Bank *of* Zambia

WP/2017/5

BoZ WORKING PAPER SERIES

Price and Exchange Rate Dynamics: The Case of Zambia

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Chungu Kapembwa

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Bank of Zambia Working Paper Series

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Chungu Kapembwa[1]
Bank of Zambia
Bank of Zambia Square

December 2017

Abstract:

This paper examines the relationship between exchange rate (import weighted) and consumer prices in Zambia using quarterly data covering the period 2001 to 2014. The study uses innovation accounting tools (impulse response and variance decomposition) within the framework of a Structural VAR to examine the degree of pass-through as well as the relative importance of a number of variables in explaining changes in domestic prices. The results show that exchange rate pass–through from the import weighted exchange rate like the bi-lateral Kwacha US Dollar, is fairly low, incomplete and is persistent. Monetary policy should take a keen interest in the exchange rates in the trading partners as this can be an important signal for future inflation developments in the country, which is import dependent.

JEL classification: F31
Key words: Price; exchange rate; impulse response

[1] Corresponding author. E-mail address: ckapembwa@boz.zm. The study also benefitted from comments received from the editors of the BoZ Working Paper Series and the Technical Committee discussions held with Bank of Zambia staff. The findings and opinions expressed in this paper are entirely those of the author and do not in any represent the views or position of the Bank of Zambia.

Contents

1. Introduction

Exchange rate pass-through (ERPT) is important in the conduct of monetary policy and is an area of interest for policymakers in central banks. The response of central banks to different economic shocks, such as exchange rate shocks, require an understanding of the transmission mechanism of monetary policy of those shocks. A low exchange rate pass-through makes for a more independent monetary policy and makes it easier to implement inflation targeting (Choudhri and Hakura 2001). Currency movements affect domestic prices directly by increasing or decreasing the domestic price of tradable goods and indirectly through changes in economic activity when foreign prices increase (decrease) relative to domestic goods prices.

Campa and Goldberg (2005) and Liu and Tsang (2008) indicate that there are three key factors that drive the extent of exchange rate pass-through. These are the pricing behaviour of exporters in the producer countries, the sensitivity of mark-ups to competitive conditions and existence of distribution costs that affect the gap between import and retail costs. Domestic firms which use imports as inputs will therefore most likely have less incentive to absorb higher import costs in their profit margins and will pass on the costs to the consumer. These feed through into the overall price of imported goods and services and ultimately into inflation.

This paper aims to add to the research on the impact of the exchange rate on domestic price levels emanating from changes in the effective exchange rates of Zambia's major trading partners, which affect the price of imports in Zambia. The analysis is conducted using a structural VAR model. Zambia is dependent on imported inputs, capital goods and other finished goods to meet domestic demand. This dependence on imports exerts pressure on demand for foreign exchange on the foreign exchange and ultimately has a pass-through effect on inflation. It is equally important in bringing to the attention of analysts and policy makers the issue of imported inflation on the domestic economy.

The rest of the paper is structured as follows: Section 2 reviews literature on exchange rate pass-through. In Section 3, the methodology and empirical model is discussed. The key findings are then discussed in Section 4, with the conclusions and policy issues presented in Section 5.

2. Literature Review

Traditional monetary theory regards excessive money creation as a common source of instability in both the exchange rate and price level. In the presence of large monetary shocks, price inflation and exchange rate depreciation should, therefore, be closely linked. Generally, scholars have accepted that, understanding the impact of exchange rate movements on prices is critical from a policy perspective in order to gauge the appropriate monetary policy response to currency movements. Empirical studies have shown that movements in the exchange rate and prices do not go one to one in the short to medium term. An extensive theoretical literature, which has developed over the past three decades, has identified various explanations why exchange-rate pass-through (ERPT) to consumer prices

is incomplete. Empirical analyses have also provided evidence of considerable cross-country differences in the ERPT. A major argument in this respect was suggested by Taylor (2000), who put forward the hypothesis that the responsiveness of prices to exchange rate fluctuations depends positively on inflation. General literature search on exchange pass-through quickly reveals that the majority of the studies made in the area are industry or product specific studies.

A smaller but equally important strand of the literature concentrates on the macroeconomic exchange rate pass-through to aggregate price indices. Menon (1995) presents an overview of empirical studies on industrialized economies, of which the most often studied is the United States. The majority of these studies conclude that exchange rate pass-through is incomplete. The degree of pass-through varies significantly across different countries. The main factors that influence the degree of pass-through across countries are the size and the openness of the individual economies. Pass-through relationships have remained largely stable over time.

Goldfajn and Werlang (2000) presented a study of 71 countries, where exchange rate pass-through into consumer prices is investigated using panel estimation methods on data from 1980 up until 1998. Both developed and emerging market economies are included in their study. They reported that the pass-through effects on consumer prices increase over time and reach a maximum after 12 months. The degree of pass-through is, furthermore, found to be substantially higher in emerging market economies than in developed economies.

Rincón (2000) in his study of Colombia for the period 1980 to 1998 found exchange rate pass-through be incomplete. The estimated long-term elasticities of import and export prices to a change in the exchange rate are 0.84 and 0.61, respectively. The direct long-term effect of the exchange rate on the consumer prices is found to be 0.48. Similarly, Feinberg (2000) studied exchange rate pass-through in Colombia, Korea and Morocco using industry level data and an OLS regression technique. The exchange rate pass-through was found to be incomplete.

The econometric tools used in estimation of ERPT have evolved over time with a number of accompanied motivations, from single equations to simultaneous equations and to a limited extent seemingly unrelated regressions (SUR). Various types of VARs are also in use. There are studies such as those that use recursive VARs, structural and unstructured VARs. The literature can also be looked at in terms of two main strands regarding characteristics based on the nature of modelling as to whether one is using a structural or reduce-form modelling effort. The first stage examines the relationship between exchange rate and import prices while the second stage looks at the pass-through from import prices to domestic prices.

McCarthy (2000) presents a comprehensive study of exchange rate pass-through on the aggregate level for a number of industrialized countries. He estimates a VAR model using import, producer and consumer-price data from 1976 up until 1998. In most of the countries analysed, the exchange rate pass-through to consumer prices is found to be modest. The rate of pass-through is, furthermore, shown to be positively correlated with the openness of the country and with the persistence of an exchange rate change, and negatively correlated with

the volatility of the exchange rate. Kim (1998) investigated exchange rate pass-through in the United States using a framework of multivariate.

The VAR approach has a marked advantage over the single equation framework; this explains the popularity of the framework in the literature (McCarthy, 2000; Hahn, 2003; Faruqee, 2006; Ito and Sato, 2006). Among the key advantages of the VAR framework is the opportunity to identify structural shocks via Cholesky decomposition of innovations. Again, while a single equation framework allows for just one domestic price index, the VAR framework makes room for a set of domestic prices, thus making it possible for an evaluation of ERPT considering a set of domestic prices within the pricing chain from the importer/producer to consumer levels. The single equation framework on the other hand is based on the assumption of causality from exchange rate to inflation and thus ignoring the possibility of reverse causality from inflation to exchange rate. Consequently, in the present study we adopt the VAR approach as the analytical framework for estimation.

On the substantive matter of estimation of ERPT, most studies focusing on developed countries conclude that ERPT has fallen over the years particularly in an environment of low inflation. Consequently, the bulk of the recent literature on ERPT has been aimed at explaining away the reasons underlying the seemingly low ERPT figures (Marazzi et al., 2006; Campa and Goldberg, 2005; Taylor, 2000). However, in the case of emerging economies, such as Zambia, not much has been accomplished by way of research. That notwithstanding, there is a growing number of studies on emerging economies in Asia (e.g. Ito and Sato, 2008). While many of these have focused on individual countries a good number of them have dwelt on cross-country samples.

The present study therefore attempts to contribute to the literature on Zambia by investigating the impact of changes in the exchange rates of its major trading partners. In terms of previous work on Zambia, Zgambo (2015), Morrissey et al (2016), and a cross country study by Chaoudri and Hakura (2001) are the studies that have been done on Zambia.

3. Data

The empirical analysis is conducted using quarterly data. The time span covered the period 2001 to 2014. Inflation is measured by the log of the consumer price index and an import weighted exchange rate which takes account of major trading partner is also in the study. The import weighted nominal effective exchange rate index is used to account for the exchange rate variable. It is equally important in bringing to the attention of analysts and policy makers the issue of imported inflation on the domestic economy.

The 91-day Treasury bill rate is used as a proxy to reflect changes in the Central Bank's behaviour given that the Policy Rate was only introduced in April 2012. In the past, bank lending rates tracked movements in the short-term (91- day) Treasury bill rate but with a lag. Therefore, implicitly, the 91-day yield rate reflects the stance of monetary policy (Simpasa et al ,2014). Other variables used include the output gap and oil prices. The data is obtained from the Bank of Zambia and Central Statistics Office. The output gap is constructed

using the Hodrick –Prescott filter based on the assumption that output fluctuates around some potential level where the output gap then is the difference between the actual output and the potential (trend) output. GDP data is only available annually. GDP is interpolated into a quarterly series using the Eviews software.

3.1. Unit Roots

Before undertaking the empirical analysis, we examined the statistical properties of the data by testing for unit root to ascertain whether or not the series was stationary. The ADF test statistic was used in the unit root analysis. The results for the seasonally unadjusted data are presented in the table 1 below. All the variables, except the output gap variable, are non-stationary in levels but stationary in their first differences.

Table 1: Unit Root Test Results

Augmented Dickey-Fuller Test		
Variable	t-statistic	t-statistic (First Difference)
Oil	-2.075505 (0.2551)	-6.531928 (0.0000)
Consumer price (CPI)	1.7560 (0.9997)	-6.8762 (0.0000)
Import Weighted Exchange Rate (iwer)	-0.4741 (0.8922)	-10.908 (0.0000)
Output gap (ygap)	-3.4976 (0.0091)	-6.2733 (0.0000)
Treasury bills (TB91)	-1.9391 (0.0907)	-10.550 (0.0000)

Critical Values (1% level: -3.464827; 5% level: -2.876595; 10% level: -2.574874), *p-values in parenthesis

4. Methodology

The method used to estimate the pass-through of the exchange rate to inflation is the structural VAR (SVAR) framework, which is used to recover the structural shocks from the forecast errors of the estimated VAR. The structural VAR tries to adopt economic theory instead of the Cholesky decomposition to recover the structural innovations from the residual of a reduced for VAR.

Inflation dynamics are assessed by impulse responses to various shocks and variance decompositions. Impulse response functions trace the impact of a shock originating from an endogenous variable to other variables through the dynamic structure of the VAR. Variance decompositions provide the percentage of the forecast variance of inflation that is attributable to various shocks in the system.

Following the work of Almounsor (2010), Moriyama (2008) and McCarthy (2000), the recursive structure of the economy assumes that the output gap is ordered first as it is unlikely to be affected contemporaneously by the other shocks. The monetary policy variable (91-day treasury bills) is ordered second followed by the exchange rate variable and the CPI is ordered last. Consumer price index like in most studies is placed at the bottom of the VAR model as it is contemporaneously affected by all the other variables in the VAR (Ocran 2010, Zgambo 2015, Morrissey et al 2016, and Almounsor 2010).

The VAR model assumes the Zambian Economy can be represented by the following structural form:

G(L)$Y_t = C(L)\, X_t + \varepsilon_t$ ..... (1)

Where G(L) is a nxn matrix polynomial in the lag operator , C(L) is an n x k matrix polynomial in the lag operator, Y_t is an n x 1 vector of endogenous variables and X_t is a k x 1 vector of exogenous variables. ε_t is a n x 1 vector of structural disturbances with var$(\varepsilon_t) = A$ is a diagonal matrix.

The reduced form structural VAR is presented as follows:

$Y_t = D(L)\, Y_t + E(L)\, X_t + \mu_t$ ..... (2)

Where D(L) and E(L) are matrices polynomial, μ_t is a vector of reduced form disturbances, with var$(\mu_t) = \sum$.

If we let F be the contemporaneous coefficient matrix in the structural form and let H (L) be the coefficient matrix in G(L) with the contemporaneous coefficients, that is

G(L) = F_+ H(L) .....(3)

Therefore, the structural and reduced form equations can be related by

D(L) = -F^{-1} H(L) and E(L) = F^{-1} C(L).....(4)

The error terms are related:

$\mu_t = F^{-1}\, \varepsilon_t$ or ε_t = Fμ_t , which implies

$\sum = F^{-1}\ AF^{-1'}$ .....(5)

The consistent estimates of F and A are inferred by estimates of $\sum$, which can be obtained by the maximum likelihood estimation. The right hand side contains n*(n+1) parameters to be estimated, while the left hand side contains only n*(n+1)/2 parameters. Therefore, we need n*(n+1)/2 restrictions which should be motivated by economic theory.

The endogenous variables in our structural VAR include the world price of oil(oil), output gap(ygap), short term interest rate(tb91), import weighted exchange rate(iwer) and consumer price index(CPI):

Y_t' = (oil ygap tb91 cpi, iwer) .....(6)

4.1. Empirical Estimation

4.1.1. Lag length Criteria

The number of lags included to each endogenous variable in the model reduces the degree of freedom while including less than optimal number could result in model misspecification. Thus, the number of lags included in this model is 4 and its choice depended on the trade-off between long lag-lengths' costs in terms of consumed degrees of freedom and small lags' length of misspecification. The selection of the lag length structure was based on results from the Akaike Information Criterion (AIC) which suggested a lag length of 4 (See Table 2 Appendix).

4.1.2. Diagnostic Tests

The diagnostic tests of the estimated VAR with 4 lags indicate the absence of serial correlation. Autocorrelation test is based on Breusch-Godfrey and the null hypothesis is no serial correlation. The estimated model is stable as the calculated roots of the characteristic polynomial are all located within the unit circle (See Tables 2 and 3 Appendix).

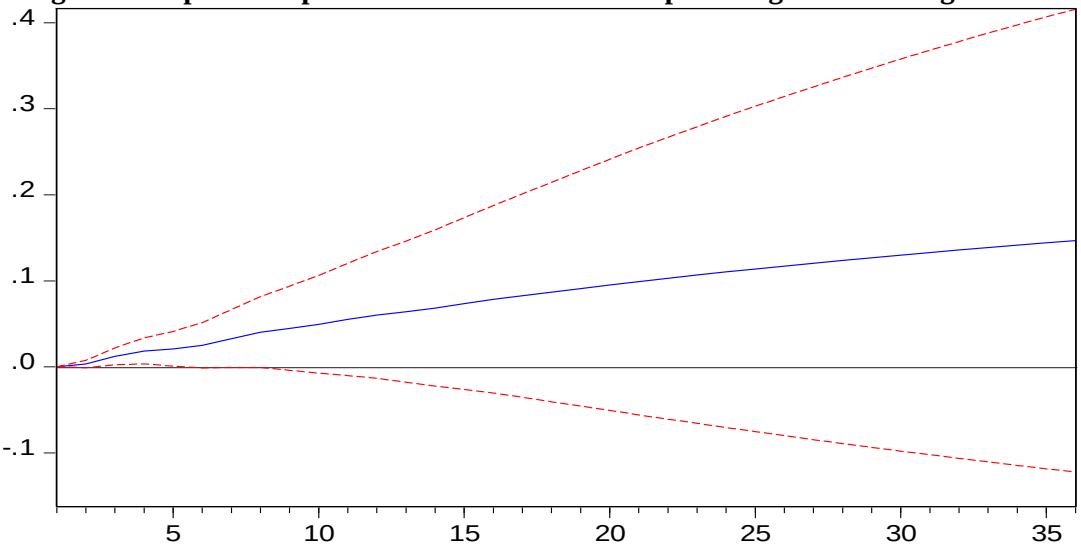
5. Main Findings

As mentioned in Section 3, the model is estimated with the aid of SVAR involving five variables: oil, output gap, import weighted nominal effective exchange rate, consumer price and short-term interest rate. The Model is estimated over the period 2001 - 2014. Following McCarthy (2000) we use innovation accounting techniques (i.e. impulse response functions and variance decompositions) to ascertain the degree of pass-through from exchange rate fluctuations to domestic inflation and also to figure out the importance of the various variables in explaining fluctuations in the domestic prices.

5.1. Impulse Response Functions

An impulse response function (IRF) traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. Consistent with economic theoretical predictions, inflation responds positively to currency depreciation. Figure1 shows that a one standard deviation shock of the import weighted exchange rate increases inflation. The results suggest that the impact of the import weighted exchange rate shock is low, persistent and incomplete in line with findings from other studies on developing countries as well as Zambia.

Figure1: Impulse Responses of CPI to Shock to Import weighted Exchange Rate



5.2. Variance Decomposition

Variance decomposition indicates the proportion of the movements in a variable due to its own "shocks" as compared to shocks to other variables in the system. In practice, it is not uncommon for a variable to explain almost completely its entire forecast error variance, particularly at short horizons and relatively smaller proportions at longer horizons. Thus the variance decomposition provides insight into the relative importance of each of the random innovation in affecting the variables in the VAR. The results presented in Table 2 indicate that the consumer price index mainly accounts for its own shocks, with own shocks accounting for almost 90 percent of the variation in the period following the shock. The results also show that the import weighted exchange rate plays a significant role to play in the accounting for variation in the consumer prices. The interest rates also play an important role in explaining the variations in inflation. The impact of import weighted exchange rate is shown to be fairly low (See Table 2).

Table 2: Consumer Price Index Variance Decomposition

Period	S.E.	Log oil	output gap	TB91	Log CPI	Log IWER
1	0.0	1.4	3.2	4.1	91.4	0.0
4	0.0	0.9	6.3	3.9	62.8	26.1
8	0.0	1.9	7.3	6.4	55.4	29.1
12	0.0	2.7	5.9	8.8	52.5	30.2
16	0.0	2.7	5.4	10.5	51.0	30.4
20	0.0	3.2	5.0	11.6	49.4	30.8
24	0.0	3.4	4.7	12.4	48.6	31.0
28	0.0	3.5	4.5	12.8	48.1	31.1
32	0.0	3.6	4.4	13.1	47.7	31.2
36	0.0	3.7	4.3	13.4	47.4	31.3

6. Conclusions

This paper sought to investigate the exchange rate pass-through to domestic prices with the aid of innovation accounting techniques within the framework of a Structural VAR. The effect of exchange rate shocks is a major focus of monetary policy and the results show that authorities have to be vigilant and fully appreciate and keep track of developments in Zambia's major trading partners which have the potential to export inflation to Zambia. The variance decompositions show that there is inertia in domestic prices as variations are mainly driven by own shocks. The variance decompositions suggest that the exchange rate pass-through is relatively low and incomplete. The high proportion of imports indicates that the import weighted exchange rate could be one of the tools that could be used to anticipate changes in inflation stemming from trading countries.

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Appendix

Table 1: Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-874.3054	NA	3.35e+08	33.81944	34.00706	33.89137
1	-582.3594	516.5198	11708.40	23.55228	24.67800*	23.98386*
2	-551.5090	48.64868	9607.639	23.32727	25.39109	24.11849
3	-525.6229	35.84227	9964.914	23.29319	26.29510	24.44405
4	-487.2438	45.75974*	6857.666*	22.77861*	26.71862	24.28912

Table 2 : VAR Residual Serial Correlation LM Tests

Sample: 2001Q1 2014Q4
Included observations: 52

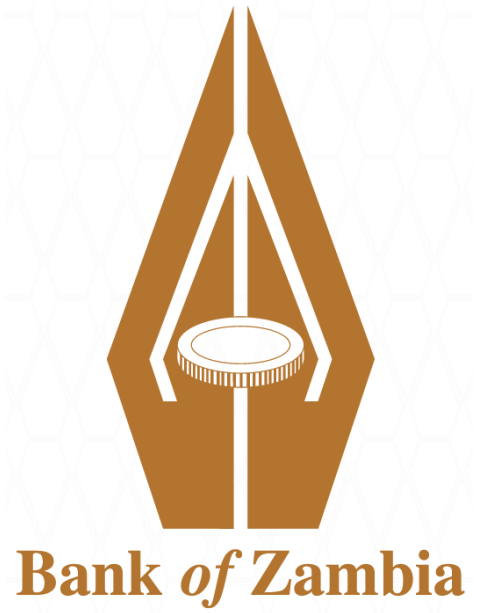
Lags	LM-Stat	Prob
1	47.82623	0.0039
2	31.66322	0.1680
3	30.77673	0.1965
4	31.39570	0.1762
Probs from chi-square with 25 df.		

Table 3: Inverse Roots of AR Characteristic Polynomial

Roots of Characteristic Polynomial
Endogenous variables: OIL YGAP TB91 CPI IWER
Exogenous variables: C
Lag specification: 1 4

Root	Modulus
0.998754	0.998754
0.725574 - 0.428458i	0.842636
0.725574 + 0.428458i	0.842636
-0.654912 - 0.511848i	0.831203
-0.654912 + 0.511848i	0.831203
0.809103 - 0.163441i	0.825446
0.809103 + 0.163441i	0.825446
0.483509 - 0.652589i	0.812190
0.483509 + 0.652589i	0.812190
0.117242 - 0.800107i	0.808652
0.117242 + 0.800107i	0.808652
-0.249765 + 0.768849i	0.808401
-0.249765 - 0.768849i	0.808401
0.554110 - 0.557277i	0.785872
0.554110 + 0.557277i	0.785872
0.641956	0.641956
0.177319 + 0.615624i	0.640652
0.177319 - 0.615624i	0.640652
-0.570582	0.570582
-0.118722	0.118722

No root lies outside the unit circle.
VAR satisfies the stability condition.



REGISTERED OFFICES

Head Office
Bank of Zambia, Bank Square, Cairo Road
P.O. Box 30080, Lusaka, 10101, Zambia
Tel: +260 211 399 300
E-mail: info@boz.zm, Website: www.boz.zm

Regional Office
Bank of Zambia, Buteko Avenue,
P.O. Box 71511, Ndola, Zambia
Tel: +260 212 399 600
E-mail: info@boz.zm, Website: www.boz.zm