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EXCHANGE RATE PASS-THROUGH TO CONSUMER PRICES IN ZAMBIA

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Abstract: This study focuses on the impact of exchange rate changes on food prices and the consumer price index in Zambia. The study uses monthly data collected from the Central Bank of Zambia (January, 1994 - December, 2013) on exchange rate, food prices, consumer price index, oil prices, treasury bills rate and real Gross Domestic Product. Using the Structural Vector Autoregression (SVAR) and the Vector Error Correction (VEC), the empirical findings suggest that there is a strong significant relationship between the consumer price indices and the exchange rate in Zambia, and that depreciation causes consumer prices to increase over the period under consideration with food prices responding faster to depreciation than does the general price level. The findings imply that depreciation of the exchange rate is a significant cause of inflation in Zambia. However, exchange rate pass-through is low, partial and persistent. This implies that the magnitude by which the consumer prices increase following depreciation of the kwacha is small. Therefore, despite a continuous depreciation, the price level can remain relatively stable over time.

Key Words: Exchange Rate Pass-through, Consumer prices, Inflation, Structural Vector Auto-Regression, deprivation, Zambian Kwacha.

1. INTRODUCTION

Currency devaluation has been a popular policy among most of the African countries. Although this policy has been seen by many policy makers and economists as a vehicle to improve competitiveness in the world market, the extent to which changes in the nominal exchange rate translates into changes in domestic consumer prices constitutes a vital policy challenge that Less Developed Countries (LDCs) are currently facing (Holmes, 2008 and Bwire, *et. al.*, 2013). The Marshall-Lerner condition states that currency devaluation will improve the balance of payments (BOPs) if and only if, the sum of price elasticities of demand for exports and imports exceeds unity. Thus, assuming that this condition holds, the elasticity approach to BOPs would suggest that currency depreciation will improve competitiveness of domestic exports and at the same time improve the efficiency of import competing sectors (Pilbeam, 2006; Istrefi & Semi, 2007 and Holmes, 2008). The theory however, does not deal with the problem of inflation which is likely to offset the depreciation or devaluation benefits. This is likely to be the case for a small open economy like Zambia which cannot influence export prices in foreign currency and whose consumption basket constitutes of mostly imported goods.

The Zambian currency (kwacha), like many other global currencies, has depreciated considerably against major currencies since the 1990s following the adoption of a flexible exchange rate system (Chipili, 2010). Based on theory, this should increase competitiveness of the export and import competing sectors. However, existing literature shows that for Zambia, the potential benefits from depreciation have been outweighed by the rise in import and consumer prices, further translating into high inflation rate. For instance, inflation rose from 7.1% in December 2013 to 7.3%, 7.6%, 7.7%, 7.8% and 7.9% in January, February, March, April and June 2014, respectively (Bank of Zambia, 2014). The rise was partly attributed to the pass-through effects of the exchange rate depreciation.

Among the consumer prices that have been affected by depreciation of the kwacha are food prices. This is because the Zambian consumer basket consists of a large share of imported food products. Thus, depreciation increases the cost of imports which in turn translates into higher food prices. According to Bank of Zambia (2014), food inflation rose from 2.8% in December, 2013 to 4.4% in June, 2014 as a result of pass-through effects of exchange rate depreciation. High food prices have an effect on the overall inflation level which in turn could adversely affect economic growth (IMF, 2008). However, in spite of the considerable amount of work done by academic and policy researchers on this subject worldwide, no study has specifically focused on Zambia. The empirical studies on exchange rate in Zambia mostly focus on examination of the determinants of the level of exchange rate, its long-run equilibrium level, the extent of exchange rate misalignment, macroeconomic effects of exchange rate volatility, among other studies (Mkenda, 2001; Mungule, 2004; and Chipili, 2010). It is against this background that this study seeks to examine the domestic price adjustment mechanism to changes in nominal exchange rates for the Zambian economy for the period 1994-2013. Specifically, the study is designed to:

(i) determine the impact of nominal exchange rate changes on the consumer price index in Zambia;
(ii) assess the impact of nominal exchange rate changes on food prices in Zambia;
(iii) draw from the results, the relevant policy implications.

The rest of the study is organized as follows: Section Two presents related studies found in literature. Section Three discusses the empirical method adopted by the study, while Section Four presents and discusses the empirical findings and Section Five presents the conclusions and policy implications of the empirical findings.

2. LITERATURE REVIEW

Literature makes a distinction between direct and indirect channels through which the exchange rate movements can be transmitted to consumer prices. The direct channel is through prices of imported consumer goods while the indirect channel is through prices of imported inputs which affect costs of production following exchange rate changes (Barhoumi, 2005; Pilbeam 2006; Holmes, 2008; Sanusi, 2010 and Bwire, *et al*, 2013). The four theoretical underpinnings of goods prices and exchange rate modelling include: the law of one price (LOOP) (Bitans, 2004 and Philbeam, 2006), exchange rate and tariff pass-through theory (Goldberg and Knetter, 1997), the pricing-to-market theory (Alessandria and Kaboski, 2007) and the Taylor hypothesis (Taylor, 2000).

The law of one price (LOOP) is associated with the concept of Purchasing Power Parity (PPP) and states that; under perfect competition and in the absence of transport costs and barriers to trade, identical goods will be sold at the same price in different countries when expressed in common currency (Bitans, 2004 and Pilbeam, 2006). This is attributed to perfect goods arbitrage in which the difference in goods prices across different markets and countries leads to the flow of goods from low priced markets to high priced markets until the prices in different markets are equalized. If the LOOP holds between two countries, then the absolute PPP theory also holds, implying a proportional relationship between exchange rates and domestic prices. The proportional relationship suggests complete exchange rate pass-through to consumer prices.

The exchange rate and tariff pass-through theory focuses on the effect of exchange rate changes on imports and exports. It assumes a one-to-one response of import prices to changes in exchange rates on the conditions that the mark-up of price over cost and the marginal costs are constant. On the basis of these conditions, the elasticity of demand of imports in the countries under consideration is responsible for trade balance responsiveness to exchange rate fluctuations. As long as the two conditions hold, exchange rate pass-through to import prices will be complete (Goldberg & Knetter, 1997).

According to the pricing-to-market (PTM) theory, exchange rate pass-through is incomplete because firms focus on mark-up adjustment rather than sales. In this case, market segmentation and product differentiation causes exporters to set their prices as a sum of marginal cost and destination specific mark-up. Thus, export price responsiveness to exchange rate variations depends on the convexity of the demand curve in the export market and change in the marginal cost induced by changes in the output level. The more responsive demand is to exchange rate fluctuations, the lower the pass-through to export prices. It can thus, be inferred that perfectly elastic demand will lead to zero ERPT whereas perfectly inelastic demand will result in complete ERPT (Alessandria & Kaboski, 2007).

The Taylor hypothesis explains the relationship between exchange rate pass-through and the inflation regime. It assumes a proportional relationship between inflation and the exchange rate. It also postulates that the extent to which the price level changes following a change in the exchange rate depends on whether the change in the exchange rate is permanent or temporary. Temporary changes in the exchange rate have little effect on prices because they do not have long-lasting impact on the marginal cost and market share. In this case, firms adjust their profit margins instead of prices. However, permanent exchange rate changes induce firms to adjust prices in order to maintain market share (Taylor, 2000). The hypothesis further assumes sticky prices and emphasizes the role of expectations. If a policy shift causes economic agents to expect low inflation in the future, then exchange rate pass-through to domestic prices would be low and incomplete.

Various empirical studies have been undertaken to provide quantitative insight into the relationship between exchange rates and domestic prices using the Vector Autoregression (VAR) models. Among the studies conducted in developed countries are; McCarthy (2000 & 2007), Hufner & Schroder (2002), Campa, *et al* (2005), Faruquee (2006), An & Wang (2011) and Boug, *et al* (2013). These studies have shown mixed results. In some studies, the exchange rate pass-through to domestic prices is high and complete (McCarthy, 2000 and 2007; and Campa *et al*, 2005; Faruquee, 2006). In other empirical studies it is low and incomplete (An & Wang, 2011; Hufner &Schroder, 2002 and Boug *et al*, 2013). However, there is a consensus in terms of declining pass-through over the years. This has been attributed to improvements in macroeconomic fundamentals in these economies.

With regard to developing countries, existing literature on Sub-Saharan Africa (SSA) include; Bhundia (2002), Mwase (2006), Holmes (2008), Sanusi (2010), Frimpong & Adam (2010), Oyinlola & Egwaikhide (2011), Parsley (2012), Tandrayen-Ragoobur & Chicooree (2012), Adeyemi & Samuel (2013), Bwire, *et al* (2013) and Aron *et al* (2014b). Like in developed countries, the VAR models were also employed in these studies and the findings were similar to those of developed countries.

Bhundia (2002), Parsley (2012) and Aron, *et al* (2014) found low exchange rate pass-through to consumer prices in South Africa. Mwase (2006) also found low and declining pass-through from exchange rate to consumer prices in Tanzania. In Ghana, Sanusi (2010), found high pass-through with 1% depreciation of the exchange rate leading to a rise in consumer prices by 0.79%. On the other hand, Frimpong & Adam (2010) found low pass-through in Ghana. For instance, a 10% appreciation of the exchange rate resulted in 0.9% decrease in consumer prices.

Tandrayen-Ragoobur & Chicooree (2012) also found low and incomplete pass-through to consumer prices in Mauritius. In Nigeria, Oyinlola & Egwaikhide (2011) found a long-run relationship between the exchange rate and the price level but the short-run relationship was negligible. Adeyemi and Samuel (2013) found large and substantial ERPT to consumer prices in Nigeria with the immediate effect of an exchange rate shock being 83% increase in the price level and full ERPT was realized as the period increased. Bwire, *et al* (2013) also found high but incomplete pass-through to consumer prices in Uganda. The results showed that 1% depreciation in the exchange rate increased the inflation rate by 0.48%.

In summary, the studies reviewed show that exchange rate pass-through to consumer prices is moderate, partial and has been declining over time. However, it is worth noting that these results are sensitive to the type of data sets, study periods, estimation techniques and macroeconomic fundamentals such as the exchange rate regime, openness of an economy, fiscal policy and the inflation rate regime of economies under study.

3. METHODOLOGY

This section discusses the empirical methods used in the econometric estimation process. These include the Structural Vector Authoregression (SVAR) and the Vector Error Correction Model (VECM).

3.1. Structural Vector Autoregression (SVAR)

In the VAR model, all variables are treated as endogenous to prevent the problem of simultaneity associated with systems of equations. The SVAR model is based on economic theory giving it an advantage over the unrestricted VAR. Thus, to determine the impact of exchange rate changes on domestic prices, SVAR technique is employed following Bwire, *et al* (2013). A 6-variable first order VAR model in matrix form is set up as follows:

$$\beta z_t = \Gamma_0 + \Gamma_1 z_{t-1} + \mu_t \quad (1)$$

where 'β' is a 6 x 6 matrix of coefficients for the variables in the current period, 'z_t' is a 6 x 1 column vector of endogenous variables, 'Γ_0' is a 6 x 1 column vector of constants, 'Γ_1' is a 6 x 6 matrix of coefficients for the lagged variables, and 'μ_t' is a 6 x 1 column vector of error terms. It is assumed that $E(\mu_t \mu'_t)$, where 'D' is a diagonal matrix of variances of the error terms. Based on economic theory and literature reviewed, the variables included in the model include; the consumer price index (CPI), oil price index (OILP), real Gross Domestic Product growth (RGDP), a 3-month treasury-bill rate (TRATE), the nominal bilateral exchange rate between the Zambian kwacha and the US dollar (EXRATE) and the food price index (FCPI). All the variables are in natural logarithm form and are assumed to be stationary. Thus;

$$Z_t = [\ln OILP_t, \ln RGDP_t, \ln TRATE_t, \ln EXRATE_t, \ln FCPI_t, \ln CPI_t] \quad (2)$$

The error terms are identically and independently distributed, uncorrelated white noise error terms. The coefficients represent elasticities of the respective variables and give the contemporaneous impact of the variables on each other.

To be able to estimate equation 1, its reduced form was obtained by pre-multiplying equation 1 by the inverse of β, β^{-1} as follows:

$$\beta^{-1} \beta z_t = \beta^{-1} (\Gamma_0 + \Gamma_1 z_{t-1} + \mu_t)$$

$$z_t = a + \theta z_{t-1} + \varepsilon_t \quad (3)$$

Where $a = \beta^{-1} \Gamma_0$, $\theta = \beta^{-1} \Gamma_1$ and $\varepsilon_t = \beta^{-1} \mu_t$. The variance-covariance matrix is

$E[\varepsilon_t \varepsilon'_t] = \beta^{-1} E[\mu_t \mu'_t](\beta^{-1}) = \Sigma$. Equation 3 is estimated as a SVAR model using the structural decomposition. However, it is still unidentified because it cannot yield unique estimates for the coefficients. Thus, estimation of the SVAR model requires that the model be identified.

Identification is achieved by using the variance-covariance matrix and imposing *a priori* short-run restrictions on the coefficients to be estimated. Since the model contains six variables, the number of restrictions to be imposed is equal to $k(k+1)/2 = 21$, where 'k' is the number of variables. These restrictions are based on economic theory and help to determine the ordering of the variables in the system. Firstly, the restriction of normalization is imposed on the diagonal elements of the matrix of coefficients to be estimated. These diagonal elements are set equal to unity with the sole purpose of scaling in the system. Thus, normalization does not affect the estimation process. This implies that the variance-covariance matrix becomes an identity matrix.

Secondly, the oil price shocks are ordered first because oil prices are considered to be the most exogenous variable. This is because oil prices are determined in the world market and are thus, independent of the Zambian domestic economy. However, changes in the world oil price affect the fuel prices in the domestic economy. This assumption implies that the oil price shocks are not contemporaneously affected by all other shocks in the system. This is equivalent to assuming that all the other coefficients in the oil price equation are zero. Thus a set of five restrictions is imposed on the five shocks in the first row of the coefficient matrix. Thirdly, it is assumed that real GDP growth is only affected by shocks to the oil prices but not by shocks to all other variables. This assumption is based on the understanding that the Zambian production system is significantly influenced by the oil prices. An increase in the oil price on the world market sufficiently affects production in the economy. Thus, zero restrictions are imposed on the remaining four shocks in the second row.

It is further assumed that the monetary policy rate shocks are contemporaneously affected by shocks to the oil price and shocks to real GDP growth but are not affected by shocks to the exchange rate, food price index and consumer price index. This implies zero restrictions on the coefficients of exchange rate, food price index and inflation shocks in the third row. The exchange rate shocks are also assumed to be independent of the food price index shocks and inflation shocks but are contemporaneously affected by shocks to the oil price, real GDP growth and monetary policy rate. This is equivalent to imposing zero restrictions on the coefficients of the food price index and inflation shocks in the fourth row. The shocks to the food price index are assumed to be influenced by shocks to the oil price index, real GDP growth, Treasury-bill rate, and the exchange rate. This imposes a zero restriction on the coefficient of the CPI shock in the fifth row. Finally, the consumer price index or inflation shocks are ordered last because they are assumed to be contemporaneously influenced by all other shocks in the system. The number of restrictions imposed is equal to that required for the SVAR model to be exactly identified. This yields the relationship between the structural disturbances and the reduced form error terms as follows:

$$\begin{bmatrix} \varepsilon_{LNOILPt} \\ \varepsilon_{LNRGDPt} \\ \varepsilon_{LNTRATEt} \\ \varepsilon_{LNEXRATEt} \\ \varepsilon_{LNFCPIt} \\ \varepsilon_{LNCPIt} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ \beta_{21} & 1 & 0 & 0 & 0 & 0 \\ \beta_{31} & \beta_{32} & 1 & 0 & 0 & 0 \\ \beta_{41} & \beta_{42} & \beta_{43} & 1 & 0 & 0 \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & 1 & 0 \\ \beta_{61} & \beta_{62} & \beta_{63} & \beta_{64} & \beta_{65} & 1 \end{bmatrix} \begin{bmatrix} \mu_{LNOILPt} \\ \mu_{LNRGDPt} \\ \mu_{LNTRATEt} \\ \mu_{LNEXRATEt} \\ \mu_{LNFCPIt} \\ \mu_{LNCPIt} \end{bmatrix} \tag{4}$$

In order to estimate the responsiveness of food prices and the general price level to exchange rate changes, the study focuses on the FCPI and CPI equations. The effect of changes in the nominal exchange rate on the two consumer price indices is estimated by the accumulated impulse response of FCPI and CPI to shocks to the exchange rate. The shocks are obtained by estimating the following equations:

$$\begin{aligned} \varepsilon_{LNFCPIt} = \beta_{51}\mu_{LNOILPt} + \beta_{52}\mu_{LNRGDPt} + \beta_{53}\mu_{LNTRATEt} \\ \beta_{54}\mu_{LNEXRATEt} + \mu_{FCPIt} \end{aligned} \tag{5}$$

$$\begin{aligned} \varepsilon_{\ln CPIt} + \beta_{61}\mu_{\ln OILPt} + \beta_{62}\mu_{\ln RGDPt} + \beta_{63}\mu_{\ln TRATEt} + \beta_{64}\mu_{\ln EXRATEt} \\ + \beta_{65}\mu_{\ln} FCPIt + \mu_{\ln CPIt} \end{aligned} \tag{6}$$

3.2. Vector Error Correction Model (VECM)

The vector error correction model is estimated when the variables are co-integrated and it measures the correction from short-run disequilibrium to long-run equilibrium. It allows for convergence of the series to their long-run equilibrium. Most importantly, the VECM constitutes a disequilibrium error correction term which represents the speed of adjustment of the series to their long-run equilibrium. In other words, the VECM allows for both short-run and long-run dynamics among the variables. The short-run dynamics of the variables in a system are influenced by the deviations from the long-run equilibrium. It is represented as:

$$\Delta Z_t = \Pi Z_{t-1} + \Sigma_{i=1}^{p-1} \Gamma_i^* \Delta Z_{t-i} + \varepsilon_t \tag{7}$$

where Π and Γ^* are functions of Γ's.

$\Gamma_i = (1 - \Gamma_1 - \Gamma_2 - \ldots - \Gamma_p)$ or $\Gamma_i^* = -\Sigma_{i=j+1}^{p} \Gamma_i$, $j = 1, 2, \ldots, p-1$

$\Pi = -(1 - \Gamma_1 - \Gamma_2 - \ldots - \Gamma_p) = -\Gamma(1)$ and the characteristic polynomial is given as $I - \Gamma_1 Z - \ldots - \Gamma_p Z^p = \Gamma(Z)$.

Z_t is as defined earlier. The Π matrix contains information about the long-run relationships between the variables. It can be decomposed into $\Pi = \alpha\beta'$ where α contains the coefficients of speed of adjustment to equilibrium, β' is the long-run matrix of coefficients and $\beta' Z_{t-1}$ is the error-correction term containing up to (n–1) vectors. The rank (r) of the matrix Π indicates the number of co-integrating equations.

3.3. Data

The study uses monthly data from January, 1994 to December, 2013. The choice of study period is based on the fact that 1994 coincides with liberalization of the exchange rate system in Zambia. In addition, the use of high frequency monthly data helps to avoid problems associated with small samples and yields robust results. The analysis of structural breaks is also avoided by considering only the period after 1994. Data on all the variables was collected from the Central Bank of Zambia (BOZ).

4. EMPIRICAL RESULTS

4.1. Unit Root Tests

Using both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, stationarity of the variables is investigated. Tables 4.1 and 4.2 present the unit root test results. The ADF results show that all the variables are integrated of order one, I(1).

The PP results show that the Treasury-bill rate and real GDP growth are stationary at levels whereas all the other variables are stationary at first difference. However, graphical inspection of the series reveals that they are non-stationary at levels. Thus, it is concluded that all the series are integrated of order one.

4.2. Co-integration Analysis

Since the variables are integrated of the same order, it is necessary to test for co-integration to determine if there is a long-run equilibrium relationship among the variables. However, before conducting the co-integration test, the optimal lag length is determined using the Akaike information criterion (AIC) and Schwarz information criterion (SIC). Results show that the optimal lag length is two. At this lag length, the Johansen approach is employed to carry out co-integration analysis and the results indicate existence of co-integration among the variables. The evidence of co-integration implies that there is a long-run relationship between the variables in the system and thus, justifies the need to estimate a VECM. Both the lag length and co-integration test results are presented in the appendix.

Table 4.1
Augmented Dickey Fuller Unit Root Test Results

Variable	*ADF t-stat in Levels*	*5% Critical t-stat in Levels*	*ADF t-stat in First Difference*	*5% Critical t-stat in first difference*	*Order of Integration*
LNCPI	-1.044168	-3.428900	-9.993488	-3.428819	I(1)
LNOILP	-3.233227	-3.428819	-11.93302	-3.428819	I(1)
LNEXRATE	-1.860356	-3.428819	-10.25794	-3.428819	I(1)
LNFCPI	-1.691336	-3.429313	-9.993004	-3.429313	I(1)
LNRGDP	-3.119652	-3.430383	-18.58243	-3.430383	I(1)
LNTRATE	-2.552020	-2.873648	-7.250938	-3.429063	I(1)

Table 4.2
PP Unit Root Test Results

Variable	*ADF t-stat in Levels*	*5% Critical t-stat in Levels*	*ADF t-stat in First Difference*	*5% Critical t-stat in first difference*	*Order of Integration*
LNCPI	-1.645030	-3.428739	-9.609724	-3.428819	I(1)
LNOILP	-3.135311	-3.428739	-11.92204	-3.428819	I(1)
LNEXRATE	-1.689708	-3.428739	-10.25579	-3.428819	I(1)
LNFCPI	-1.691274	-3.428739	-8.552864	-3.428819	I(1)
LNRGDP	-5.576335	-3.429923	-18.16931	-3.430383	I(0)
LNTRATE	-3.636703	-3.428739	-11.11285	-3.428819	I(0)

4.3. Structural Vector Autoregression Estimation Results

The unrestricted VAR model in first difference is estimated first in order to obtain the residuals. The residuals are then used to estimate the SVAR model through structural factorization. The estimated SVAR results are presented in the appendix and summarised as a system of shocks below:

$$\varepsilon_{LNOILP} = 0.0773\ \mu_{LNOILP} \quad (4.1)$$
$$(0.0000)$$

$$\varepsilon_{LNRGGDP} = -0.2555\ \mu_{LNOILP} + 0.2292\ \mu_{LNRGDP} \quad (4.2)$$
$$(0.2065) \quad (0.00000)$$

$$\varepsilon_{LNTRATE} = 0.1429\ \mu_{LNOILP} - 0.0154\ \mu_{LNRGDP} + 0.1369\ \mu_{LNTRATE} \quad (4.3)$$
$$(0.2385) \quad (0.7056) \quad (0.0000)$$

$$\varepsilon_{LNEXRATE} = 0.1230\ \mu_{LNOILP} + 0.0018\mu_{LNRGDP} - 0.0204\ \mu_{LNTRATE} + 0.0336\ \mu_{LNEXRATE} \quad (4.4)$$
$$(0.0000) \quad (0.8582) \quad (0.2240) \quad (0.0000)$$

$$\varepsilon_{LNFCPI} = 0.0236\ \mu_{LNOILP} + 0.0037\ \mu_{LNRGDP} - 0.0058\ \mu_{LNTRATE} + 0.0161\ \mu_{LNEXRATE} + 0.0151\ \mu_{LNFCPI} \quad (4.5)$$
$$(0.0912) \quad (0.4154) \quad (0.4417) \quad (0.5995) \quad (0.0000)$$

$$\varepsilon_{LNCPI} = 0.0005\ \mu_{LNOILP} + 0.0017\ \mu_{LNRGDP} - 0.0032\ \mu_{LNTRATE} + 0.0483\ \mu_{LNEXRATE} + 0.5790\ \mu_{LNFCPI} + 0.0046\ \mu_{LNCPI}$$
$$(0.9096) \quad (0.2102) \quad (0.1590) \quad (0.0000) \quad (0.0000) \quad (0.0000)$$
$$(4.6)$$

The values in the parentheses denote p-values and the structural shocks coefficients, μp, represent the respective standard deviations. Of interest to this study is how the exchange rate movements affect the food price index and total consumer price index. Disaggregating the two price indices helps to assess the difference between the pass-through from the exchange rate to food prices and the general consumer prices. Thus, the main focus is on equations 4.5 and 4.6. The exchange rate coefficients in the two equations are positive implying that depreciation of the exchange rate would lead to a rise in food prices and the general price level. Therefore, there is evidence of pass-through to consumer prices from exchange rate changes in Zambia. The complete impact of exchange rate movements on food prices and the price level in general over time is derived from the accumulated impulse response functions and the dynamic pass-through elasticity. However, there is need to test for stability of the SVAR model in order to obtain efficient and consistent estimates of the impulse response functions. As shown in the appendix, the estimated SVAR satisfies the stability condition.

4.3.1. Dynamic Pass-Through Elasticity of Exchange Rate to Domestic Prices

The dynamic pass-through elasticity provides the impact of exchange rate changes on domestic prices over time and is calculated as:

$$PT_t = \frac{\%\Delta FCPI_t}{\%\Delta EXRATE_t} = \frac{\Delta LNFCPI_t}{\Delta LNEXRATE_t} \text{ and}$$

$$PT_t = \frac{\%\Delta CPI_t}{\%\Delta EXRATE_t} = \frac{\Delta LNCPI_t}{\Delta LNEXRATE_t} \quad (4.7)$$

for food price index and consumer price index respectively, where 'PT_t' is the dynamic pass-through elasticity from period 0 to *t*, '$\%\Delta CPI_t$' is the percentage change in the food price index between period 0 and t, '$\%\Delta CPI_t$' is the percentage change in the consumer price index between period 0 and t, and '$\%\Delta EXRATE_t$' is the percentage change in the exchange rate between period 0 and t. The percentage change in the exchange rate is represented by a structural one standard deviation shock given by the SVAR estimate in equation 4.4. Table 4.3

presents the accumulated impulse response estimates of domestic prices to exchange rate shocks and their respective dynamic pass-through elasticities.

Exchange Rate Pass-Through to Food Price Index

Column 2 shows that a one standard deviation shock (i.e. 0.0336) to the exchange rate leads to an increase in the food price index by about 0.000542 after the first month. This is equal to a dynamic pass-through elasticity of 0.0161%. After the second month, food prices increase by about 0.000646 due to depreciation of the kwacha, representing a dynamic pass-through elasticity of 0.0192%. The food prices continue to increase until after the sixth month when the maximum impact of depreciation is realized with a dynamic pass-through elasticity of 0.1862%.

Thereafter, the food prices increase at a decreasing rate representing a slight decline in the exchange rate pass-through to food prices. After the tenth month, the full impact of a one standard deviation shock to the exchange rate on food prices is realized. This implies that it takes a maximum of about ten months for economic agents to fully adjust food prices upwards following an unexpected shock (depreciation) to the exchange rate. This is because economic agents do not adjust prices at once due to a number of reasons such as contractual obligations and costs associated with price adjustment. Thus, the results show that after 10 months, the food price level will increase by approximately 0.17% of the margin of the depreciation in the exchange rate indicating partial and low pass-through to food prices.

Exchange Rate Pass-Through to Consumer Price Index

Column 3 shows that a one standard deviation shock to the exchange rate results in an increase in the consumer price index by about 0.001312, which is equal to a dynamic pass-through elasticity of 0.03905% after the first month. This pass-through elasticity is incomplete but significant. After the second month, CPI increases by about 0.002897 following depreciation of the kwacha, representing a dynamic pass-through elasticity of 0.0862%. After six months, the maximum impact of a one standard deviation shock to the exchange rate on CPI is realized with a dynamic pass-through elasticity of 0.2545%. Thereafter, pass-through declines until after the tenth month when the complete impact of a one standard deviation shock

Table 4.3
Accumulated Impulse Responses of Domestic Prices and Dynamic Elasticity

Period	*Estimated accumulated impulse of LNFCPI to one SD shock to LNEXRATE (C2)*	*Estimated accumulated impulse of LNCPI to one SD shock to LNEXRATE (C3)*	*Estimates of one SD shock to LNEXRATE (C4)*	*Dynamic Pass-Through Elasticity of LNEXRATE to LNFCPI* (C5)=(C2)/(C4)	Dynamic Pass-Through Elasticity of LNEXRATE to LNCPI (C6)=(C3)/(C4)
M1	0.000542	0.001312	0.0336	0.01613	0.03905
M2	0.000646	0.002897	0.0336	0.01923	0.08622
M3	0.003081	0.005684	0.0336	0.09169	0.16917
M4	0.005374	0.007516	0.0336	0.15994	0.22369
M5	0.006200	0.008327	0.0336	0.18452	0.24783
M6	0.006256	0.008552	0.0336	0.18619	0.25452
M7	0.006062	0.008537	0.0336	0.18042	0.25408
M8	0.005858	0.008457	0.0336	0.17435	0.25169
M9	0.005704	0.008377	0.0336	0.16976	0.24932
M10	0.005605	0.008318	0.0336	0.16682	0.24756

Notes: The estimates of one SD shocks to the exchange rate are given by the SVAR coefficient as shown in equation (5.4). The estimates of the impulse of FCPI and CPI are then divided by the SD shocks to estimate the dynamic pass-through elasticity based on equation (5.7) to the exchange rate on the consumer price index is realized. After the 10th month, a 0.0336 depreciation of the kwacha leads to an increase in the price level by about 0.008318 which is equivalent to a dynamic pass-through elasticity of 0.24756%. Thus, after 10 months, the domestic price level will increase by about 0.25% of the margin of the depreciation in the exchange rate.

Comparing the pass-through to food prices and the consumer price index, it can be noted that the pass-through to the total consumer price is larger than that to food prices. This implies that the consumer price index consists of both the food price index and the non-food price index components. Thus, exchange rate pass-through to the general price level is a cumulative value comprising of pass-through to food prices plus pass-through to non-food prices. Hence, pass-through to general inflation can be expected to be larger than that to food inflation.

The results indicate that the exchange rate pass-through to consumer prices in Zambia is significant. This implies that a proportionate depreciation of the Kwacha will lead to a less than proportionate increase in the price level. Evidence of exchange rate pass-through in Zambia can be attributed to the continuous depreciation of the Kwacha during the period under study. A continuous depreciation in the exchange rate causes economic agents to increase their expectations of further depreciation. Consequently, the agents adjust the prices upwards. However, the magnitude of pass-through is low implying that continuous depreciation of the Kwacha only increases the price level by a small magnitude. Thus, the general domestic price level can remain stable despite a continuous depreciation of the kwacha. Significance of the exchange rate pass-through implies that exchange rate depreciation is an important cause of variations in the price level in Zambia. A summary of the dynamic exchange rate pass-through is illustrated in Figure 4.1 and it shows that although the exchange rate pass-through is low, it is persistent.

4.4. Impulse Response Function Analysis

The structural decomposition is used to estimate the impulse response functions for consumer price index and food price index. Figure 4.2 and 4.3 present the impulse response function of consumer price index to the following shocks: Shock 1 (oil price), shock 2 (real GDP growth), shock 3 (treasury-bill rate), shock 4 (exchange rate shock), shock 5 (food price index shock and shock 6 (own shock).

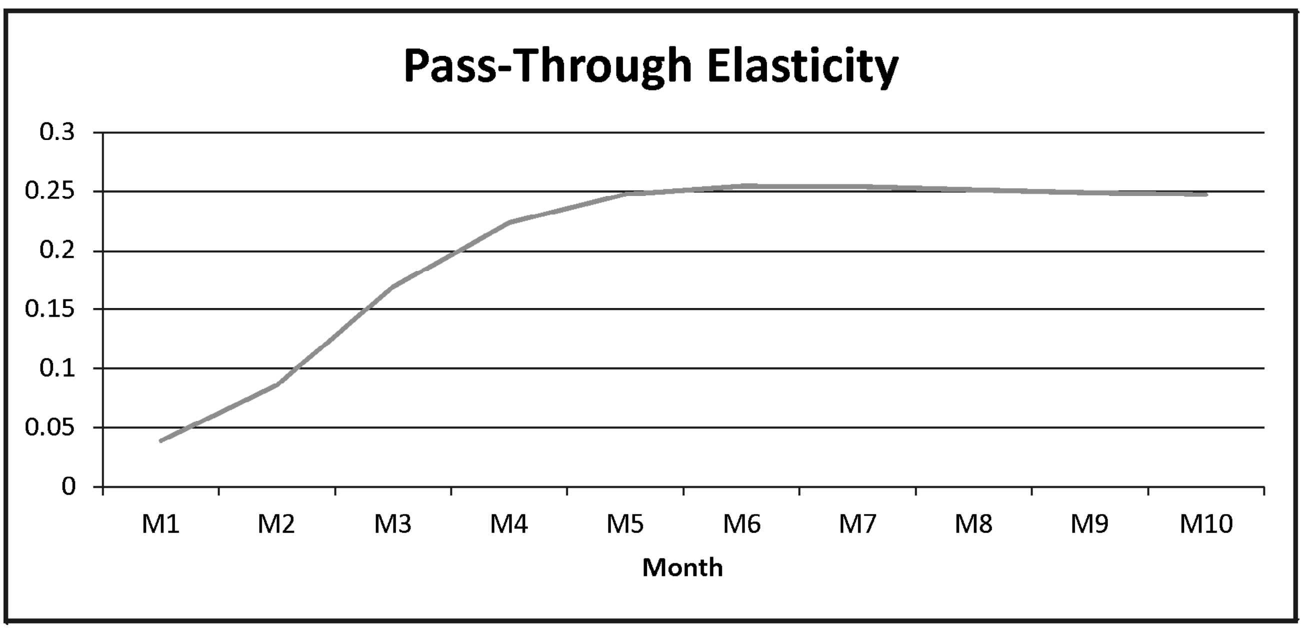

Figure 4.1: Dynamic Exchange Rate Pass-Through to Consumer Prices

Source: Author's own computation

Responsiveness of CPI

Figure 4.2 shows that an unexpected depreciation of the exchange rate (shock 4) will lead to an increase in the consumer price index by a small magnitude after the first period suggesting that exchange rate pass-through to the price level may not necessarily be immediate. After the second and third periods, the magnitude of the rise in the consumer price index following depreciation increases further. Thus, the effect of depreciation on the price level is not immediate. These findings are consistent with the expectations of price adjustment by firms, which depends on a number of factors such as the expected duration of the depreciation, the costs associated with adjusting prices and the demand conditions among other factors.

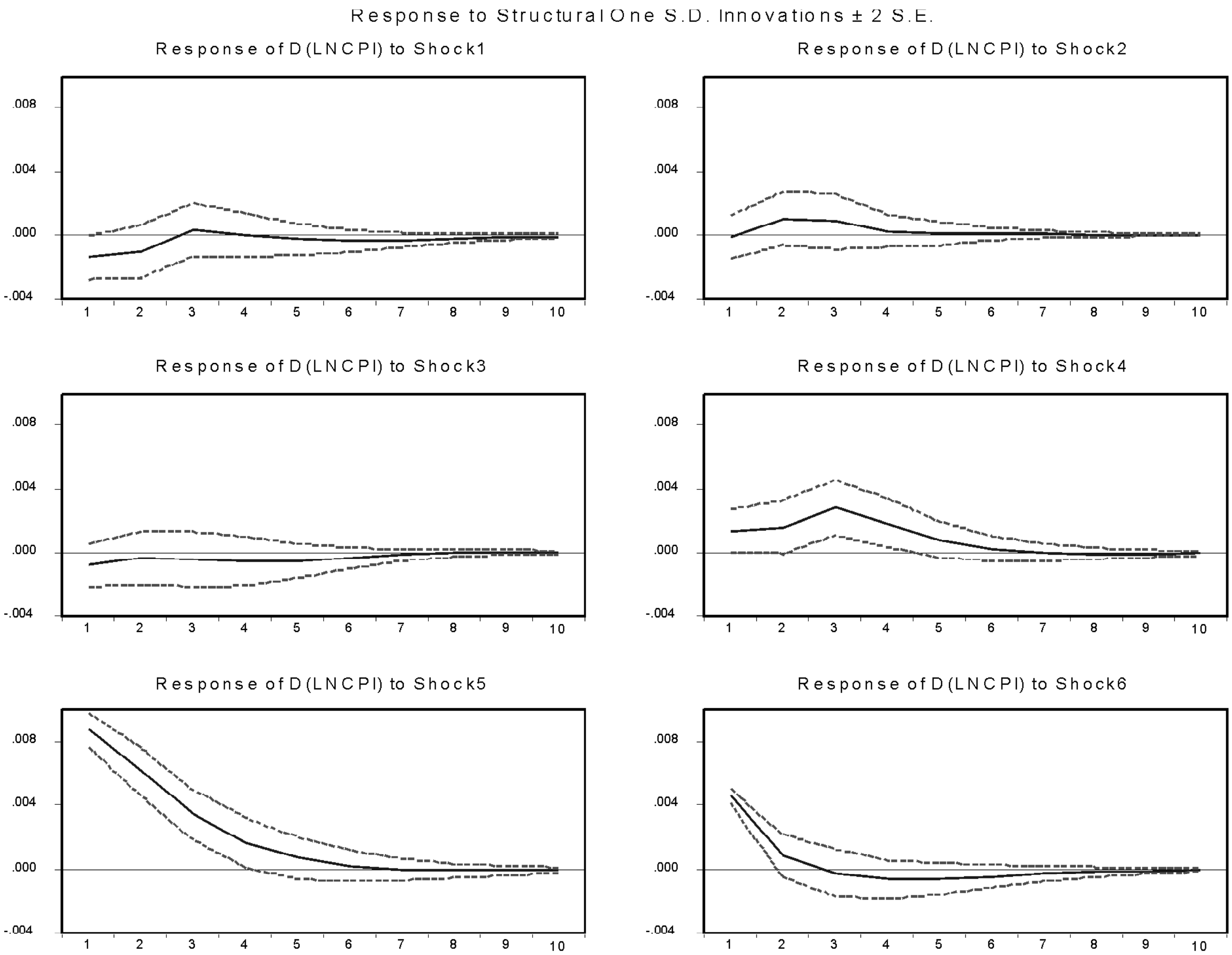

Figure 4.2: Impulse Response Function of Consumer Price Index

Responsiveness of Food Price Index

Figure 4.3 shows the positive effect of exchange rate shock (shock 4) on the food price index with depreciation resulting in an increase in food prices within the first month. The immediate food price adjustment resulting from depreciation can be attributed to the food demand conditions. Food demand is inelastic implying that changes in the food prices do not affect the demand for food. Therefore, exchange rate depreciation leads to an immediate upward adjustment in food prices by economic agents.

4.5. Variance Decomposition Analysis

The variance decomposition shows the relative importance of each shock in explaining the variation for

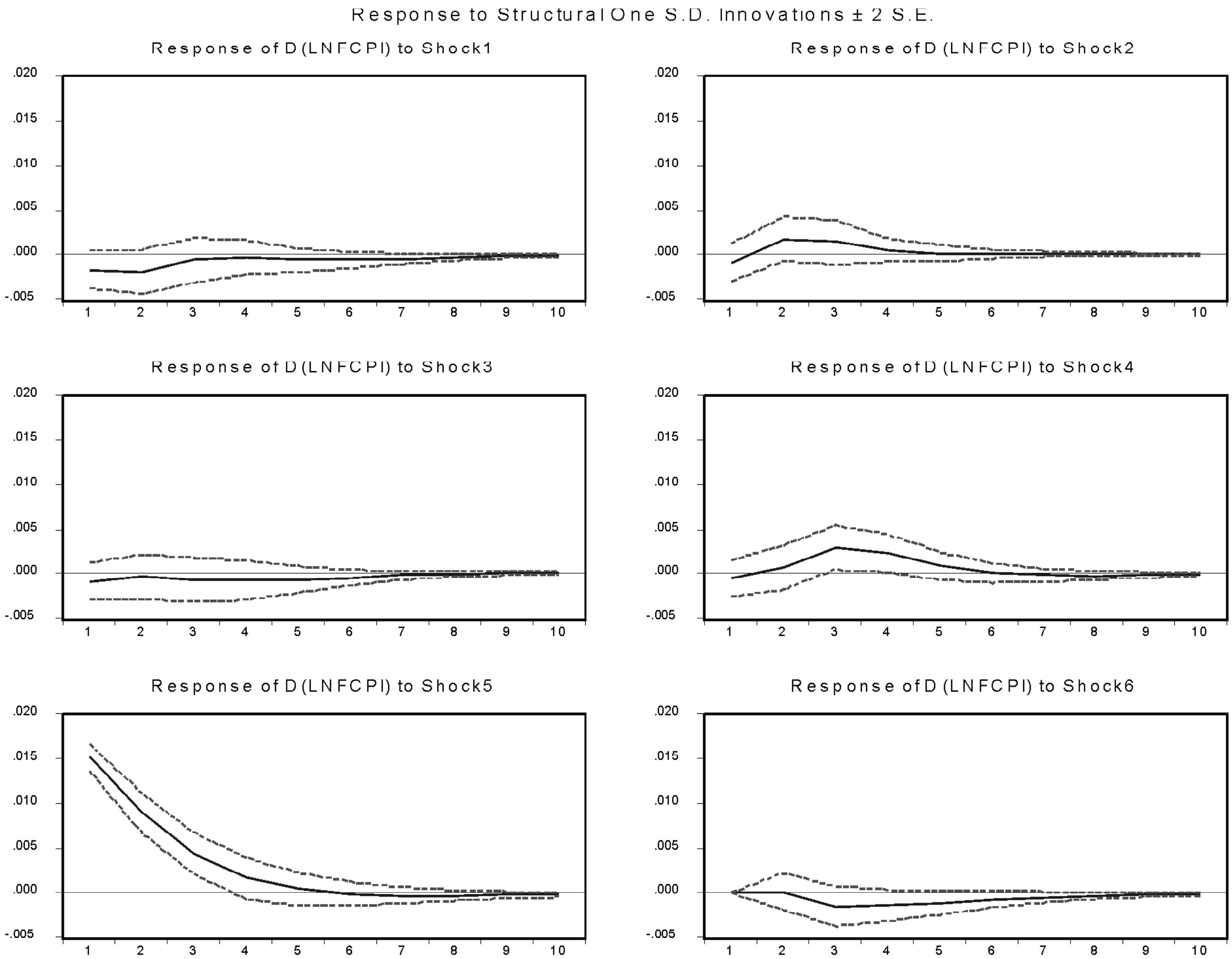

Figure 4.3: Impulse Response Function of Food Price Index

each of the variables under discussion: Consumer price index and its breakdown into the category of food prices. The results show that the exchange rate shock accounts for a relatively moderate share of variations in the general price level. However, changes in the food price index are largely influenced by its own shocks whereas shocks to the exchange rate accounts for only a small proportion. This is because food prices are likely to adjust more to factors such as adverse weather conditions than to changes in the exchange rate.

4.6. Vector Error Correction Model (VECM) Estimation Results

Having found co-integration between the variables, a Vector Error Correction Model is estimated to determine both the short-run and long-run dynamics of the system. This helps to evaluate the adjustment process of the domestic price level to its long-run equilibrium. Table 4.4 presents the estimated VECM results.

The diagnostic tests show that the model is a fairly good fit and thus, the estimates are unbiased, efficient and consistent. The estimated vector error correction terms are negative and significant implying that when there is disequilibrium in the consumer price index caused by changes in one of the variables in the system, it will adjust to equilibrium in the long-run. Furthermore, the vector error correction term coefficients give the speed of adjustment.

The results show that in the long run, the domestic price level in Zambia significantly depends on real GDP

Table 4.4
Vector Error Correction Model Estimation Results

Variable	*Coefficient*		*Probability*
INTERCEPT	0.013648***	(9.383580)	0.0000
D(LNOILP(-1))	-0.004123	(-0.451517)	0.6521
D(LNOILP(-2))	0.016754**	(2.410654)	0.0168
D(LNRGDP(-1))	0.211417**	(0.350686)	0.0214
D(LNRGDP(-2))	0.253898	(0.459862)	0.6461
D(LNTRATE(-1))	-0.000305	(-0.096923)	0.9229
D(LNTRATE(-2))	-0.002459	(0.511490)	0.6096
D(LNEXRATE(-1))	0.036846*	(1.828552)	0.0689
D(LNEXRATE(-2))	0.045476**	(2.116642)	0.0355
D(LNFCPI(-1))	0.461596***	(4.311852)	0.0000
D(LNFCPI(-2))	0.275087***	(2.808723)	0.0055
D(LNCPI(-1))	-0.198651	(-1.150303)	0.2514
D(LNCPI(-2))	-0.537979***	(-4.585035)	0.0000
VECT (-1)	-0.003673***	(-5.135390)	0.0000
VECT(-2)	-0.007145***	(-5.837192)	0.0000

R-Squared: 0.5375; Adjusted R-Squared: 0.5059; F-statistic: 17.0215[0.0000]; DW Statistic: 1.9931
Notes
****denotes significance at 1%, **significance at 5% and *significance at 10%*
() - t statistics
[] - probability value
Diagnostic Tests

LM Test for Serial Correlation	*: LM Stat = 41.19426 [0.2538]*
White Test for Heteroscedasticity	*: Chi-square = 148.5820 [0.2995]*
Residual Normality Test	*: Chi-square = 97.95249*

growth, oil prices, nominal exchange rate, food price index, its own past values and the vector error correction term. The estimated coefficients of these variables represent short-run elasticities of inflation with respect to each of the variables. Any change in one of the variables creates a discrepancy between the short-term and long-term price level. This discrepancy is then corrected by the error correction term to restore long equilibrium in the consumer price index. Real GDP growth, oil price, exchange rate and food prices have a positive long-run impact on the Zambian consumer price index. This means that an increase in these variables in the short-run requires the price level to increase in order for long-run equilibrium to be attained.

The coefficients of the exchange rate represent the long-run pass-through elasticities to the domestic price level. Like the results from the structural VAR model, the VECM results also provide evidence of exchange rate pass-through to domestic prices and show that depreciation of the exchange rate leads to an increase in the price level. Since the VECTs are significant, the discrepancy between the short-term and long-term price level induced by 10% depreciation of the kwacha will require an upward price level adjustment of approximately 0.37% within the second month and 0.45% within the third month to restore long-run equilibrium. Of this discrepancy, only about 0.003673% is corrected within two months and about 0.007145% is corrected within three months. Thus, the speed of adjustment of inflation to its long-run equilibrium following depreciation of the kwacha is quite slow.

5. CONCLUSION, POLICY IMPLICATIONS AND RECOMMENDATIONS

5.1. Conclusions

This study has empirically examined the responsiveness of consumer prices to nominal exchange rate movements in Zambia using the SVAR and VEC models. The exchange rate pass-through to both food prices and the general price level was found to be partial and low but significant. Thus, depreciation of the Kwacha only leads to a rise in consumer prices by a small magnitude. For instance, the complete impact of a shock to the exchange rate on the consumer price index is attained after the tenth month and equivalent to a dynamic pass-through elasticity of approximately 0.25%. However, the impact of exchange rate shocks on domestic prices is persistent in the Long-run. Thus, depreciation is an important cause of inflation in Zambia. In addition, it was found that domestic price adjustment to changes in the exchange rate is not immediate. It takes about one month for the prices to increase following depreciation of the Kwacha.

Furthermore, the results reveal that food prices are adjusted earlier than non-food prices following depreciation. This is attributed to the inelastic demand for food. The variance decomposition analysis showed that exchange rate depreciation accounts for a larger proportion of the rise in food prices and the general price level than does real GDP growth and oil prices. However, the largest proportion of the rise in food prices was accounted for by the past food price shocks implying that other factors such as adverse weather conditions and demand are responsible for changes in food prices.

5.2. Policy Implications and Recommendations

The findings of this study imply that, despite its importance in achieving the required external balance, the flexible exchange rate system can endanger the central bank's goal of achieving price stability if there are large exchange rate movements. Therefore, policies that aim at achieving price stability should not only focus on monetary stability but also on exchange rate stability. Thus, the monetary authorities should continue intervening in the foreign exchange market to minimize exchange rate volatility whilst taking into account the general macroeconomic environment. For instance, efforts should be directed towards generating investment in the industrial sector in order to increase productivity. Increased output from this sector would increase export earnings and the increased inflow of foreign currency would eliminate excess demand in the foreign exchange market. This will contribute to domestic currency stability.

With regard to food prices, given that a large proportion of change in food prices is caused by shocks to the lagged food prices, there is need for the government to invest in capital goods and technology that would improve production efficiency in the agriculture sector. Improved production efficiency can improve the quality and quantity of local production of food products. Increased local food products would increase food supply and eliminate structural bottlenecks that sustain food inflationary pressures.

Furthermore, it should be noted that the Zambian financial sector is still underdeveloped with foreign exchange market participants having little or no access to hedging facilities. Thus, there is need to implement policies that aim at financial sector development. This would increase access to hedging facilities and help economic agents to cushion against exchange rate fluctuations effects. In turn, the exchange rate pass-through to consumer prices would be further reduced and price stability would be achieved.

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APPENDIX

Appendix 1: Lag Length Selection Criteria

Lag	*AIC*	*SIC*
0	-0.799256	-0.696718
1	-20.10235	-19.38459
2	-20.77585*	-19.44286*
3	-20.68379	-18.73557
4	-20.56315	-17.99971
5	-20.41189	-17.23322
6	-20.28905	-16.49515
7	-20.27101	-15.86189
8	-20.33933	-15.31499

** denotes lag order selected by the criterion*

Appendix 2: Johansen Co-integration Test Results

Null hypothesis	*Alternative hypothesis*	*Trace Test*		*Maximum Eigenvalue Test*		
		Statistic	*Critical value*	*Alternative hypothesis*	*Statistic*	*Critical value*
r = 0	r = 1	137.5359**	95.75366	r ≥ 1	62.27279**	40.07757
r ≤ 1	r = 2	75.26315**	69.81889	r ≥ 2	33.76347	33.87687
r ≤ 2	r = 3	41.49968	47.85613	r ≥ 3	21.81587	27.58434
r ≤ 3	r = 4	19.68381	29.79707	r ≥ 4	12.78082	21.13162
r ≤ 4	r = 5	6.902986	15.49471	r ≥ 5	4.104245	14.26460
r ≤ 5	r = 6	2.798741	3.841466	r = 6	2.798741	3.841466

Note: r is the number of co-integrating equations
Critical values are all at 5% level of significance
**denotes significance at 5% level of significance

Appendix 3: SVAR Estimation Results

Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I

Restriction Type: short-run pattern matrix

A =

1	0	0	0	0	0
C(1)	1	0	0	0	0
C(2)	C(6)	1	0	0	0
C(3)	C(7)	C(10)	1	0	0
C(4)	C(8)	C(11)	C(13)	1	0
C(5)	C(9)	C(12)	C(14)	C(15)	1

B =

C(16)	0	0	0	0	0
0	C(17)	0	0	0	0
0	0	C(18)	0	0	0
0	0	0	C(19)	0	0
0	0	0	0	C(20)	0
0	0	0	0	0	C(21)

	Coefficient	*Std. Error*	*z-Statistic*	*Prob.*
C(1)	-0.255513	0.202269	-1.263236	0.2065
C(2)	0.142936	0.121258	1.178775	0.2385
C(3)	0.123015***	0.029889	4.115715	0.0000
C(4)	0.023595*	0.013968	1.689257	0.0912
C(5)	0.000483	0.004253	0.113569	0.9096
C(6)	-0.015388	0.040734	-0.377775	0.7056
C(7)	0.001789	0.010012	0.178701	0.8582
C(8)	0.003669	0.004505	0.814383	0.4154
C(9)	0.001710	0.001365	1.252948	0.2102
C(10)	-0.020374	0.016757	-1.215860	0.2240
C(11)	- 0.005820	0.007565	-0.769299	0.4417
C(12)	-0.003227	0.002291	-1.408360	0.1590
C(13)	0.016115	0.030685	0.525189	0.5995
C(14)	0.048341***	0.009287	5.205139	0.0000
C(15)	0.579045***	0.020628	28.07034	0.0000
C(16)	0.077281***	0.003727	20.73644	0.0000
C(17)	0.229204***	0.011053	20.73644	0.0000
C(18)	0.136898***	0.006602	20.73644	0.0000
C(19)	0.033636***	0.001622	20.73644	0.0000
C(20)	0.015134***	0.000730	20.73644	0.0000
C(21)	0.004577***	0.000221	20.73644	0.0000

Log likelihood 2252.757
*denotes significance at 1%, **significance at 5% and * significance at 10%

Stability Test

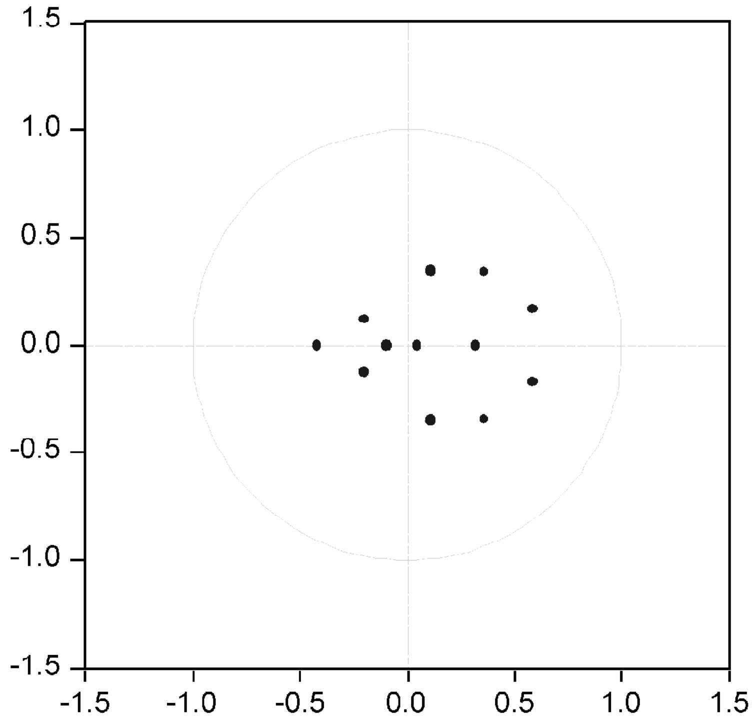
The stability test is conducted in order to check whether the estimated SVAR model is well-specified and stationary. If it is well-specified, then the impulse response functions must converge to zero with time after a shock to the system. This would imply that the SVAR model is stable or stationary. To test for stability, the AR Roots Table and AR Roots Graph are used. The AR Roots Table is used to check if all the inverse roots of the characteristic AR polynomial have absolute modulus values less than unity. The AR Roots Graph checks if all the roots of a characteristic polynomial lie within the unit circle. If all roots have absolute values less than unity and lie within the unit circle, then the VAR model is stable. This implies that, any unexpected shock to the system will lead to changes in the variables, but after sometime, the variables will converge to zero or move back to equilibrium. There should be (number of variables) x (number of model lags) roots visible on the graph.

Appendix 4: AR Roots Table

Root	*Modulus*
0.581146 - 0.170867i	0.605745
0.581146 + 0.170867i	0.605745
0.355651 - 0.343428i	0.494399
0.355651 + 0.343428i	0.494399
-0.423098	0.423098
0.108737 - 0.348406i	0.364980
0.108737 + 0.348406i	0.364980
0.318711	0.318711
-0.202073 - 0.121840i	0.235962
-0.202073 + 0.121840i	0.235962
-0.095150	0.095150
0.043403	0.043403

Appendix 5: AR Roots Graph

Inverse Roots of AR Characteristic Polynomial



Appendix 1 shows that all the roots of the characteristic polynomial have absolute values less than unity and Appendix 5 indicates that no root lies outside the unit circle. Thus, the estimated SVAR model satisfies the stability condition.

Appendix 6: Consumer Price Index Equation Estimation Results

Variable	*Coefficient*		*Probability*
D(LNOILP RES(-1))	0.001092	(0.114995)	0.9086
D(LNOILP RES(-2))	0.019723**	(2.112957)	0.0358
D(LNRGDP RES(-1))	0.005763*	(1.931516)	0.0548
D(LNRGDP RES(-2))	0.002521	(0.856197)	0.3929
D(LNTRATE RES(-1))	-0.001620	(-0.321180)	0.7484
D(LNTRATE RES(-2))	-0.001038	(-0.205274)	0.8376
D(LNEXRATE RES(-1))	0.048453**	(2.217488)	0.0277
D(LNEXRATE RES(-2))	0.048386**	(2.106969)	0.0363
D(LNFCPI RES(-1))	0.314401***	(3.268931)	0.0013
D(LNFCPI RES(-2))	0.047519	(0.485875)	0.6276
D(LNCPI RES(-1))	0.173121	(1.181987)	0.2386
D(LNCPI RES(-2))	-0.118123	(-0.837077)	0.4035
INTERCEPT	0.007317***	(5.877769)	0.0000

R-Squared: 0.6329; Adjusted R-Squared: 0.5417; F-Statistic: 6.7152 [0.000]

Appendix 7: Food Consumer Price Index Equation Estimation Results

Variable	*Coefficient*		*Probability.*
D(LNOILP RES(-1))	-0.010041	(-0.698207)	0.4858
D(LNOILP RES(-2))	0.013245*	(0.936557)	0.0780
D(LNRGDP RES(-1))	0.009234**	(2.042630)	0.0424
D(LNRGDP RES(-2))	0.004015	(0.900206)	0.3691
D(LNTRATE RES(-1))	-0.000280	(-0.036687)	0.9708
D(LNTRATE RES(-2))	-0.004167	(-0.543904)	0.5871
D(LNEXRATE RES(-1))	0.033390	(1.008654)	0.3143
D(LNEXRATE RES(-2))	0.063796*	(1.833621)	0.0681
D(LNFCPI RES(-1))	0.603532***	(4.141917)	0.0001
D(LNFCPI RES(-2))	0.159943	(1.079458)	0.2816
INTERCEPT	0.007411	(3.929750)	0.0001

R-Squared: 0.5726; Adjusted R-Squared: 0.4390; F-Stat: 6.08799 [0.0000]

Notes:

*** denotes significance at 1%, **significance at 5% and *significance at 10%

() - t statistics

[] - probability value

'RES' denotes residual

VAR Diagnostic Tests

LM Test for Serial Correlation : LM Stat = 51.30658 [0.4528]

White Test for Heteroscedasticity : Chi-Square = 95.2275 [0.3329]

VAR Residual Normality Test : Chi-Square = 77.04676[0.0000]

Appendix 8: Variance Decomposition of Consumer Price Index

Period	*S.E.*	*Oil Price Shock*	*Real GDP Growth Shock*	*Treasury-bill Rate Shock*	*Exchange Rate Shock*	*Food Price Index Shock*	*Consumer Price Index Shock*
1	0.077281	1.950596	0.016924	0.617924	1.686151	75.20721	20.52120
2	0.081207	2.084148	0.789467	0.513348	2.908649	78.80440	14.89998
3	0.082077	1.888498	1.132291	0.556223	7.214551	76.13642	13.07202
4	0.082326	1.812090	1.127573	0.711990	8.860794	74.70047	12.78708
5	0.082438	1.838532	1.120193	0.870845	9.139073	74.17421	12.85714
6	0.082486	1.907366	1.119166	0.949109	9.138569	73.96280	12.92299
7	0.082504	1.954390	1.120019	0.968008	9.127967	73.87608	12.95354
8	0.082511	1.974825	1.120635	0.969387	9.127181	73.84375	12.96422
9	0.082513	1.981681	1.120798	0.969188	9.128810	73.83246	12.96706
10	0.082514	1.983530	1.120785	0.969370	9.129967	73.82889	12.96745

Appendix 9: Variance Decomposition of Food Price Index

Period	*S.E.*	*Oil Price Shock*	*Real GDP Growth Shock*	*Treasury-bill Rate Shock*	*Exchange Rate Shock*	*Food Price Index Shock*	*Consumer Price Index Shock*
1	0.077281	1.202717	0.313671	0.303295	0.125794	98.05452	0.000000
2	0.081207	2.025049	1.192161	0.259413	0.238947	96.27486	0.009574
3	0.082077	1.938494	1.634953	0.379884	2.650641	92.77466	0.621370
4	0.082326	1.904877	1.654136	0.521635	4.015045	90.78051	1.123797
5	0.082438	1.994713	1.646164	0.633723	4.168656	90.11006	1.446681
6	0.082486	2.093702	1.642831	0.681383	4.157610	89.85385	1.570621
7	0.082504	2.147878	1.642164	0.689136	4.162143	89.74549	1.613191
8	0.082511	2.166821	1.641942	0.688820	4.170914	89.70597	1.625536
9	0.082513	2.171802	1.641757	0.689195	4.176236	89.69231	1.628700
10	0.082514	2.172753	1.641624	0.689865	4.178481	89.68800	1.629277