of dynamic interrelationships among the variables using impulse response analysis.

The optimal lag length used in the VAR was determined by Schwartz Information Criterion (SIC) and the Akaike

**Table 2.** Cointegration Test: Fuel Imports

HYPOTHESED NO OF CE(s)	Eigen value	Trace statistic	0.05 Critical Value	Prob*	Max-Eigen Statistic	Prob*	0.05 Critical Value
r=0	0.377622	53.85622	47.85613	0.0123	30.82345	0.0185	27.58434
r= 1	0.240733	23.03278	29.79707	0.2445	17.90115	0.1336	21.13162
r= 2	0.065068	5.131629	15.49471	0.7947	4.373277	0.8180	14.26460
r= 3	0.011599	0.758352	3.841466	0.3838	0.758352	0.3838	3.841466

**Table 3 .** Cointegrating Vector: Fuel Imports

One Cointegrating Equation	Log Likelihood 436.3882		
LnRFuel	LnRGDP	LnRER	Vol(Masd)
1.00000	-2.056715	4.704773	-50.68079
Standard Error	(0.57928)	(0.74289)	(7.78332)
t-statistic	[-3.55047]	[6.33307]	[6.51146]

Information Criterion (AIC) respectively. The AIC produced conflicting lag length choices to the SIC. In case of a conflict in the lag length, the SIC is selected because it estimates the order of the VAR more consistently than the AIC which asymptotically overestimates the order with positive probability (Lutkepohl and Kratzig, 1999).

### Cointegrating vector (fuel imports)

Since we have established cointegration between Fuel Imports, RER, GDP and Volatility (MASD), we then apply the Johansen procedure to obtain long run coefficients of the model. Table 3 presents the normalized coefficients of the variables in the model.

The cointegrating vector can be obtained by normalizing Fuel imports. The cointegrating vector in Table 3 can be rewritten as the long run function for Botswana's Fuel Imports:

$$\text{LnRFuel} = 2.06\text{Ln RGDP} - 4.70\text{LnRER} + 50.68\text{Vol (Masd)} \quad (5.1)$$

[3.55]                      [-6.33]                      [6.51]

Looking critically at the values of the coefficients and their respective signs, it is the case that GDP and RER variables are significant and have correct signs. This implies that when GDP increases Fuel imports increase in the long run. Real exchange rate has the expected negative sign .When the Rand/Pula exchange rate depreciates it reduce Botswana's capacity to import Fuel. The results for GDP and RER conform to economic theory. Volatility (Masd) which is the variable of major interest has a positive sign. This implies that the

Rand/Pula exchange rate volatility has a positive long run impact on Fuel imports

### VECM for fuel imports

The analysis in this section seeks to examine the short run effects of the Rand/Pula exchange rate volatility on Fuel imports .The motive of the analysis is to discover whether the short run dynamics are influenced by the estimated long run equilibrium condition. i.e., the cointegrating vector. The VECM restricts the long run behavior of endogenous variables to converge to their cointegrating relationships while allowing for short run adjustment dynamics.

Table 4 shows the results of the VECM for Fuel imports using the MASD measure of exchange rate volatility. The lagged dependent coefficients for Fuel imports are not significant. The result suggests that past volumes of Fuel imported do not influence current volumes. This is because Fuel prices are volatile in nature and they are dependent on current prices in the international scenario. The VECM results for Fuel imports reveal that, GDP, RER and Vol (MASD) are statistically significant. This implies that these variables have short run effects on Fuel imports in addition to the long run effects. Both the long and short run analysis is showing that volatility has a negative short and long run effect on Fuel imports in Botswana.

A crucial parameter in the estimation of the short run dynamic model is the coefficient of the error correction term. It measures the speed of adjustment of Fuel imports to its equilibrium level. The results show that the parameter of the error correction term in the model is statistically significant and has the correct negative sign.

**Table 4.** VECM Results: Fuel Imports

	Equation 1 (LnRFuel)	Equation 2 (LnRER)	Equation 3 (LnRGDP)	Equation 4 (Vol_MASD)
(LnRFuel (-1))	-0.012587 [-0.09944]	-0.014312 [-0.76046]	-0.243766 [-3.41853]	-0.005984 [-0.84915]
(LnRFuel (-2))	0.049765 [ 0.76500]	-0.000641 [-0.06629]	-0.088713 [-2.42070]	-0.003655 [-1.00925]
(LnRER(-1))	-2.419341* [-2.92215]	-0.409639 [-3.32759]	-1.380905 [-2.96063]	-0.048116 [-1.04383]
(LnRER(-2))	-0.085558 [-0.09253]	-0.405848 [-2.95207]	0.228496 [ 0.43867]	-0.028300 [-0.54975]
(LnRGDP(-1))	-1.915431* [-4.85315]	0.008481 [ 0.14452]	-0.021304 [-0.09581]	0.018326 [ 0.83398]
(LnRGDP(-2))	-0.729302* [-3.11538]	0.046259 [ 1.32901]	0.027821 [ 0.21095]	0.001751 [ 0.13439]
(Vol_MASD(-1))	-3.228421* [-2.36025]	0.089916 [ 0.25479]	1.149626 [ 0.85980]	0.163152 [ 1.23473]
(Vol_MASD(-2))	1.795151 [ 0.72934]	-0.248989 [-0.68035]	1.204281 [ 0.86851]	-0.124002 [-0.90490]
C	-0.008771 [-0.26705]	-0.000615 [-0.12602]	-0.010626 [-0.57428]	0.000761 [ 0.41599]
ECM	-0.972978 [-5.86958]	0.003164 [ 0.12835]	0.469086 [ 5.02311]	0.014480 [ 1.56896]
DUMMY	0.021199 [ 0.35289]	-0.001134 [-0.12698]	0.018326 [ 0.54151]	-0.001890 [-0.56497]
R-squared	0.661408	0.315209	0.755266	0.148080

This confirms that Fuel Imports in Botswana have an automatic adjustment mechanism and that the Fuel imports respond to deviations from equilibrium. The adjustment of Fuel imports towards equilibrium is about 97% per quarter. This is a very high rate of adjustment. Fast adjustment of Fuel imports to equilibrium can also be explained by the volatile Fuel prices. The regime dummy variable is negative and statistically insignificant. This implies that the crawling peg exchange rate regime has not had any impact on Fuel imports.

### IMPULSE RESPONSE

Impulse response analysis is used to uncover the dynamic relationship between the variables within the VAR models. Impulse responses measure the time profile of the effect of a shock, or impulse on the (expected) future values of a variable (Watson, 1994).

We examine the response for Fuel imports to one standard deviation shock on itself, RER, RGDP and Vol Masd (See Figure 1). Fuel imports exhibit a positive response from a one standard deviation shock on itself which also dominates in the first quarter. The response from RER is negative suggesting a shock to RER negatively affect Fuel imports. A shock to GDP and

exchange rate volatility yields a positive response. Fuel imports react more significantly to a one standard deviation shock on itself and GDP.

### FOOD, BEVARAGES AND TOBACCO IMPORTS

#### Cointegration Test

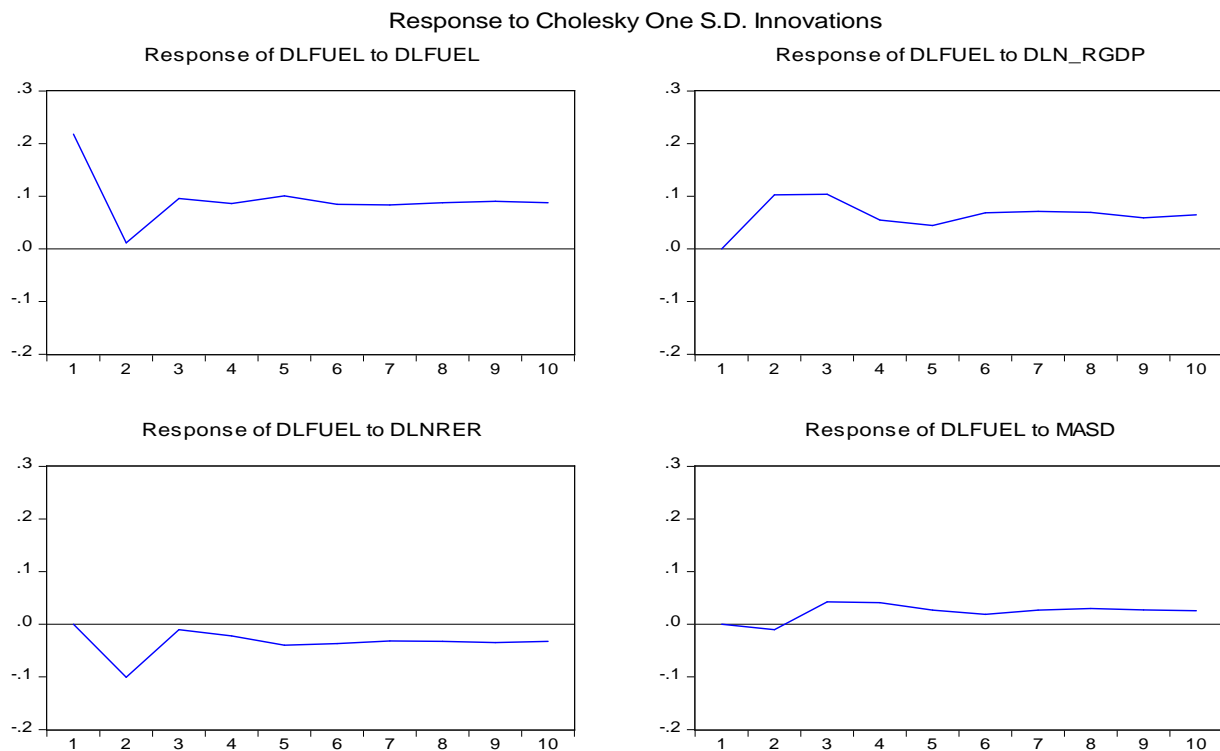
Unit root test results have shown that the variables, Food, Beverages and Tobacco, RER, RGDP and Volatility (Garch) are not stationary at levels. According to Johansen trace and Eigen statistic in Table 5, the null hypothesis of no cointegration ( $r = 0$ ) is rejected at 95 % level. There is one cointegrated vector, which means there exist a long run relationship between the variables.

#### COINTERGARTING VECTOR

The cointegrating vector in Table 6 can be written as the long run function for the Food, Beverages and Tobacco Imports:

$$\text{LnRFood} = 0.32\text{LnRGDP} - 2.32\text{LnRER} - 7.69\text{Vol (Garch)}$$

[2.31]      [-4.41]      [-3.64]



**Figure 1.** Impulse Response: Fuel Imports

**Table 5.** Cointegration Test: Food, Beverages and Tobacco Imports

HYPOTHESED NO OF CE(s)	Eigen value	Trace statistic	0.05 Critical Value	Prob*	Max-Eigen Statistic	0.05 Critical Value	Prob*
r=0	0.428775	51.49862	47.85613	0.0219	36.39819	27.58434	0.0029
r= 1	0.153378	15.10043	29.79707	0.7735	10.82254	21.13162	0.6650
r= 2	0.055047	4.277887	15.49471	0.8799	3.680282	14.26460	0.8915
r= 3	0.009152	0.597604	3.841466	0.4395	0.597604	3.841466	0.4395

\* denotes the rejection of the null hypothesis at 5% level of significance

**Table 6.** Cointegrating Vector: Food, Beverages and Tobacco Imports

One Cointegrating Equation	Log Likelihood 323.2382		
LnRFood	LnRGDP	LnRER	Vol(Garch)
1.00000	-0.324624	2.323573	7.695413
Standard Error	(0.14033)	(0.52660)	(2.11315)
t-statistic	[2.3133]	[4.412401]	[3.641679]

GDP has the expected positive sign, this reveals that GDP has a positive long run relationship with these imports. Real exchange rate also has the expected negative sign. Volatility (Garch) which is the variable of major interest has a negative sign. This implies that the Rand/Pula exchange rate volatility has a negative long run impact on Food imports in Botswana.

#### VECM for food, bevarages and tobbaeco imports

The analysis in this section seeks to examine the short run effects of the Rand/Pula exchange rate volatility on Food imports .The motive of the analysis is to discover whether the short run dynamics are influenced by the

**Table 7.** VECM (FOOD BEVARAGES AND TOBBACCO IMPORTS)

	Equation 1 (LnRFood Beverages and Tobacco)	Equation 2 (LnRER)	Equation 3 (LnRGDP)	Equation 4 (Vol GARCH)
( LnRFood Beverages and Tobacco (-1)	-0.338473 [-1.98115]	-0.000957 [-0.16457]	-0.115979 [-6.17357]	-0.000847 [-0.23241]
( LnRFood Beverages and Tobacco (-2)	-0.259135* [-2.25383]	-5.12E-05 [-0.01308]	-0.058528 [-4.62934]	0.002469 [ 1.00671]
(LnRER(-1)	-8.061947* [-2.00258]	-0.354627 [-2.58677]	0.210012 [ 0.47441]	-0.245198 [-2.85548]
(LnRER(-2)	-7.017034 [-1.75259]	-0.289758 [-2.12520]	0.294025 [ 0.66784]	-0.113609 [-1.33030]
(LnRGDP(-1)	-8.038544* [-4.11815]	0.004619 [ 0.06949]	0.562101 [ 2.61880]	-0.008649 [-0.20774]
(LnRGDP(-2)	-3.166824* [-2.89887]	0.047678 [ 1.28163]	0.317377 [ 2.64206]	0.001140 [ 0.04894]
(Vol GARCH(-1)	5.173123 [ 0.80404]	0.259029 [ 1.18225]	-3.299805 [-4.66419]	-0.793360 [-5.78106]
(Vol GARCH(-2)	13.45253 [ 2.29296]	-0.107539 [-0.53827]	-2.057133 [-3.18873]	-0.493378 [-3.94261]
C	-0.092903 [-0.66257]	0.000289 [ 0.06062]	0.015037 [ 0.97529]	5.60E-05 [ 0.01873]
ECM	-0.895882 [-4.41455]	0.000693 [ 0.10021]	0.170794 [ 7.65370]	-0.001487 [-0.34354]
DUMMY	0.264635 [ 1.01055]	-0.002935 [-0.32910]	-0.038626 [-1.34139]	0.002378 [ 0.42565]
R-squared	0.742746	0.342061	0.829214	0.616496

estimated long run equilibrium condition, that is, the cointegrating vector.

Table 7 shows the results of the VECM for Food, Beverages and Tobacco imports using the GARCH measure of exchange rate volatility. Looking at the dynamics of Equation 1, the coefficient of the lagged Food dependent variable is significant. This illustrates the influence of previous Food imports on the current volumes of Food. The coefficients for GDP and RER are statistically significant. Therefore GDP and RER have short run influence in addition to the long run impacts on Food imports. The coefficient for volatility is insignificant. The error correction term explains that about 89% of disequilibrium in Food imports is corrected per quarter. This is a very fast rate of adjustment to equilibrium. The exchange rate regime dummy variable is negative and statistically insignificant for all the equations. Adoption of the crawling peg exchange rate policy in 2005 has not had any impact on Food imports in Botswana.

### Impulse response

A shock to Food Imports yields a positive response from itself. The response was negative for a very short period

in the second quarter before becoming positive. The positive wobble lasts the entire horizon. The response of Food, Beverages and Tobacco to a shock in RER is negligible. A one standard deviation shock to GDP creates a positive response. This explains that there is a positive relationship between GDP and Food imports. A shock to volatility results in both negative and positive response. Food imports react more significantly to exchange rate volatility and own shocks (See Figure 2).

### Metals and metal products

#### Cointegration test

We use the Johansen cointegration test to establish whether there exists a long term equilibrium relationship between Metals and metal products, RER, GDP and Volatility (MASD). Table 8 presents this results.

In Table 8, the null hypothesis of no cointegration ( $r = 0$ ) is rejected. The maximum Eigen value shows that there are two cointegrating vectors and the trace statistic shows that there exists one cointegrating vector. For consistency between the two we adopt one cointegrating vector. The results explain that there exists a long run



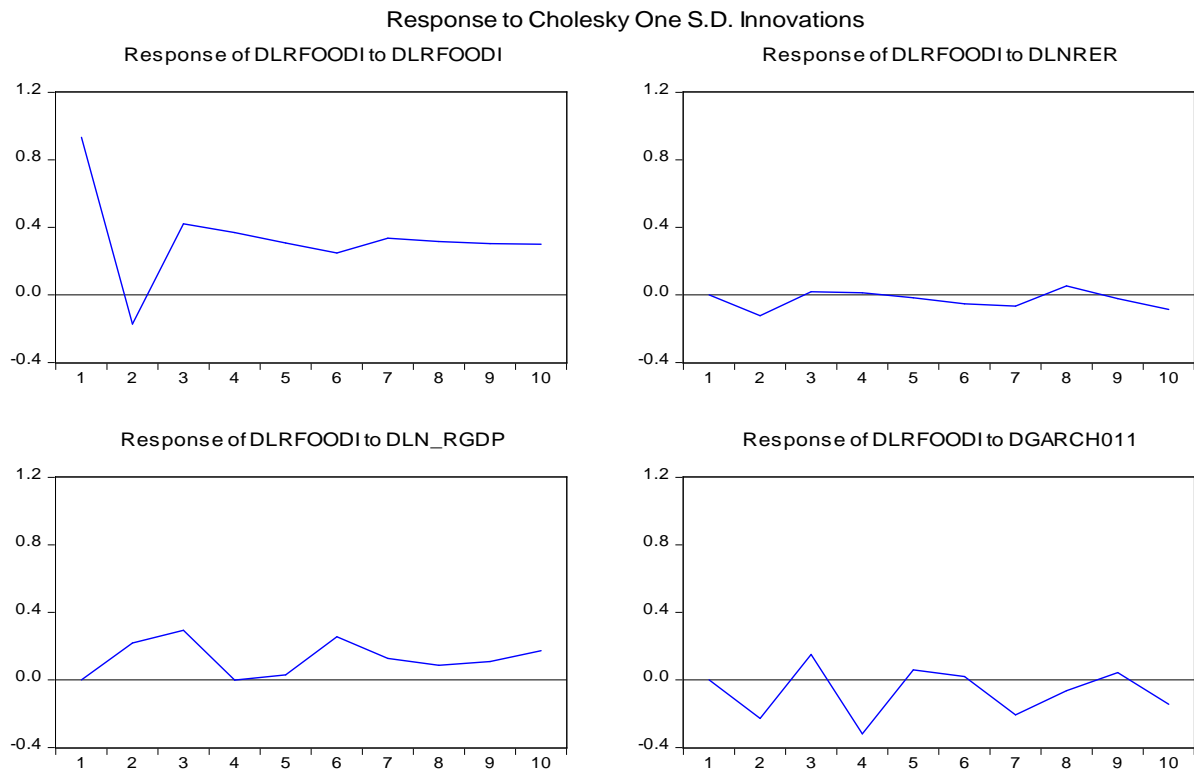


Table 8. Cointegration Test: Metals and Metal Products Imports

HYPOTHESISED NO OF CE(s)	Eigen value	Trace statistic	0.05 Critical Value	Prob*	Max-Eigen Statistic	0.05 Critical Value	Prob*
r=0	0.354625	55.04223	47.85613	0.0091	28.46500	27.58434	0.0385
r= 1	0.287419	26.57723	29.79707	0.1124	22.02599	21.13162	0.0374
r= 2	0.060146	4.551232	15.49471	0.8545	4.032011	14.26460	0.8560
r= 3	0.007956	0.519220	3.841466	0.4712	0.519220	3.841466	0.4712

relationship among Metals and metal products, RER, GDP and Volatility (MASD) among these variables.

### Cointegrating vector

We apply the Johansen procedure to obtain long run coefficients of the model. Table 9 presents the normalized coefficients of the variables in the model. The long run function for the Metal imports in Botswana can be written as:

$$\text{LnRMetals} = 1.01\text{Ln\_RGDP} - 1.29\text{Ln\_RER} + 22.62\text{Vol (Masd)}$$

[-2.97]                      [2.93]                      [4.85]

The long run function shows that there is a positive long run relationship between Metal imports and real

GDP. There exists a negative long run relationship between Metal imports and the RER. A depreciation of the Pula leads to a reduction in Metal imports. The results for GDP and RER are conforming to economic theory. The variable that we are interested in establishing its relationship with Metal imports, Vol (Masd) is positive. This implies that the Rand/Pula exchange rate volatility has a positive long run effect on Metal imports.

### VECM for metal imports

The estimation of a VECM yields the results presented in Table 10. The coefficient for Metal lagged dependent variable is significant. This result suggests that previous volumes of Metal imports have an effect on current volumes. The coefficient for GDP is statistically

**Table 9.** Cointegrating Vector: Metals and Metal Products Imports

One Cointegrating Equation	Log Likelihood 391.6238		
LnRMetals	LnRGDP	LnRER	Vol(Masd)
1.00000	-1.009923	1.288601	- 22.62893
Standard Error	(0.34060)	(0.43857)	(4.66670)
t-statistic	[-2.96513]	[2.93819]	[-4.84902]

**Table 10.** VECM Results: Metals and Metal Products Imports

	Equation 1 (LnRMetals & Metal products )	Equation 2 (LnRER)	Equation 3 (LnRGDP)	Equation 4 (Vol MASD)
( LnRMetals & Metal Products (-1)	-0.645989 [-3.82549]	0.027200 [ 1.57588]	-0.371493 [-6.75528]	0.004654 [ 0.67887]
( LnRMetals & Metal Products(-2)	-0.170366 [-1.36956]	0.016343 [ 1.28538]	-0.159989 [-3.94931]	0.002143 [ 0.42444]
(LnRER(-1)	-1.687897 [-1.32515]	-0.308645 [-2.37071]	0.429754 [ 1.03603]	-0.003319 [-0.06418]
(LnRER(-2)	-1.094000 [-0.90632]	-0.379551 [-3.07636]	0.585282 [ 1.48889]	-0.038144 [-0.77840]
(LnRGDP(-1)	-2.262142 [-3.46636]	0.057824 [ 0.86689]	0.721640 [ 3.39551]	0.005817 [ 0.21957]
(LnRGDP(-2)	-1.154571 [-3.36622]	0.064917 [ 1.85173]	0.299322 [ 2.67974]	-0.005161 [-0.37062]
(Vol MASD(-1)	5.417948 [ 1.69363]	0.201795 [ 0.61715]	0.201795 [ 1.67403]	0.221947 [ 1.70900]
(Vol MASD(-2)	-1.133957 [-2.33818]	-0.410903 [-1.19893]	1.692083 [ 1.54955]	-0.214841 [-1.57827]
C	-0.012851 [-0.29173]	0.000294 [ 0.06541]	0.004564 [ 0.31815]	0.000963 [ 0.53856]
ECM	-0.545462 [-3.49158]	0.010431 [ 0.65327]	0.443870 [ 8.72459]	0.004300 [ 0.67806]
DUMMY	0.054395 [ 0.66825]	-0.002513 [-0.30207]	-0.015621 [-0.58928]	-0.002257 [-0.68294]
R-squared	0.792413	0.408273	0.850453	0.171725

significant. This implies that GDP has short run effects on Metal imports in addition to the long run. Volatility also does not have short run impact on Metal imports. The model has a correct and significant error correction term. The error correction term explains that about 54% of disequilibrium in Metal imports is corrected per quarter. The regime dummy variable is negative and statistically insignificant. This implies that the crawling peg exchange rate regime has not had any impact on Metal imports.

### Impulse response function

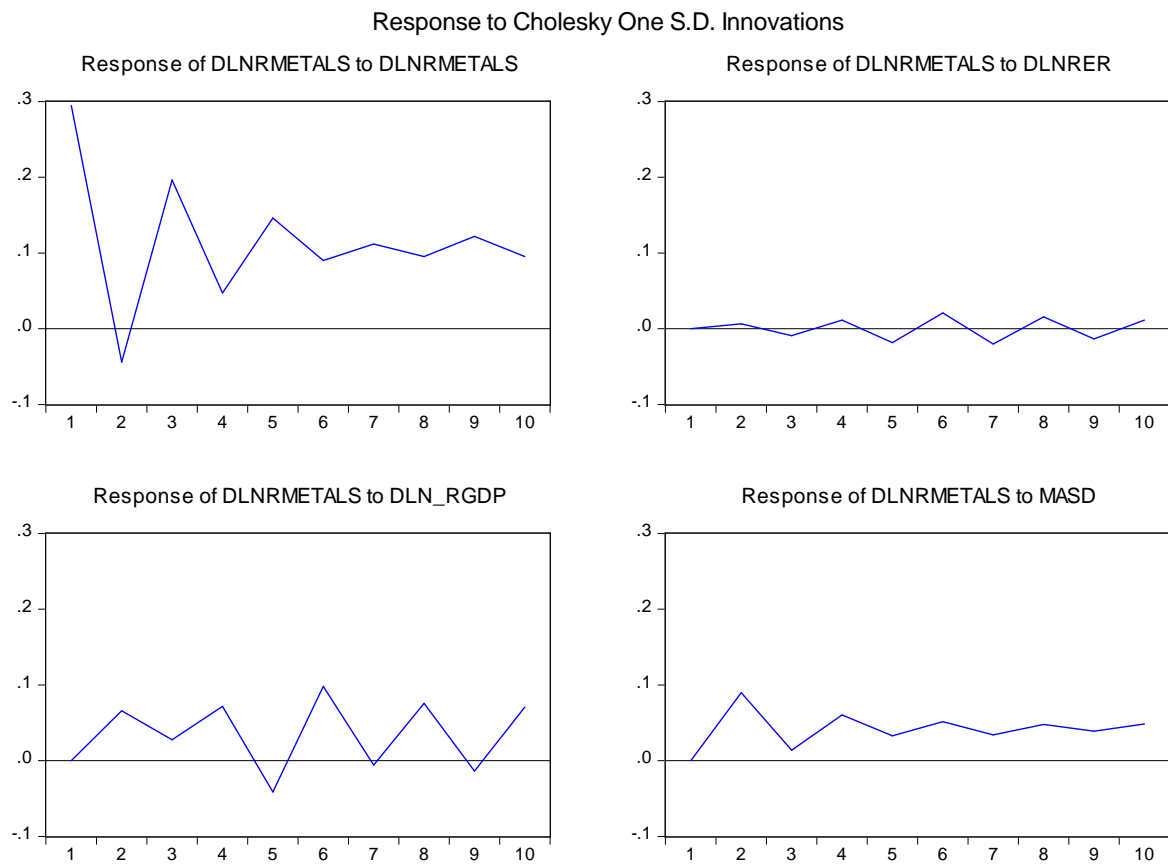
A shock to Metal imports yields a positive response from itself. The response was negative for a very short period in the second quarter before becoming positive. The

positive wobble lasts the entire horizon. The response of Metal imports to a shock in RER is negligible. A one standard deviation shock to GDP yields a significant positive response. This explains that there is a positive relationship between GDP and Metal imports. A shock to volatility results yields a positive mild response (See Figure 3).

### Textiles and footwear imports

#### Cointegration test

The null hypothesis of no cointegration ( $r = 0$ ) is rejected at 95 % level (See Table 11). We also fail to reject the null hypothesis that there is at most one cointegrating



**Figure 3.** Impulse Response: Metals and Metal Products Imports

**Table 11.** Cointegration Test: Textiles and Footwear Imports

HYPOTHESED NO OF CE(s)	Eigen value	Trace statistic	0.05 Critical Value	Prob*	Max-Eigen Statistic	0.05 Critical Value	Prob*
r=0	0.455543	74.91014	47.85613	0.0000	39.51787	27.58434	0.0009
r= 1	0.375942	35.39227	29.79707	0.0102	30.64829	21.13162	0.0017
r= 2	0.058540	4.743979	15.49471	0.8354	3.921055	14.26460	0.8676
r= 3	0.012581	0.822924	3.841466	0.3643	0.822924	3.841466	0.3643

relationship. It suggests the existence of a long run relationship between the Textiles and Footwear, RER, RGDP and Volatility (Masd). A VECM is to be estimated for Textiles and Footwear imports.

#### Cointegrating vector

Since we have established cointegration between Textile & Footwear imports, RER, GDP and Volatility (Masd), we then apply the Johansen procedure to obtain long run coefficients of the model. Table 12 presents the normalized coefficients of the variables in the model. The

long run function for the Textile and Footwear imports is written as:

$$\text{LnRTextiles} = 0.194 \text{LnRGDP} - 0.908 \text{Ln\_RER} + 11.05 \text{Vol (Masd)}$$

[0.517]                      [-1.88]                      [2.18]

The results suggest that there exists a positive relationship between GDP and Textiles & footwear imports. This relationship is as explained by economic theory. The results also show that there is a negative relationship between Textile imports and RER. The relationship between Textiles and exchange rate volatility is positive. This implies that Textile imports increase with an increase in the Rand/Pula exchange rate volatility.

**Table 12.** Cointegrating Vector: Textiles and Footwear Imports

One Cointegrating Equation	Log Likelihood 436.3882		
LnRTextiles	LnRGDP	LnRER	Vol(Masd)
1.00000	-0.194214	0.907973	-11.04974
Standard Error	(0.37555)	(0.48264)	(5.06408)
t-statistic	[-0.517145]	[1.8812]	[-2.18194]

**Table 13.** VECM Results: Textiles and Footwear Imports

	Equation 1 (LnRTextiles and Footwear)	Equation 2 (LnRER)	Equation 3 (LnRGDP)	Equation 4 (Vol Masd)
(LnR LnRTextiles and Footwear (-1))	-0.862511* [-7.28793]	0.003836 [ 0.91531]	-0.000559 [-0.04570]	-0.000315 [-0.20371]
(LnR LnRTextiles and Footwear (-2))	-0.268295* [-2.26950]	-0.000575 [-0.13732]	-0.002498 [-0.20439]	0.001118 [ 0.72488]
(LnRER (-1))	-10.37453 [-2.54377]	-0.356428 [-2.46820]	0.490333 [ 1.16271]	-0.016905 [-0.31760]
(LnRER (-2))	-4.346071 [-1.12736]	-0.331411 [-2.42791]	0.526735 [ 1.32139]	-0.025542 [-0.50767]
(LnRGDP (-1))	-5.730760 [-2.45173]	0.046486 [ 0.56167]	0.953827 [ 3.94642]	0.030647 [ 1.00464]
(LnRGDP(-2))	-1.861263 [-1.59280]	0.060292 [ 1.45717]	0.408074 [ 3.37726]	0.007747 [ 0.50797]
(Vol Masd (-1))	4.813836 [ 0.48044]	0.005541 [ 0.01562]	1.264860 [ 1.22085]	0.197106 [ 1.50735]
(Vol Masd (-2))	-21.16053 [-2.03860]	-0.127239 [-0.34620]	1.766692 [ 1.64604]	-0.156464 [-1.15501]
C	-0.033098 [-0.24203]	9.62E-05 [ 0.01987]	0.001729 [ 0.12225]	0.000962 [ 0.53878]
ECM	-0.072822 [ -2.79603]	-0.000427 [-0.46272]	-0.023272 [-8.64129]	-0.000493 [-1.45074]
DUMMY	0.100604 [ 0.39899]	-0.002161 [-0.24199]	-0.008020 [-0.30762]	-0.002337 [-0.71028]
R-squared	0.574802	0.315058	0.854579	0.174349

### VECM for textile & footwear imports

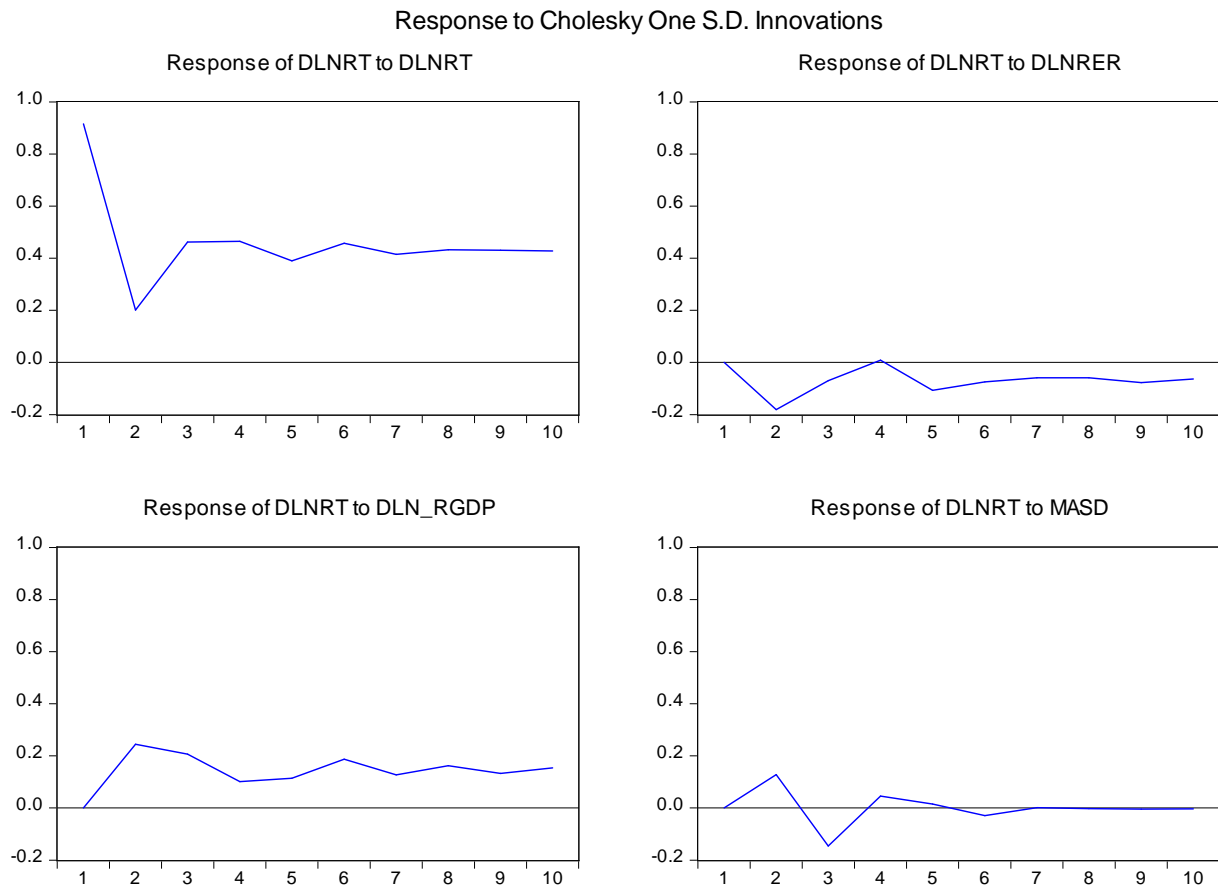
This subsection seeks to examine the short run effects of the Rand/Pula exchange rate volatility on Textile imports.

The lagged coefficients for Textiles are significant (See table 13). This illustrates the influence of previous trade on current volumes of Textile imports. The results reveal that, GDP, RER and Vol (MASD) are statistically significant. The parameter of the error correction term in the model is statistically significant and has the correct

negative sign. The adjustment rate of the Textiles and Footwear imports towards equilibrium is about is only 7%. This implies a slow rate of adjustment towards the long run equilibrium.

### Impulse response

Textile imports exhibit a positive response from a one standard deviation shock on itself. The response from



**Figure 4.** Impulse Response: Textiles and Footwear Imports

RER is mild and negative suggesting a shock to RER negatively affect Textile imports. A shock to GDP yields a positive response. Textile imports react more significantly to a one standard deviation shock on itself and GDP. The response to volatility is both negative and positive in the first six quarters before converging to zero (See Figure 4).

## CONCLUSIONS

The primary objective of this paper was to explore the effects of the Rand/Pula exchange rate volatility on imports. Two measures of exchange rate volatility were employed in the study. These are the moving average standard deviation (MASD) and the generalized autoregressive conditional heteroscedasticity (GARCH) measure. The short run impact of exchange rate volatility is assessed using a VECM analysis. The impact of shocks to different import groups are examined by the use of impulse response analysis. The results have shown that exchange rate volatility generally has the least explanatory power on changes on import demand.

Its magnitude varies substantially across the four groups of imports studied (Fuel, Textiles, Food and Metals). From the results it is clear that the exchange rate volatility impact has been more significant in the long run than short run. A negative relationship exists between Food imports and exchange rate volatility. Thus a volatile Rand/Pula exchange rate negatively affects the volume of Food imports in Botswana. An interesting aspect of the results is that exchange rate volatility was found to be statistically significant with a positive effect on Fuel, Metal and Textiles imports. It could conceivably be hypothesized that importers move to avoid any reduction in revenues arising from increased exchange rate volatility, thus they are risk averse. This result is consistent with other previous studies that found exchange rate volatility to be beneficial to imports (McKenzie and Brook, 1997). An almost negligible response of imports to real exchange rate shocks in the overall picture of the results enforces the idea of an inelastic import demand. Furthermore, the results have shown that adopting the crawling peg exchange rate regime has not had any impact on the demand for imports in Botswana.

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