

Exchange Rate Passthrough to Sectoral Prices: Evidence from Zambia

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Abstract
The objective of the study was to examine the exchange rate pass through (ERPT) to sectoral prices in Zambia. We look at the agriculture, manufacturing and services sectors. For analysis, we use the SVAR model with annual data from 1983 to 2017. The results from the study showed that the ERPT is less than complete in the three sectors but highest in the services sector followed by manufacturing and agriculture sectors respectively. High ERPT in the services sector might be because the services sector is dominated by final consumer services such as wholesale and retail trade, transportation and tourism industry which might be sensitive to exchange rate movements. High ERPT in the manufacturing sector could be because most of the raw materials that are used in the manufacturing sector are imported. Lower ERPT in the agriculture sector might suggest that items in this sector are less sensitive to exchange rate movements.
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1. Introduction

The plethora of literature on the exchange rate pass through (ERPT) have tended to concentrate on the effects of exchange rate fluctuations on domestic consumer prices. There is scanty empirical literature on the ERPT to sectoral prices. This is especially so in Africa and many developing countries. This compels us to study the ERPT to economic sectors in Zambia. This is important because exchange rate movements do affect firm decisions, production and expectations. As Castro and Nino (2018) put it, firms in various economic sectors pay attention to how exchange rate shocks affect the local price of imported inputs, production cost and expectations about future pricing behavior. For instance, an exchange rate appreciation can lead to an increase in the price of inputs. This is likely to affect production, pricing decisions and future prices at firm level in the various economic sectors (Hahn, 2007; Castro & Nino, 2018). However, Due to structural differences across sectors such as the degree of trade openness, product differentiation, competition and the degree of responsiveness of demand to price, various sectors may be affected differently by exchange rate shocks (Hahn, 2007).

Zambia posits as a good case to study the ERPT to sectoral prices. This is because, the Zambian economy has undergone rapid depreciation of the Zambian Kwacha over the past decades. Cheelo and Banda (2019) estimate that between 2008 and 2015, the Zambian Kwacha depreciated by 108% cumulatively against the US Dollar. They show that the Kwacha fell by 51% against the US Dollar and 31.1% against the South Africa Rand in 2015 alone. Chipili (2021) shows that the Zambian Kwacha has continued to depreciate against major currencies such as the US Dollar and this has been accompanied by increases in inflation. Chipili (2021) shows that inflation increased from 7.9% in June 2014 to 14.5% and 22% in October 2015 and February 2016 respectively. It might be thought-provoking to study how sectoral prices in Zambia respond to exchange rate movements.

It is also important to realize that since the First National Development Plan (1966-1970), policy makers in Zambia have been urging for the diversification of exports away from the mining to other sectors. They have identified five sectors to be the key drivers of the diversification strategy (Phiri et al, 2020; Kaunda & Zulu, 2020). These sectors are mining, energy, agriculture, tourism, and manufacturing (Phiri et al, 2020; Kaunda &

Zulu, 2020). It will therefore, be important to see how these sectors are affected by shocks in exchange rate movements. This paper therefore, focuses on the agriculture, manufacturing and services sectors because of their long-term potential for export diversification and growth. This is especially important given the fact that the mining industry is based on minerals which are exhaustible assets. This study contributes to the existing literature on ERPT by examining the ERPT to these three key sectors in Zambia. The study does not include the energy sector and looks at the total services rather than merely tourism sector because of data unavailability.

This study, is very important to the Zambian economy and developing economies. This is because examining the ERPT to various sectors in an economy is critical to the understating of how exchange rate shocks spill over to the rest of the economy. Such findings could be of great help to the design of sector specific monetary, exchange rate and fiscal policies. It will also help policy makers respond quickly to international shocks and design policies aimed at cushioning the effects of external shocks. In addition, studies on the ERPT to sectoral prices are scanty. Therefore, by studying the ERPT to sectoral prices, the study contributes to the less explored realm of ERPT. Furthermore, most of the studies on the ERPT to sectoral prices use single equation models which do not account for endogeneity. Our study contributes to literature by using the SVAR which accounts for endogeneity.

2. Literature Review

Available empirical evidence shows that sectors of the economy are affected differently by exchange rate shocks. For instance, Hahn (2007) used the SVAR framework to investigate the effects of exchange rate shocks on sectoral activity and prices in the Euro area. He found substantial differences in the impact of exchange rate shocks on sectoral activity and prices. The findings showed that exchange rate shocks had more impact in the manufacturing than the trade and transport services sectors. Knetter (1993) studied the pricing behavior of the exporting firms across industries in the UK, USA and Japan. The findings showed that there is a great variation in the ERPT to industry prices across industries. Campa et al. (2005) investigated the differential impact of the ERPT to sectoral prices of nine sectors in the Euro area. They found not only incomplete ERPT but also that different sectors are affected differently by exchange rate movements.

Parsely (2012) examined the ERPT across different categories of imported final goods for South Africa. He found that the ERPT across the different goods differed depending on the source country. Solorzano (2017) investigated the effect of exchange rate fluctuations on the prices of the final goods and services in Mexico. In the study, he focused on whether or not the contrasting ERPT is associated with region and product specific characteristics. The findings showed that the ERPT to prices is not only incomplete but also differs across regions and industries. Solorzano (2017) sighted a number of region and product specific characteristics responsible for the differential ERPT across regions and products. These are demand conditions, the level of economic development and distance to the U.S. border, import intensity, price change dispersion and expenditure share.

Osbat, et al. (2021) examined the sectoral exchange rate pass through in the Euro area. Their findings showed that the magnitude or size of the exchange rate pass through is heterogeneous across sectors. Their study also applied various model specifications, including import penetration, market integration, competition and value chain integration. Their findings showed that higher concentration and higher backward integration in global chain decrease exchange rate pass through. Casas (2019) on the other hand, analysed the relationship between exchange rate pass through into export and import prices and volumes and use of imported inputs in production across industries using the microdata of Columbia. Casas (2019) findings showed that the manufacturing industries differ significantly in their use of imported inputs and in the estimated exchange rate pass through.

In the study on the sectoral exchange rate pass through to disaggregated import prices, Ben Cheikh and Rault (2017), found that the degree of the exchange rate pass through for more homogeneous goods and commodities, such as oil and raw materials is higher than that for highly differentiated manufactured products, such as machinery and transport equipment. Their results also confirmed that cross country differences in the exchange rate pass through may be due to divergences in the product composition.

Feenstra (1989), examined the symmetric pass through of tariffs and exchange rate on U.S prices of Japanese cars, trucks and motor cycles under imperfect competition. The study tested whether the long run pass through of tariffs and exchange rates are identical. The finding in this study showed that the exchange rate pass through relation varies across products, ranging from 0.6 for trucks to unity for motorcycles.

Campa and Minguez (2006) studied the differences in the exchange rate pass through across commodities and countries in the Euro Area. They found exchange rate pass through to be unequal and incomplete across commodities and countries in the short run. They attributed this result to market structure, international market segmentation, non-homogeneity of products, trade openness, currency of trade invoicing and inflation.

3. Methodology

To model the ERPT to sectoral prices, we abstract the ERPT equation from the pricing to market model advanced by Marston (1990). It can be expressed in log form and first difference as follows;

$$\Delta SPRICE_t = \beta + \gamma \Delta LNEXR_t + \rho \Delta LNOIL_t + \pi \Delta LNGAP_t + Dume + \mu \quad (1)$$

Where SPRICE is the log of sectoral price index in each sector. *LNEXR* is the log of nominal exchange rate; *LNOIL* is the log of US Dollar price of crude oil. It is a proxy for foreign marginal cost. *LNGAP* is output gap which is the proxy for demand pressure. The last term μ is the error term. Parameters β, γ, ρ and π are coefficients to be estimated. γ measures the ERPT to sectoral prices. The variable *Dume* is an interactive dummy variable of exchange rate. It accounts for exchange rate liberalization that occurred in 1994. It is constructed by interacting exchange rate with the time dummy variable. The time dummy variable takes the value of one for the period after 1994 and the value of zero before 1994.

3.1 Econometric Model: Structural Vector Autoregressive (SVAR) Model

We applied the SVAR to model the ERPT to domestic sectoral prices in Zambia. The SVAR can be expressed as follows;

$$AX_t = \mathrm{A}_0 + \sum_{i=1}^{P-1} \mathrm{A}_1 X_{t-1} + \mathrm{B}\varepsilon_t \quad (2)$$

Where A is n x n matrix of coefficients for X_t variables. A_0 is n x 1 vector of constants. X_{t-1} is n x 1 column vector of lagged endogenous variables. A_1 to A_p is n x n matrix of coefficients of the endogenous variables (X_{t-1}). p denotes the optimal lag length while ε_t is a n x 1 vector of uncorrelated structural shocks corresponding to each X variable. B is a matrix of coefficients that captures the effect of some ε_t on some X variables. The matrix of B has variance-covariance matrix expressed as $E(\varepsilon_t, \varepsilon_t') = \Sigma_{\varepsilon}$.

The SVAR model expressed in equation 2 is not directly observable. To estimate the true values of A and B, one has to estimate the reduced form VAR. We obtain the reduced form VAR, by pre-multiplying equation 2 by A^{-1}. The reduced form VAR is expressed in equation (3) as follows;

$$\mathrm{X}_t = \Gamma_0 + \sum_{i=1}^{P-1} \Gamma_1 \mathrm{X}_{t-1} + e_t \quad (3)$$

Where $\Gamma_0 = A^{-1}\mathrm{A}_0$, $\Gamma_1 = A^{-1}\mathrm{A}_1$; $\Gamma_2 = A^{-1}\mathrm{A}_2$; ,.., ; $\Gamma_p = A^{-1}\mathrm{A}_p$; $e_t = A^{-1}\mathrm{B}\varepsilon_t$. e_t is a n x 1 vector of white noise errors. It is assumed that e_t has a zero mean and constant covariance variance matrix expressed as $E(e_t, e_t') = \Sigma_e$. The white noise errors ($e_t = A^{-1}\mathrm{B}\varepsilon_t$) relates the structural shocks (ε_t) and the reduced form residuals (e_t). To recover the structural shocks from the reduced form VAR, we use the white noise errors (ε_t). However, we have to impose restrictions on matrices A and B. This is called the AB model following Amisano and Giannini, (1997). The A and B are n x n matrices. Therefore, $2n^2$ elements can be identified in A and B. Thus, to identify elements in A and B, at least $2n^2 - n(n+1)/2$ restrictions have to be imposed. Following Amisano and Giannini (1997) AB model, the identification strategy for the ERPT to domestic sectoral prices in this study can be expressed as follows;

$$\mathrm{X}_t' = LNOIL, LNGAP, LNEXR, SPRICE \quad (4)$$

Where elements in X_t' are expressed in equation (4) thereby producing the following identification structure;

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{bmatrix} \begin{bmatrix} e_t^{LNOIL} \\ e_t^{LNGAP} \\ e_t^{LNEXR} \\ e_t^{SPRICE} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ 0 & 0 & b_{33} & 0 \\ 0 & 0 & 0 & b_{44} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{LNOIL} \\ \varepsilon_t^{LNGAP} \\ \varepsilon_t^{LNEXR} \\ \varepsilon_t^{SPRICE} \end{bmatrix}$$

Where ε_t^{LNOIL}, ε_t^{LNGAP}, ε_t^{LNEXR}, ε_t^{SPRICE} are oil price, output gap (demand pressure), exchange rate and sectoral price shocks respectively.

The AB identification strategy displayed in matrix form above is equivalent to Cholesky decomposition scheme ($X_t' = LNOIL, LNGAP, LNEXR, SPRICE$). It produces a system of shocks. The economic intuition behind the Cholesky decomposition is that the variable that is ordered earlier is more exogenous than the variables that come later (Guillermo et al, 2014). Therefore, oil price (*LNOIL*) contemporaneously affects all variables in the model but is not affected by any. Output gap (*LNGAP*) contemporaneously affects all other variables except *LNOIL* and so on.

It is vital to state here that the identified SVAR was applied to each sector in estimating impulse response functions, the variance decomposition and ERPT elasticity to sectoral prices.

3.2 Data and Variable Description

This study employed annual data from 1983 to 2017. The source of data on exchange rate and sectoral GDP for agriculture, manufacturing and services sectors is the World Development Indicators (WDI), while data on oil prices were obtained from the World Bank Commodity Prices. The sectoral price indices were constructed from the sectoral GDP for each sector. It was constructed by dividing nominal sectoral GDP by real sectoral GDP for each sector in the same way the GDP deflator is calculated. The output gap was calculated using the Hodrick and Prescott (1997) filter.

All the variables are expressed in logarithm except for output gap. Table 1 below provides variable description and summary statistics for annual data from 1983 to 2017

Table 1: Variable Description and Summary Statistics-1983-2017

Variable	Description	Mean	Std. Dev.
SPRICE1	Prices in agriculture sector (2010=100)	0.43	0.50
SPRICE2	Prices in manufacturing sector (2010=100)	0.47	0.51
SPRICE3	Prices in services sector (2010=100)	0.48	0.54
LNEXR	Nominal exchange rate (K/USD)	3.01	2.89
LN OIL	US Dollar Price of Crude oil	41.68	30.19
LNGAP	Output gap in Millions of kwacha	-0.16	1.24

SPRICE1, SPRICE2 & SPRICE3 are price indices in Agriculture, Manufacturing and Services Sectors respectively. Std. Dev=Standard Deviation

Source: Authors' calculation

4. Empirical Analysis of the Sectoral Models

4.1 Unit Root Test Results

Table 2 presents the Augmented Dickey Fuller (ADF) and Philip Perron (PP) unit root test results for the variables. The results in table 2 show that all the variables are stationary at first difference since the ADF and PP statistics are greater than their respective critical values at 1% level of significance. The price index for manufacturing sector (SPRICE2) is stationary at level and first difference.

Table 2: Unit Root Test For All Variables

	Level		First Difference		Mackinnon Critical Values	
Variable	ADF	PP	ADF	PP	Critical value	Critical value
	t-stat	t-stat	t-stat	t-stat	1% Level	5% Level
SPRICE1	-1.253	-0.627	-6.825*	-10.19*	-4.263	-4.285
SPRICE2	-4.754*	-4.754*	-6.561*	-15.82*	-4.263	-4.285
SPRICE3	-3.367	-3.376	-5.499*	-7.660*	-4.263	-4.285
LNEXR	-1.629	-1.179	-5.848*	-8.202*	-4.263	-4.285
LNOIL	-2.282	-3.317	-5.523*	-5.523*	-4.263	-4.285
LNGAP	-3.057**	-1.841	-4.070**	-3.883*	-4.263	-4.285

**** and ** denote variable is integrated at 1% and 5% respectively, 5% critical value is -3.552973***

SPRICE1, SPRICE2 & SPRICE3 are price indices in Agriculture, Manufacturing and Services Sectors respectively. LNEXR=logged exchange rate; LNOIL=oil price in US Dollar per barrel; LNGAP=output gap;

Source: Authors' own estimation based on sample data

4.2 Optimal Lag Length Results

Table 3 below displays the results for the information criterion for optimal lag length selection. All the information criteria indicate that the optimal lag length ranges between one and two. However, since most of them indicate optimal lag length of one, the current study chose optimal lag of one for all the models.

Table 3: Var Lag Order Selection Criterion For All Sectors

Var Lag Order Selection Criterion For Agriculture Sector						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-13.329	NA	4.46E-05	1.333	1.6995*	1.4545
1	6.869	32.823*	3.49e-05*	1.0707*	2.1699	1.4351*
2	19.403	17.233	4.64E-05	1.2873	3.1195	1.8946
Var Lag Order Selection Criterion For Manufacturing Sector						
Lag	LoGL	LR	FPE	AIC	SC	HQ
0	-0.2717	NA	0.0000	0.5170	0.8834*	0.6384*
1	17.1142	28.2520*	1.84e-05*	0.4304*	1.5297	0.7948
2	25.2328	11.1632	0.0000	0.9229	2.7551	1.5303
Var Lag Order Selection Criterion For Services Sector						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-21.1798	NA	0.0001	1.5737	1.7570	1.6345
1	12.6786	57.1360	0.0000	0.4576	1.3737*	0.7612*
2	32.0504	27.8471*	1.60e-0*	0.2468*	1.8958	0.7934

Source: Authors' own estimation based on sample data

4.3 Coefficients of The Shocks From The SVAR System For Each Sector.

Table 4 below displays coefficients of the shocks obtained from the SVAR output for each of the three sectors. The SVAR output for each of the three sectors is presented in appendix A table 1A, 2A and 3A respectively. Table 4 below shows that the ERPT coefficients for agriculture, manufacturing and services sectors are 0.2254, 0.5897 and 0.6031 respectively. These coefficients mean that 1% increase in exchange rate causes sectoral prices to increase by 0.23%, 0.59% and 0.60% in the agriculture, manufacturing and services sectors respectively. It is clear that the ERPT to sectoral prices is greatest in the services sector followed by the manufacturing sector and least in the agriculture sector. This entails that the most sensitive sector to changes in exchange rate is the services sector followed by the manufacturing sector. On the other hand, the agriculture sector prices are less sensitive to exchange rate movements. It is clear from the results displayed in table 4 that in all the three sectors, ERPT is incomplete. The findings in this study of incomplete pass through are similar to the findings by Marston (1990) and Otan et al. (2003) who also found incomplete ERPT.

Table 4: Coefficients of SVAR Shocks of The Sprice Equation For Each Sector

Target Variable is Sprice			
	Agriculture Sector	Manufacturing Sector	Services Sector
Variable	Coefficient	Coefficient	Coefficient
LNEXR	0.2254	0.5897*	0.6031*
	(0.2556)	(0.1593)	(0.1094)
LNOIL	0.0882	0.5020	0.1762**
	(0.1572)	(0.1001)	(0.0687)
LNGAP	0.2554**	0.0008	-0.1290**
	(0.1127)	(0.0747)	(0.0536)
SPRICE	0.2201*	0.1465*	0.1005*
	0.0270	(0.0108)	(0.0124)

*, ** and ***show significance at 1%, 5% and 10% respectively.

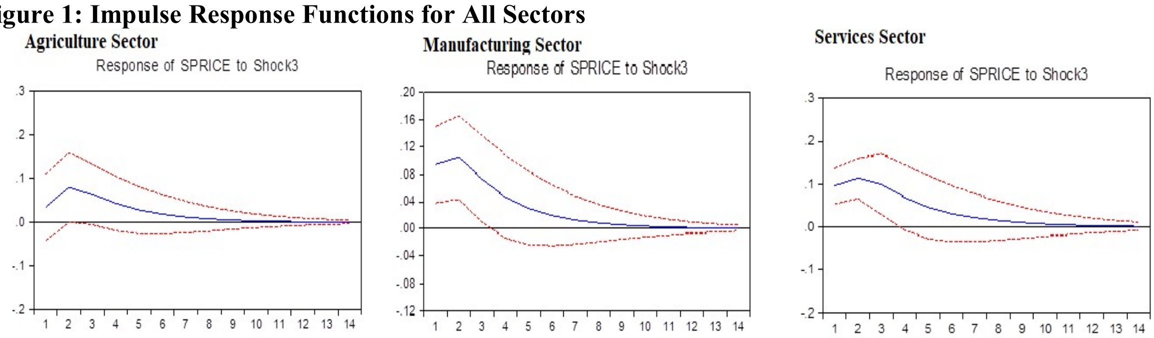
Figures not in parenthesis are shocks coefficients and in parenthesis are standard errors

Source: Authors' own estimation based on sample data

4.4 Impulse Response Function Analysis For All Sectors

Figure 1 presents impulse response functions of the sectoral prices to the shock in exchange rate for agriculture, manufacturing and services sectors respectively. Figure 1 shows that there is a difference in the ERPT to sectoral prices both in terms of the impact and propagation among the sectors. Although in all the three sectors, one standard deviation shock to exchange rate causes sectoral prices to increase and reach maximum in period two, the impact is different. For instance the impact of one standard deviation shock to exchange rate causes sectoral prices to rise to a maximum impact of 8%, 10.5% and 13% in period two in the agriculture, manufacturing and services sectors respectively as shown in figure 1. Thus, the effect of the ERPT to sectoral prices is greater in the services sector followed by manufacturing sector and least in the agriculture sector. Furthermore, figure 1 shows that one standard deviation shock to exchange rate is more persistent in the services sector followed by manufacturing sector and less in the agriculture sector. For instance, the shock last for eight, nine and eleven periods in the agriculture, manufacturing and services sector respectively. This implies that the effect of the shock is more persistent in the services sector followed by manufacturing and agriculture sector respectively.

Figure 1: Impulse Response Functions for All Sectors



Source: Authors' own estimation based on sample data

4.5 ERPT to Price Elasticity for All Sectors

To calculate the ERPT elasticity, we followed Guillermo et al (2014) formulation. They define ERPT elasticity (ERPTE) as the ratio of cumulative response of sectoral price inflation to cumulative exchange rate changes in response to shocks in exchange rate as shown in equation (6).

$$ERPTE_s = \frac{\%\,\Delta SPRICE_{t,t+s}}{\%\Delta LNEXR_{t,t+s}} \qquad (6)$$

Where $ERPTE_s$ is the ERPT elasticity s periods due to a shock in exchange rate that occurred at time t. $\%\Delta SPRICE_{t,t+s}$ is the cumulative sectoral price inflation changes s periods due to an exchange rate shock at time t. On the other hand, $\%\Delta LNEXR_{t,t+s}$ is the cumulative exchange rate changes in response to a shock in exchange rate s periods after the shock at time t. Cumulative sectoral price inflation responses can be interpreted as the percentage change in the corresponding sectoral price index at period *t+s* due to one standard deviation exchange rate shock (Guillermo et al. 2014). Thus, the ratio of the cumulative responses of sectoral price inflation to the cumulative responses in exchange rate is an elasticity (Guillermo et al. 2014).

The computed ERPT elasticities are tabulated in table 5. In table 5, it can be seen clearly that the ERPT elasticity is greatest in the services sector followed by manufacturing sector and least in the agriculture sector for the entire period under consideration. The average ERPT elasticity for the whole period is 0.53832, 0.66472 and 0.8775 for agriculture, manufacturing and services sectors respectively as shown in table 5 below.

Table 5: Exchange Rate Pass-Through Elasticity For All Sectors

Period	Agriculture Sector	Manufacturing Sector	Services Sector
1	0.2254	0.58967	0.6031
2	0.45423	0.68634	0.7389
3	0.5389	0.68979	0.8396
4	0.56875	0.68122	0.8915
5	0.58106	0.67415	0.9164
6	0.5871	0.66956	0.9299
7	0.59045	0.66671	0.9384
8	0.59245	0.66493	0.9441
9	0.59369	0.66381	0.9479
10	0.59448	0.6631	0.9505
11	0.59499	0.66264	0.9523
Average ERPT	0.53832	0.66472	0.8775

Source: Authors' own estimation based on sample data

It is not surprising that the services sector is the most affected and sensitive sector to exchange rate movements. This could be because the services sector is dominated by final consumer services such as wholesale and retail trade, transportation and tourism industry which might be very sensitive to fluctuations in exchange rate. This might cause the ERPT to be high in the services sector. ZDA (2020) notes that a bigger percentage of wholesale and retail trade in Zambia is dominated by foreign goods. Therefore, any movements in the exchange rate could drastically affect the services sector prices. It is also expected for the manufacturing sectoral prices to be sensitive to exchange rate movements because the manufacturing sector depends on the imported inputs which could make this sector to be sensitive to external shocks such as the exchange rate.

4.6 Variance Decomposition for All Sectors

To explore further the differences in the ERPT to agriculture, manufacturing and services sector, the study compared the forecast error variance decomposition (FEVD) of sectoral prices in the three sectors. The FEVD may also enhance an understanding of the relative importance of exchange rate shocks in explaining the percentage variance in sectoral prices in the three sectors under consideration. The results of the forecast error variance of sectoral prices (*SPRICE*) for each sector are presented in table 6. In table 6, it can be observed that the exchange rate shocks explain a bigger percentage of variance in sectoral prices in the services and manufacturing sectors as compared to the agriculture sector. For instance, in the first period exchange rate explains 42.69%, 21.11% and 1.49% variance in sectoral prices in the services, manufacturing and agriculture sector respectively. However, beyond period two, the exchange rate shock explains relatively almost the same variance of sectoral prices in the services and manufacturing sector. However, table 6 shows clearly that exchange rate shock explains the smallest percentage variance in sectoral prices in the agriculture sector. This shows that the agriculture sector is the least affected by exchange rate movements.

Table 6: Variance Decomposition for All Sectors

Variance Decomposition of SPRICE			
	Agriculture Sector	Manufacturing Sector	Service Sector
Period	Exchange Rate Shock	Exchange Rate Shock	Exchange Rate Shock
1	1.487762	21.11449	42.69222
2	7.679518	34.73177	34.33715
3	10.80312	39.50525	37.42394
4	12.09071	41.24939	39.50034
5	12.61833	41.93416	40.37832
6	12.8375	42.21545	40.73771
7	12.92951	42.33370	40.89878
8	12.96837	42.38393	40.97631
9	12.98482	42.40535	41.01412
10	12.99179	42.41450	41.03242
11	12.99475	42.41841	41.04124

Source: Authors' own estimation based on sample data

4.7 Diagnostic Tests

The diagnostic test results are displayed in table 7, 8 and 9. They show that the SVAR models for agriculture, manufacturing and services sector do not suffer from serial correlation and non-normality of residuals. The probability value of the test statistics in all the cases are greater than 5%. The SVAR for the services sector does not suffer from heteroscedasticity. This is because the probability of the test statistic of 0.0649 is above 5%.

Table 7: VAR Diagnostic Tests for Agriculture Sector

Test Type	Coefficient/ Chi-square	Probability
Lagrange Multiplier test for Serial Correlation	25.29079	0.0649
White Test for Heteroscedasticity	124.3983	0.0496
VAR-Jarque Bera-Residual Normality test	12.31858	0.1375

Source: Authors' own estimation based on sample data

Table 8: VAR Diagnostic Tests for Manufacturing Sector

Test Type	Coefficient/ Chi-square	Probability
Lagrange Multiplier test for Serial Correlation	14.21927	0.5824
White Test for Heteroscedasticity	127.9181	0.0313
VAR-Jarque Bera-Residual Normality test	8.742925	0.3644

Source: Authors' own estimation based on sample data

Table 9: VAR Diagnostic Tests for Services Sector

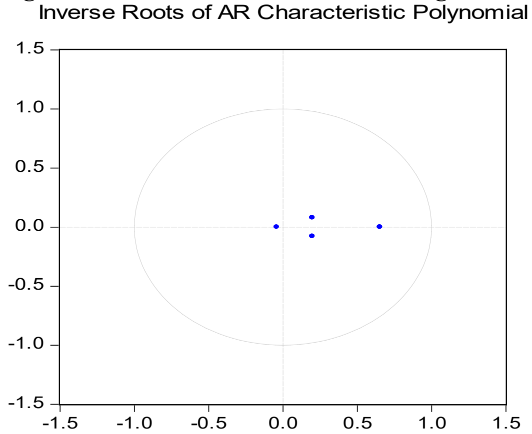
Test Type	Coefficient/ Chi-square	Probability
Lagrange Multiplier test for Serial Correlation	24.63734	0.0765
White Test for Heteroscedasticity	99.96618	0.0649
VAR-Jarque Bera-Residual Normality test	4.693664	0.7898

Source: Authors' own estimation based on sample data

4.8 Stability Tests

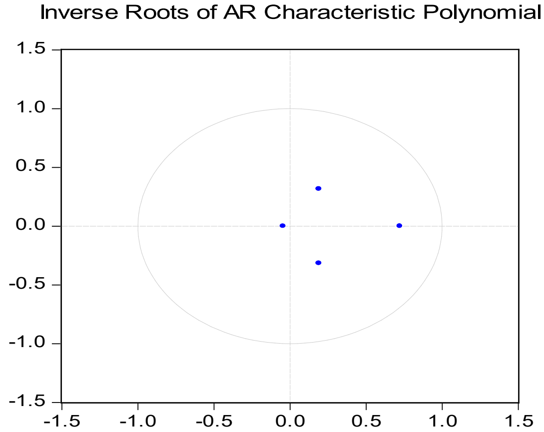
The AR roots for stability test are displayed in figures 2, 3 and 4. They show that the SVARs for agriculture, manufacturing and services sector respectively are well specified, stable and stationary. This is because the inverse roots of the characteristic polynomial lie inside the unit circle.

Figure 2: AR Roots For Manufacturing Sector



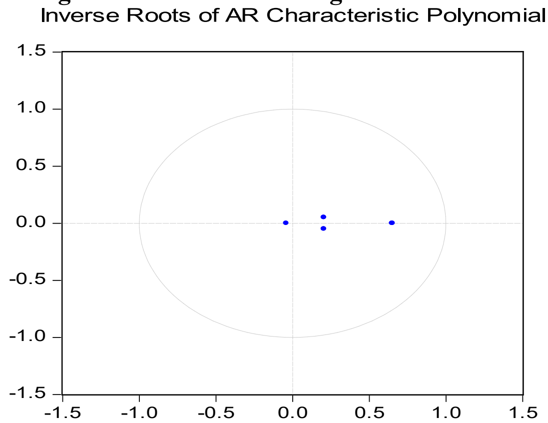
Source: Authors' computation based on sample data data

Figure 3C: AR Roots For Services Sector



Source: Authors' computation based on sample

Figure 4: AR Roots For Agriculture Sector



Source: Authors' computation based on sample data

5. Conclusion and Policy Implications.

In conclusion, the ERPT is less than complete in the three sectors namely agriculture, manufacturing and services. However, the ERPT is very high in the services sector probably due to the dominance of final consumer services such as wholesale and retail trade, transportation, financial and tourism sectors which might be very sensitive to exchange rate movements. The manufacturing sector also exhibited a high degree of the ERPT. This could be due to the fact that most of the raw materials that are used in the manufacturing sector are imported. Thus, it is expected that changes in exchange rate should be able to affect a bigger percentage of the inputs in this sector. The findings in this study have shown that the effect of exchange rate movements on sectoral prices in the agriculture sector is least among all the sectors.

The empirical results from the sectoral ERPT study have implication for exchange rate and inflation policies management regarding the sectors especially the manufacturing and services. First the manufacturing sector is also very affected by exchange rate changes. This is because this sector depends on the imported inputs, which are sensitive to exchange rate fluctuations. The government needs to design policies to encourage firms to increase local content in production. This might reduce dependence on imported inputs. However, this requires developing local resources and skills. Increased local content in production might reduce the use of imported inputs in production. This will consequently reduce pressure on the US Dollar. This will have the effect of stabilizing the Zambian Kwacha and consequently the prices in the long term.

Another suggestion is for the government to create economic zones targeted at encouraging local production of manufactured goods so as to boost exports. Exports will increase export earnings and the availability of foreign exchange. This will ultimately stabilize the Zambian Kwacha and may lessen the impact of exchange rate shocks not only in the manufacturing sector but also in the services sector.

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Appendix A

Table 1A: Structural VAR (SVAR) Estimates For Agriculture Sector

	Coefficient	Std. Error	z-Statistic	Prob.
C(2)=LNOIL	-0.57321	0.312594	-1.833724	0.0667
C(4)=LNOIL	-0.210948	0.100575	-2.09742	0.0360
C(5)=LNGAP	0.317135	0.053356	5.943780	0.0000
C(7)=LNOIL	0.088185	0.157197	0.560985	0.5748
C(8)=LNGAP	0.255410	0.112722	2.265847	0.0235
C(9)=LNEXR	0.225401	0.255579	0.881926	0.3778
C(1)=LNOIL	0.272373	0.033527	8.124038	0.0000
C(3)=LNGAP	0.489104	0.060204	8.124038	0.0000
C(6)=LNEXR	0.149913	0.018453	8.124038	0.0000
C(10)=SPRICE	0.220101	0.027093	8.124038	0.0000
Log likelihood	-8.204428			
Estimated A matrix:				
1.000000	0.000000	0.000000	0.000000	
0.573210	1.000000	0.000000	0.000000	
0.210948	-0.317135	1.000000	0.000000	
-0.088185	-0.25541	-0.225401	1.000000	
Estimated B matrix:				
0.272373	0.000000	0.000000	0.000000	
0.000000	0.489104	0.000000	0.000000	
0.000000	0.000000	0.149913	0.000000	
0.000000	0.000000	0.000000	0.220101	

Source: Authors' estimation from sample data

Table 2A: Structural VAR Estimates For Manufacturing Sector

	Coefficient	Std. Error	z-Statistic	Prob.
C(2)=LNOIL	-0.459943	0.324472	-1.417511	0.1563
C(4)=LNOIL	-0.149068	0.106232	-1.403233	0.1605
C(5)=LNGAP	0.344789	0.055333	6.231130	0.0000
C(7)=LNOIL	0.050176	0.100069	0.501416	0.6161
C(8)=LNGAP	0.000804	0.074702	0.010759	0.9914
C(9)=LNEXR	0.589666	0.159296	3.701711	0.0002
C(1)=LNOIL	0.270257	0.033266	8.124038	0.0000
C(3)=LNGAP	0.503745	0.062007	8.124038	0.0000
C(6)=LNEXR	0.160123	0.019710	8.124038	0.0000
C(10)=SPRICE	0.146526	0.018036	8.124038	0.0000
Log likelihood	2.332359			
Estimated A matrix:				
1.000000	0.000000	0.000000	0.000000	
0.459943	1.000000	0.000000	0.000000	
0.149068	-0.344789	1.000000	0.000000	
-0.050176	-0.000804	-0.589666	1.000000	
Estimated B matrix:				
0.270257	0.000000	0.000000	0.000000	
0.000000	0.503745	0.000000	0.000000	
0.000000	0.000000	0.160123	0.000000	
0.000000	0.000000	0.000000	0.146526	

Source: Authors' estimation from sample data

Table 3A: Structural VAR Estimates For Services Sector

	Coefficient	Std. Error	z-Statistic	Prob.
C(2)=LNOIL	-0.49719	0.32079	-1.54990	0.12120
C(4)=LNOIL	-0.16429	0.10552	-1.55687	0.11950
C(5)=LNGAP	0.37249	0.05529	6.73738	0.00000
C(7)=LNOIL	0.17624	0.06872	2.56481	0.01030
C(8)=LNGAP	-0.12902	0.05356	-2.40893	0.01600
C(9)=LNEXR	0.60311	0.10941	5.51234	0.00000
C(1)=LNOIL	0.27332	0.03364	8.12404	0.00000
C(3)=LNGAP	0.50366	0.06200	8.12404	0.00000
C(6)=LNEXR	0.15996	0.01969	8.12404	0.00000
C(10)=SPRICE	0.10054	0.01238	8.12404	0.00000
Log likelihood	14.43033			
Estimated A matrix:				
1.00000	0.00000	0.00000	0.00000	
0.49719	1.00000	0.00000	0.00000	
0.16429	-0.37249	1.00000	0.00000	
-0.17624	0.12902	-0.60311	1.00000	
Estimated B matrix:				
0.27332	0.00000	0.00000	0.00000	
0.00000	0.50366	0.00000	0.00000	
0.00000	0.00000	0.15996	0.00000	
0.00000	0.00000	0.00000	0.10054	

Source: Authors' estimation from sample data