Issues On The Zambian Economy

Working Papers

Bank *of* Zambia

THE BOZ READER, VOL.02, NO. 01, 2015

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Published by the Bank of Zambia
Bank Square
Cairo Road
P. O. Box 30080
Lusaka
Zambia

http://www.boz.zm

ISBN: 968-9983-870-32-0

Printed by Mission Press, Ndola – Zambia

First Printed in August 2003

CONTENTS

Foreword

The Bank of Zambia (BoZ) is pleased to publish this first issue of Volume Two of the BoZ Reader – Issues on the Zambian Economy, Working Papers. The publication is aimed at information dissemination and to exchange views on topical issues pertaining to the Zambian economy. The Reader is also aimed at contributing to economic literature on theoretical, policy and practical issues on the Zambian economy.

In this issue of the Reader, there are seven articles on contemporary issues affecting the Zambian economy. The articles include Inflation Forecasting: A Disaggregated Approach; The Dynamic Effects of Fiscal Policy Shocks on Inflation and Economic Activity; Exchange Rate Pass-through to Domestic Prices in Zambia; The Zambian Quarterly Macroeconometric Model; Bayesian Vector Auto-Regression Short-Term Inflation Forecasting Model for Zambia; Interest Rate Formation in Zambia: Issues and Solutions; and Employment Creation Potential in the Bee-keeping Sector of Zambian Economy.

The Bank would like to express its gratitude to all the authors of the articles contained in this publication, and hope that their contributions will motivate other economists, researchers, social scientists and writers to put their ideas on paper and, thereby contribute to a pool of literature on the Zambian economy through this publication. The Bank wishes to invite comments or brief notes on the articles. The comments or brief notes can be channelled to the Bank's Communications Division or to the authors in cases where the author's contact details have been provided. Economists, social scientists, researchers and writers are hereby invited to contribute articles on various topics that are of relevance to the Zambian economy. All correspondence, in this regard, should be channelled to Director, Economics Department, Bank of Zambia, P. O. BOX 30080, Lusaka Zambia or by email to pr@boz.zm.

Finally, the Bank would like to note that the views expressed in this Reader are those of the authors' and do not necessarily represent the views and policies of the Bank of Zambia.

Denny H. Kalyalya

Governor
Bank of Zambia

CHAPTER ONE

Inflation Forecasting: A Disaggregated Approach

Jonathan M Chipili*

Abstract

Disaggregating the price index into its sub-components often improves the information content and forecasting accuracy of inflation, especially if the dynamic properties of individual components vary. In this paper, two inflation forecasting models (aggregated and disaggregated) were developed using quarterly data over the period 1994-2014. A disaggregated approach was used to provide more information about inflation dynamics in Zambia. The empirical results show the preference of the disaggregated to the aggregated approach to inflation forecasting as the former provides more information about the factors underlying inflation. To ensure information content and improvements in forecasting accuracy, it is recommended that inflation forecasting utilises information generated from the disaggregated model of CPI.

1. Introduction

Inflation remains a widely studied macroeconomic variable. Despite a long history of research interest, policymakers and academics alike continue to pursue the subject to the extent that the significance of inflation is now recognised in most central bank statutes as a core deliverable (Aron and Muellbauer, 2008). For instance, in Zambia, price stability is enshrined in the Bank of Zambia Act No.43 of 1996 in Section 4(1).

Currently, policy efforts by central banks are directed at inflation stabilisation. The focus on inflation is motivated by the costs it imposes on the economy that ultimately lead to lower long-term level of economic growth. The costs include uncertainty on firms to invest and consumers to spend, income re-distribution, menu costs relating to frequent price adjustments and the erosion of competitiveness. Further, inflation influences economic decision vis-à-vis indexation to maintain purchasing power and affects economic welfare (Lebow and Rudd, 2006).

Typically, inflation is assumed to originate from monetary and foreign sectors in an open economy setting, acting through the money demand and purchasing power parity (Durevall and Ndung'u, 1999). This stems from the background that no particular theory can adequately explain inflation, let alone identify a dominant factor of inflation (Durevall and Sjö, 2012). Thus, real output, money supply (driven largely by government expenditures), rates of returns on various assets, exchange rate and foreign prices tend to influence inflation. Domestic food supply constraints, world food price increases that ultimately raise

* Bank of Zambia, P.O. Box 30080, Lusaka, 10101. Zambia. E-mail: jchipili@boz.zm Tel: +260 211 228888-92. I wish to express my gratitude to Francis Z Mbao for assisting in manipulating the forecasting technique employed in the study. I remain responsible for all the errors and omissions.

domestic food prices, policy changes and external shocks such as poor harvests and energy price hikes are other potential inflation factors. It is noted that weak institutional frameworks, thin financial markets and imperfect competition among banks tend to inhibit inflation control in many sub-Saharan African countries (Durevall and Sjö, 2012). Durevall et al. (2013) argue for the inclusion of world food prices and domestic agricultural production in the estimation of consumer price index (CPI) inflation in developing economies where the CPI is dominated by food prices to avoid obtaining biased estimates and misguiding policy decision.

There are however, country variations in terms of the factors that govern inflation. In Zambia, inflation has been studied notably by Mwenda (1997), Mwansa (1998), Pamu and Simuchile (2004), Mutoti (2006) and Musongole (2011). All these studies investigate the determinants of aggregate CPI inflation over different sample periods. The only exception is Musongole (2011) who attempts to estimate core inflation over the period 1986-2008 to distinguish permanent long-run trend of the inflation rate from its transitory movements[1]. Fiscal deficits, expansion in money supply, exchange rate depreciation, output, interest rates, foreign prices and terms of trade are cited as key drivers of aggregate consumer price index (CPI) inflation in Zambia. Exchange rate innovations are found to bear a stronger effect on inflation than money supply innovations (Mwansa, 1998).

Unlike previous studies, this paper estimates an inflation forecasting model using a disaggregated approach. Central banks have recently taken a keen interest in forecasting (underlying) sub-components of the overall CPI (Aron and Muellbauer, 2009). Information content and improvements in forecasting accuracy of inflation increases with the disaggregation of the price index into its sub-components especially if the dynamic properties of individual components vary. This contrasts with the aggregated model approach which forces potential factors across all sub-components to have the same response (Aron and Muellbauer, 2008).

The estimated model takes account of CPI sub-components (food and non-food CPI) over the period 1994-2014 using quarterly data. The food and non-food CPI components are each estimated using a single-equation error correction approach to determine their underlying factors. The parsimonious equations are then pooled together using their weights in the CPI basket to generate the final CPI inflation forecasting model. The final CPI inflation model is compared with the aggregated CPI inflation model to determine its suitability as a forecasting model. This approach aims at providing further insights into the underlying inflation dynamics as the Bank of Zambia (BoZ) transits to inflation targeting by having a broad range of models to guide inflation forecasts and strengthen inflation control strategies.

The rest of the paper is structured as follows. Section 2 briefly describes the CPI. Section 3 specifies the model to be estimated and the estimation technique. Section 4 describes the data while the empirical results are presented in section 5. Section 6 concludes and offers policy recommendations.

2. Brief Description of the Consumer Price Index

The weights for food and non-food components of the overall CPI have varied over time, with the latter gaining 21 weights in 2009 when the last revision took place (Tables 1 and 2 in the appendix). The non-food CPI sub-component has been disaggregated further from 7 to

Core inflation was found to trend lower than headline CPI inflation. Food (white maize and mealie meal) and energy (charcoal, petrol and diesel) items were excluded from the measure of core inflation, driven mostly by transitory (and reversible) shocks on account of high volatility. Such shocks tend to have short-lived (non-lasting) impact on inflation.

10 categories, reflecting new spending preferences.

The food sub-group is dominated by bread and cereals with a total weight of 145.8: mealie meal (breakfast and roller including maize grain) has the largest weight of 64.8 followed by wheat products (bun and bread) with a weight of 44.6 and lastly rice (local and imported) with a weight of 18.9. In the meat category, beef products dominate with a weight of about 62.0. The fish category is led by kapenta (40.0) followed by dried bream (25.4) and frozen bream and buka buka (23.0) while pasturised fresh milk lead the milk, cheese and eggs category. Cooking oil, both local and imported, dominate the oils and fats category with a combined weight of 35.0. Groundnuts (11.5) lead the fruits category. For vegetables, dried beans (14.7), rape (13.1) and tomatoes (12.6) have sizeable weights. Sugar dominates the sugar, jam, honey, chocolate and confectionary category with a weight of 33.0 while salt (15.4) leads the other food products category. The weight of non-alcoholic beverages is negligible in the food items sub-group and so is alcoholic beverages and tobacco. Thus, mealie meal, wheat products, rice, beef products, kapenta, breams, buka buka, pasturised fresh milk, cooking oil, groundnuts, dried beans, rape, tomatoes, sugar and salt have sizeable weights that might influence food inflation and thus require close monitoring for inflation forecasts.

Housing, water, electricity, gas and fuels; clothing and footwear; furnishings, household equipment; and transport sub-categories have larger weights in the non-food CPI (Table 1 in the appendix). House rent, electricity tariffs and charcoal are key in the housing, water, electricity, gas and other fuels category. In the transport category, prices for motor vehicles both new and second hand, price of diesel and petrol as well as fares for the minibus, coach and taxi have relatively large weights. Finally, private primary and secondary school fees dominate the education category.

3. Model Specification

The two inflation forecasting models are presented in equations 1 and 2. Model 1 is the weighted sum of the food and non-food CPI ($\Delta lcpi_t - w$) while model 2 ($\Delta lcpi_t - a$) is the aggregate CPI estimated directly on the aggregate CPI. Both models take account of a rich specification with the same potential inflation factors and longer lags to allow time for underlying relationships to feed through.

Model 1

$$\Delta lcpi_t - w = w\Delta lcpif_t + (1-w)\Delta 1\ cpinf_t + \varepsilon_t \tag{1}$$

$$\Delta lcpif_t = \sum_{i=1}^{k1}\gamma_i \Delta lcpif_{t-i} + \sum_{i=0}^{k2}\pi_i \Delta x_{t-i} + \phi D_t + \alpha_1 ec\_lcpif_{t-1} + \alpha_2 ec\_rmb_{t-1} + \alpha_3 output\_gap_{t-1} + \varepsilon_t \tag{1.1}$$

$$ec\_lcpif_{t-1} = lcpif_{t-1} - \beta_1 lwfp_{t-1} - \beta_2 ls_{t-1} \tag{1.1.1}$$

$$ec\_rmb_{t-1} = (m_{t-1} - p_{t-1}) - \beta_1 y_{t-1} + \beta_2 r_{t-1} \tag{1.1.2}$$

$$output\_gap_{t-1} = \log agricoutput_{t-1} - agrictrend_{t-1} \tag{1.1.3}$$

$$\Delta\ lcpinf_t = \sum_{i=1}^{k1}\gamma_i \Delta\ lcpinf_{t-i} + \sum_{i=0}^{k2}\pi_i \Delta x_{t-i} + \phi D_t + \alpha_1 ec\_\ lcpinf_{t-1} + \alpha_2 ec\_rmb_{t-1} + \varepsilon_t \tag{1.2}$$

$$ec\_lcpinf_{t-1} = lcpinf_{t-1} - \beta_1 oilp_{t-1} - \beta_2 ls_{t-1} + \beta_3 cpi^{SA}_{t-1} \quad (1.2.1)$$

Model 2

$$\Delta lcpi_t - a = \sum_{i=1}^{k1} \gamma_i \Delta lcpi_{t-i} + \sum_{i=0}^{k2} \pi_i \Delta x_{t-i} + \phi D_t + \alpha_1 ec\_lcpi_{t-1} + \alpha_2 ec\_rmb_{t-1} + \alpha_3 output\_gap_{t-1} + \varepsilon_t \quad (2)$$

$$ec\_lcpi_{t-1} = lcpi_{t-1} - \beta_1 loilp_{t-1} - \beta_2 ls_{t-1} - \beta_3 lwfp_{t-1} \quad (2.1)$$

where $\Delta lcpi_t - w$ is the change in the disaggregated inflation measure obtained as the weighted sum of food CPI inflation and non-food CPI inflation with as the weight on food CPI (0.5501) and (1 - w) as the weight on non-food CPI (0.4500) in the CPI basket; $\Delta lcpi_t - a$ is the change in aggregate inflation measured by the consumer price index (cpi_t); Δx_{t-i} is a vector of lagged potential inflation explanatory variables in first difference values; D_t is a vector of deterministic terms; ec_rmb_{t-1}, ec_lcpif_{t-1}, and ec_lcpinf_{t-1}, are error correction terms; $output\_gap_{t-1}$ is agricultural output gap; and ε_t is a stochastic error term; rmb_t is real money balances defined as (m_t - p_t) where m_t is money supply while p_t is the price level, y_t is real income, and r_t is the opportunity cost of holding money or returns of holding money proxied by the treasury bill rate (tbr_t), inflation (cpi_t) – the expected cost of holding money instead of goods and the exchange rate (s_t) – the expected cost of holding domestic money balances instead of foreign currency); cpi^{SA}_t is the consumer price index for South Africa representing imported inflation as most of the imported consumer goods are sourced from South Africa; log $agricoutput_t$ is the logarithm of actual agricutural output representing mainly maize production, $agrictrend_t$ is the estimated long-run trend in agricultural output; $cpif_t$ is domestic food inflation; wfp_t is world food prices; $cpinf_t$ is non-food CPI inflation; and $oilp_t$ is world crude oil prices.

Similar to Durevall and Sjö (2012), modelling of inflation takes into account the role of excess money supply in overall inflation dynamics as specified in the real money balances error correction equation (1.1.2). This is on the basis that expansionary fiscal policy financed by printing money is the key cause of high inflation. The ec_rmb_t captures the deviations from an assumed long-run equilibrium relation between the supply and demand for real money balances.

The importance of food in the inflation dynamics in Zambia is captured in agricultural output which constitutes about 55% of overall CPI inflation. A positive domestic agricultural supply shock is expected to reduce domestic prices and subsequently lower inflation whereas a negative agricultural supply shock will drive prices up and increase inflation unless imports are allowed to cover excess demand (Durevall and Sjö, 2012).

Explicit modelling of food inflation is essential due to its significant weight in the overall CPI in Zambia of 0.55 (refer to Section II). Thus, shocks to food items that include food prices, rainfall and agricultural production are bound to bear significant short-run impact on inflation. According to equation (1.1.1), domestic food CPI inflation is assumed to adjust to world food prices and the exchange rate in the long-run.

Domestic non-food CPI inflation is assumed to adjust to world crude oil prices, foreign inflation and the exchange rate in the long-run. The motivation for including oil prices is that energy constitutes the largest weight of about 25% in non-food inflation, which combined with food CPI amounts to about 66% in weight in total CPI.

The core model 1 is compared with the alternative model 2 to determine its suitability as a robust forecasting model. The root mean square error (RMSE) is used to evaluate the appropriateness of model 1[2].

4. Data Sources and Description

All the data except real GDP, agricultural output, crude oil price and the world food price index are obtained from the Bank of Zambia. Real GDP and agricultural output are taken from the Central Statistical Office of Zambia database. Crude oil price and the world food price index are obtained from the World Bank Commodity Price Data (The Pink Sheet).

The overall consumer price index (cpi_t) incorporates both food CPI ($cpif_t$) and non-food CPI ($cpinf_t$) components as described in section II with 2009=100 as the base year. Real GDP (y_t) and agricultural output (ay_t) are interpolated from annual series using the cubic match method to obtain quarterly data. Agricultural output reflects production values expressed in millions of Kwacha from the agriculture, forestry and fishing sector and represent agricultural supply shocks. Thus $output\_gap_t$ is the difference between actual agricultural output ($agricoutput_t$) and the estimated long-run trend in agricultural output ($agrictrend_t$) obtained using the Hodrick-Prescott filter. Money supply (*M2*) includes foreign currency deposits and is expressed in millions of Kwacha. The exchange rate (s_t) is the nominal quarterly average Kwacha/US dollar (kusd) while tbr_t is the 3-month average Treasury bill rate. Crude oil price ($oilp_t$) is expressed in US dollars per barrel. World food prices (wfp_t) is an index dominated by maize and wheat prices, which are relevant to Zambia as these two items dominate the food CPI as explained in section II.

5. Empirical Results

The empirical estimates of equations (1) and (2) are reported below. This is preceded by the determination of time series properties of the variables.

All the variables are non-stationary and integrated of order one, with an exception of the Treasury bill rate and agricultural output gap, based on the ADF unit root test results presented below.

ADF Unit Root Test

Variable	ADF			Variable Description
	level	First Difference	lags	
$lcpi_t$	-1.05	-9.97***	0	Logarithm of overall consumer price index
$lcpif_t$	-1.69	-9.97***	0	Logarithm of food consumer price index
1 $cpinf_t$	-2.96	-12.70***	0	Logarithm of non-food consumer price index
$lM2$	-2.10	-18.22***	0	Logarithm of broad money supply ( )
$lrmb_t$	-3.29	-16.63***	0	Logarithm of real money balances defined as $^{lM2}/_{lcpi_t}$
ly_t	-1.70	-3.93***	5	Logarithm of real GDP
tbr_t	-5.06***		1	3-month Treasury bill rate
$lwfp_t$	-2.39	-11.59***	1	Logarithm of the world food price
$lcpi_t^{SA}$	-2.59	-11.94***	0	Logarithm of the CPI for South Africa
$loilp_t$	-3.23	-11.93***	0	Logarithm of the world crude oil price in US dollars per barrel
ls_t	-1888	-10.35***	1	Logarithm of the nominal k/usd
$output\_gap_t$	-3.49**		4	Agricultural output gap

***, **, and * imply 1%, 5% and 10% levels of significance. The ADF test includes a constant and trend.

The VAR models and Johansen cointegration tests for the long-run relationships in models 1 and 2 are reported below.

Model 1

$$\Delta lcpi_t - w = 0.501\Delta lfcpi_t + 0.500\Delta 1\ cpinf_t$$

$$\Delta lcpif_t = \underset{(12.34)}{0.06} - \underset{(-6.13)}{0.52}\Delta lcpif_{t-2} - \underset{(-2.48)}{0.08}\Delta lwfp_{t-2} - \underset{(-8.52)}{0.11}ec\_lcpif_{t-1}$$

$$\Delta 1\ cpinf_t = \underset{(-2.55)}{-0.02} - \underset{(-2.44)}{0.25}\Delta 1\ cpinf_{t-4} + \underset{(3.04)}{0.59}\Delta ls_{t-1} - \underset{(-7.41)}{0.05}ec\_1\ cpinf_{t-1} - \underset{(-2.88)}{0.07}ec\_rmb_{t-1} + \underset{(2.98)}{0.01}DQ1$$

$$ec\_lcpif_{t-1} = lcpif_{t-1} - \underset{(-6.01)}{0.99}ls_{t-1} - \underset{(-3.74)}{0.79}lwfp_{t-1} + \underset{(0.80)}{0.005}trend + 1.27$$

$$ec\_1\ cpinf_{t-1} = 1\ cpinf_{t-1} - \underset{(-2.63)}{0.44}ls_{t-1} - \underset{(-2.64)}{0.38}loilp_{t-1} - \underset{(-4.49)}{2.86}$$

$$ec\_rmb_{t-1} = lrmb_{t-1} - \underset{(-5.27)}{1.09}ly_{t-1} + \underset{(7.02)}{8.09}ls_{t-1} - 2.32$$

Model 2

$$\Delta lcpi_t = \underset{(13.15)}{0.06} - \underset{(-4.99)}{0.47}\Delta lcpi_{t-2} - \underset{(-9.87)}{0.07}ec\_lcpi_{t-1}$$

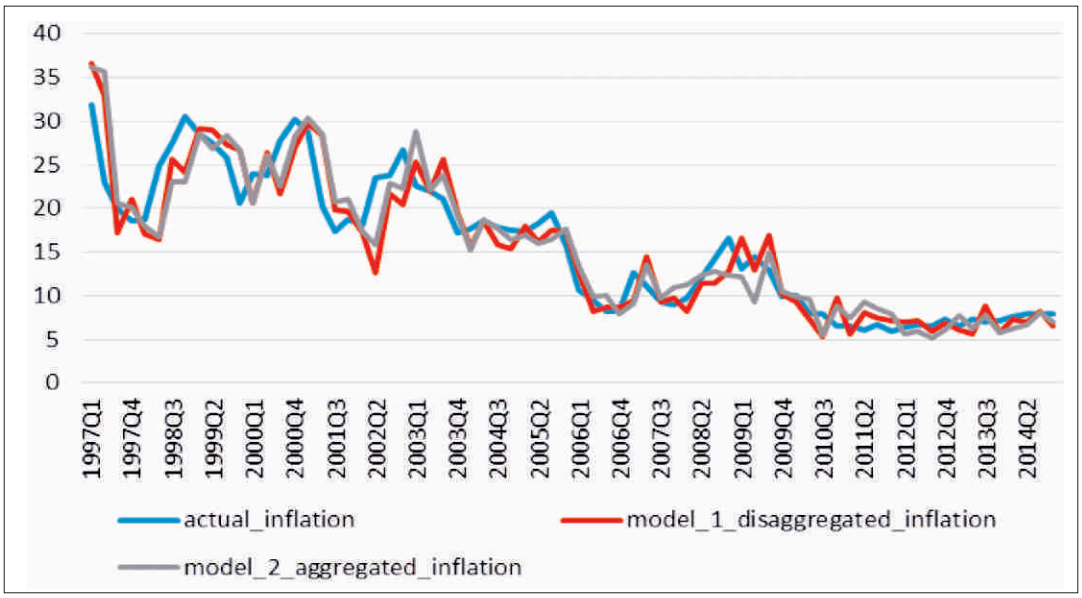
$$ec\_lcpif_{t-1} = lcpif_{t-1} - \underset{(-5.38)}{0.96}ls_{t-1} - \underset{(-2.50)}{0.64}lwfp_{t-1} - \underset{(-1.05)}{0.23}loilp_{t-1} + \underset{(1.60)}{0.01}trend + 0.91$$

Model 1 provides more information about the factors underlying inflation dynamics while model 2 simply reflects inflation inertia and the adjustment of inflation to deviations from its long-run trend. The in-sample forecast in the chart below reveal that both the aggregate and disaggregated forecasts closely track actual CPI inflation. However, the RMSE for model 1 (disaggregated) of 3.270762 is lower than that for model 2 (aggregate) of 3.309400. This result therefore confirms the preference of model 1 to model 2 in line with the argument that information content and improvements in forecasting accuracy of inflation increases with the disaggregation of the price index into its sub-components. Moreover, model 1 is amenable for policy analysis as it reveals more information that is relevant for policy decision.

The estimated real money demand equation, the exchange rate provided more robust results compared to the Treasury bill rate and inflation as alternative measures of the cost of holding money. The sign on the Treasury bill rate in equation (1.1.2) was contrary to expectation reflecting weak link on money demand. The CPI for South Africa was excluded

from the final model as it generated invalid results when included together with the exchange rate[3].

Actual and Forecasted Inflation



6. Conclusion and Policy Recommendations

Two inflation forecasting models were developed using quarterly data over the period 1994-2014. A disaggregated approach was used to provide more information about the underlying behaviour of inflation in Zambia. The results reveal that the disaggregated model of inflation forecasting provides more information about the underlying influences of inflation and therefore preferred for policy analysis than the aggregated model. To ensure information content and improvements in forecasting accuracy, it is recommended that inflation forecasting utilises information generated from the disaggregated model of CPI.

[3]The two variables are highly correlated such that the effects of the exchange rate in the non-food CPI are stronger than imported inflation.

References

Aron, J., and Muellbauer, J. (2009) Some Issues in Modelling and Forecasting Inflation in South Africa, CSAE Working no. 01/2009

Aron, J., and Muellbauer, J. (2008) New Methods for Forecasting Inflation and its Sub-Components: Application to the USA, University of Economics Discussion paper Series No.406.

Bauer, A., Halton, N., and Peterman, W. (2004) Decomposing Inflation, *Economic Review*, Federal Reserve Bank of Atlanta, First Quarter.

Central Statistical Office (CSO), Prices Statistics, 2014.

Durevall, D., and Ndung'u, N.S. (1999) A Dynamic Model of Inflation for Kenya, 1974-1996, IMF Working Paper, WP/99/97, Washington DC.

Durevall, D., and Sjö, B. (2012) The Dynamics of Inflation in Ethiopia and Kenya, African Development Bank Group Working Paper No.151, August.

Lebow, D. E., and Rudd, J. B. (2006) Inflation Measurement, Federal Reserve Board, Washington, D.C., Finance and Economics Discussion Series, 2006-43

Musongole, M.C. (2011) Core Inflation Measure for Zambia, *The BoZ Reader*, Vol. 01, No. 06. Lusaka.

Mutoti, N. (2006) Food and Non-food Inflation: An Econometric Analysis, Bank of Zambia (unpublished).

Mwansa, L. (1998) Determinants of Inflation in Zambia, PhD Thesis, *University of Coteborg*, Sweden.

Mwenda, A. (1997) Inflation Formation in Post-Liberalization Zambia and its Implications for Stabilization Policy, Bank of Zambia (unpublished).

Pamu, E.M., and Simuchile, H. (2004) Dynamics of Inflation Determination in Zambia, *The BoZ Reader*, Vol. 03, No. 02.

Appendix

Table 1: CPI Main Groups (2009 Base Year) **CPI Main Groups (1994 Base Year**

	Weight		Weight
Food Items	550.1	Food Items	571
Food and Non-Alcoholic beverages	534.9	Food and Beverages	571
Alcoholic beverages and tobacco	15.2		
Non-Food Items	**450.0**	**Non-Food Items**	**429**
Clothing and footwear	80.8	Clothing and footwear	68
Housing, water, electricity, gas and other fuels	114.1	Rent, fuel and lighting	85
Furnishings, household equipment, and routine house maintenance	82.4	Furniture and household goods	82
Health	8.2	Medical care	8
Transport	58.1	Transport and communication	96
Communication	12.9		
Recreation and culture	13.8	Recreation and education	49
Education	26.6		
Restaurant and hotel	3.4		
Miscellaneous goods and services	49.7	Other goods and services	41
All Items	**1000**		**1000**

Table 2: Main components of Food Items

Food sub-group	**Weight**
Bread and cereals	145.831
Meat	82.723
Fish	89.084
Milk, cheese and eggs	23.629
Oils and fats	40.006
Fruits	17.754
Vegetables	74.223
Sugar, jam, honey, chocolate and confectionary	34.837
Other food products	17.442
	525.523
Non-alcoholic beverages	**8.577**
Alcoholic beverages	**13.687**
Tobacco	**1.476**

Source: CSO, Prices Statistics, 2014

CHAPTER TWO

The Dynamic Effects of Fiscal Policy Shocks on Inflation and Economic Activity

Patrick Mumbi Chileshe

Abstract

This study investigates the dynamic effects of fiscal policy shocks on consumer prices and economic activity using monthly time series data from Zambia. Using impulse response functions and variance decomposition from a structural VAR, the result indicates that fiscal policy shocks have significant effects on prices and economic activity. Specifically, positive innovations to the government wage bill is followed by persistent and significant rises in the consumer prices and economic activity while positive shocks to tax revenue is followed by a significant fall in output. However, innovations in the expenditure on goods and services have no significant effects on prices and output. Results from this study imply that there is need for fiscal authorities to be cautious of the effects of their actions on macroeconomic stability especially with regard to price stability.

1. Introduction

The macroeconomic implications of fiscal policy have been a subject of interest from economists and policy makers' world over. For example, Keynesian demand management theories advocate the use of expansionary fiscal policy to stimulate economic activity. Textbook analyses of the macroeconomic implications of such a move are easier to arrive at. For example, under a simple Keynesian macroeconomic model with sticky prices such a move would result in increased output while the classical macroeconomic model with flexible prices would predict increases in inflation as prices and wages are assumed to be fully flexible. However, available empirical literature seem to suggest that the impact of fiscal policies may not actually be as simple as these analyses and their magnitude differ from one country to another (Rezk et al. (2007); Blanchard and Perotti (2002); Giordano et al. (2005), Fatas' and Mihov (2001); and Heppke-Falk (2006)). Furthermore, much of the available literature is from advanced and a few emerging economies and very scant from the developing economies. To the knowledge of the author, there is no empirical evidence on Africa. Thus, given the foregoing, an empirical study on the macroeconomic effects of fiscal policy in a developing country such as Zambia would significantly add to literature on understanding the impact of fiscal policy on macroeconomic variables such as inflation and economic activity.

Understanding the macroeconomic implications of fiscal policy, especially the various components of public expenditure, is important both to the fiscal and monetary policy makers. On one hand, fiscal policy makers find such information useful in designing effective policy that can spur growth and create jobs. On the other hand, monetary authorities require this information for designing policies that correctly respond to shocks from the fiscal sector in order to maintain price stability. Against this background, the main

objective of this paper is to study the effects of government spending, distinguishing between wage and non-wage expenditure and of net revenues on macroeconomic variables such as output and inflation.

The rest of the paper is organised as follows: Section 2 outlines a brief overview of literature; Section 3 presents an overview of developments in fiscal indicators as well as macroeconomic indicators, Section 4 outlines the model specifications as well as the data used in the study; Section 5 presents and discusses empirical results while conclusions and recommendations are given in section 6.

2. Brief Overview of Literature

Studies on the impulse response functions' estimation in Zambia have been mainly developed for monetary policy issues with none analysing the impact of fiscal shocks on macroeconomic variables. However, on the contrary there is a lot of international literature on the topic especially from the developed and emerging economies (Blanchard and Perotti, 2002; Giordano et al., 2005; Hepke-Falke et al., 2006; Rezk et al., 2006; Ravnik and Zilic, 2010).

Blanchard and Perotti (2002) use a structural VAR specification to characterise the dynamic effects of shocks in government expenditure and taxes on economic activity in the USA. They defended the use of a VAR on grounds that it is better suited for fiscal policy studies as fiscal variables change for many reasons such that it is difficult to isolate them. Therefore, they argue that decision and implementation of fiscal policy lags ensure that discretionary response of fiscal policy to unexpected contemporaneous movements in output would be rare. Their VAR model consists of three variables namely real GDP, government expenditure, and net revenues. Their results showed that positive innovations in public spending and in taxes respectively had a positive and negative impact on output while they find that innovations to taxes and spending has a strong effect on private sector investment.

Giordano *et al.* (2005) use a seven variable SVAR model of the Italian economy which includes real private GDP, private GDP deflator, private employment, nominal interest rate, real government spending on goods and services, real government wages and real net taxes. They find that a shock to government spending on goods and services has a relatively larger effect on economic activity and employment than a shock to government wage bill. However, the reactions of interest rates and inflation to a shock to both public sector wages and purchases of goods and services are small and short lived. Further, they show that a shock to net taxes has smaller effect on both inflation and output.

Heppke-Falk *et al.* (2006) uses a SVAR model to analyse the impact of fiscal policy in the Germany economy. Their model consists of five endogenous variables which include real GDP, inflation, short-term interest rates, direct government expenditure and net tax revenues of government. They find that shocks to government expenditure increases output and private consumption. The results also indicate that shocks to net revenue do not significantly affect output and inflation.

Rezk *et al.* (2006) uses a 5-variable VAR model to study the dynamic impact of fiscal shocks on macroeconomic variables in Argentina such as gross domestic product, inflation and the level of unemployment. Using quarterly data, the impulse response function indicate relative significance of fiscal shocks upon macroeconomic variables and a short lived impact of innovations.

Ravnik and Zilic (2010) uses a structural VAR model to study the effects of fiscal shocks on economic activity, inflation and short-term interest rates in Croatia. The model includes 5-variables which includes real government expenditure, inflation, short-term interest rates,

net revenues and real GDP. The results suggest that the effects of government expenditure shocks and of the revenues shocks are relatively the highest on interest rates and lowest on inflation. A tax shock is found to increase inflation in the short term and also decreases interest rates and after one year stabilisation is achieved at the initial level.

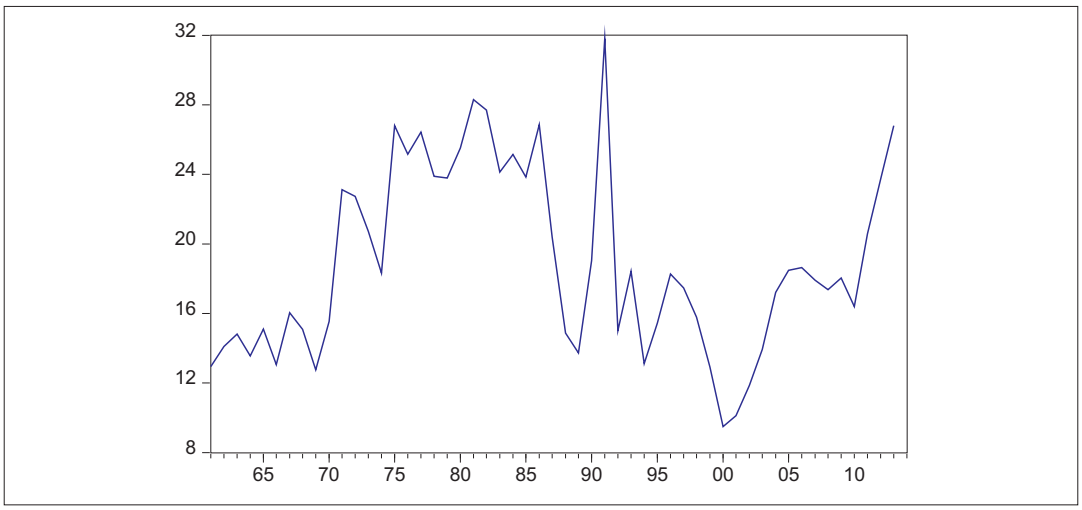
The studies reviewed in this paper are all based on the methodological approach developed by Blanchard and Perotti (2002). Furthermore, it is important to note that the results of the reviewed studies also vary from one country to another.

3. Evolution in fiscal policy indicators and Macroeconomic Indicators in Zambia since Independence

At Independence in 1964, Zambia inherited a relatively stable macroeconomic environment with a mixed economic structure. In 1965, per capita income stood at US $965, economic growth was at 3.1% per annum, external reserves stood at 9.5 months of import cover while the rich mineral resource-especially copper contributed around 18.5% towards government revenue (Whitworth, 2012).

Under the earlier Federal administration, Northern Rhodesia lacked control over key issues-such as fiscal, industrial and commercial policy, transport and communication, defense and foreign affairs and education policy- which are critical in the management of any modern day state. Lack of such power implied that Zambia inherited very poor infrastructure, industry and public administration systems to support the new government compared to other former colonies. This prompted the new government to devise ambitious programs aimed at accelerating development of economic infrastructure as well as massive investment in social infrastructure. In addition, in order to cushion the urban population from rising expenses government introduced food subsidies. Government expenditure to GDP ratio rose from slightly 13% in 1965 to over 23% in 1971 (see figure 1 below) supported mainly by mining taxes which averaged 52% of total government revenue over this period.

Figure 1: Trends in Government Expenditure to GDP ratio, 1961 - 2013



Source: Computations by the author

In 1965, the Government of Southern Rhodesia unilaterally declared independence from Great Britain. Great Britain supported by fellow western countries imposed economic sanctions on Southern Rhodesia. Zambia took the brunt of this standoff between Southern Rhodesia and the rest of the world. For example, the oil embargo on Southern Rhodesia cut

off Zambia's supplies, too, and it had to depend on a ridiculously elaborate and expensive airlift over distances of more than a thousand miles (Martin, 1972). To find a longer lasting solution to this dependence on Rhodesia and other countries, Zambia formulated the Mulungushi and Matero reforms in 1968 and 1969, respectively. Under these set of reforms, government wanted to reduce its dependence on foreign manufactured goods through the import substitution strategy as well as opening up new trade routes through the port of Dar es Salaam. All this meant increased pressure on the country's fiscal resources, such that public sector wages grew by an average of 18% between 1965 to 1969 (Whitworth, 2012). Nonetheless, the government was able to sustain this through high revenue from mineral taxes which averaged 59% of total government revenue. For example, Whitworth (2012) notes that 'with mining revenues averaging 17% of GDP between 1965 and 1970, GRZ was able to dramatically increase public expenditure while seemingly following conservative macroeconomic policies". In addition, during much of this period government budget was usually in surplus.

Massive investment in economic and social infrastructure helped to bolster economic growth during the period 1965 to 1970, with the economy growing by an average of 3.9% while per-capita income grew by 0.8%.

Table 1: Trends in Macroeconomic variables

Indicator Name	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011	2012
Real Per Capita GDP growth	0.8	-1.9	-1.8	-1.7	2.8	3.6	4.0
Real GDP growth	3.9	1.5	1.1	0.8	5.6	6.8	7.3
Inflation	-	-	76.9	68.1	15.5	6.4	6.6
External debt stocks (% of GNI)	-	75.3	206.1	214.3	89.9	27.4	27.6
External Debt(% of GDP)	-	48.7	119.3	147.3	67.9	18.1	19.0
Total debt service (% of exports)	2.9	26.2	25.1	25.0	12.9	2.2	2.2
Total reserves (% of total external debt)	-	10.1	2.8	2.8	23.1	47.0	56.5
Total Reserves (% of GDP)	18.6	7.1	4.5	5.0	9.1	12.1	14.7
Broad money (% of GDP)	19.3	29.0	30.9	18.2	21.3	23.4	24.1
Broad money growth (annual %)	27.2	10.5	41.5	49.9	22.7	21.7	17.9
Real interest rate (%)	-	0.8	-15.5	3.1	11.3	5.6	5.6
Domestic credit (% of GDP)	-0.3	41.9	63.9	59.6	28.2	18.1	18.5
Domestic credit to private sector (% of GDP)	8.5	17.1	14.0	7.5	9.6	12.3	14.8
External balance (% of GDP)	15.1	0.9	-1.7	-6.9	-2.4	9.0	-

Source: World Bank database and re-computations by author

Although government increased its expenditure to support its development agenda it still remained sustainable. However, in 1974 there were fundamental external shocks to the economy, copper prices crashed on the international markets causing mineral tax revenue to fall from 53% of government revenue in 1974 to 13% in 1975 and only 4% in 1976 while oil prices fundamentally rose. This state of affairs lead to a fiscal and foreign exchange crisis, leading to budget deficits averaging 12.3% in the 1970s while the current account deficit was 85% of total exports (Whitworth, 2013, 2012). In addition, rising fuel transportation costs following the closure of the Southern Rhodesia border compounded the problem.

The government interpreted these as temporal and not permanent shocks and hence they responded by increasing its borrowing on both the domestic and external financial markets to sustain the development efforts started earlier. This caused average external debt stock as a percent of GDP to rise above 48.7% during the period. In the domestic markets, government borrowing contributed nearly 258% increase in domestic credit expansion between 1974 and 1978, leading to an increase in money supply and consequently inflation (Whitworth, 2013). Fiscal deficits kept rising for much of the 1980s as subsidies continued to rise on account of rising food prices, oil prices and funding to failing parastatals.

During the 1970s and 1980s, the prices of copper continued to fall while budget deficits persisted; this caused government to turn to external borrowing which reached an average 119.3% of GDP in the 1980s from 48.7% in 1970s. In absolute terms, external debt stock doubled from about US$800 million in 1970 to $1.6 billion in 1975 and doubled again to $3.3 billion in 1980, and reached $7.2 billion in 1990 (Fernholz, 2004:266). The rising foreign debt greatly incapacitated the ability of government expenditure on key economic programs with debt service (on interest rate alone) rising from 5% in 1975 to 15% in 1984, 31% in 1985 and close to 41% in 1986.

Deterioration of the fiscal position manifested itself in key macroeconomic variables. Economic growth slowed further from 1.5% in 1970s to 1.1% in 1980s while the per-capita income continued to shrink (see table 1 above). Annual inflation worsened from 20% at the start of the 1980s to over 100% at the close of the 1980s.

In 1991, a new government was ushered into office after a general election. The new government inherited an economy with almost all macroeconomic variables out of track. Annual inflation was well over 100%, economic growth was shrinking at 1.1% per annum while per capita income was growing at -3.6%, and external debt stock stood at 223.0% of GDP during the 1991 to 1995 period.

To improve the poor macro-economic environment, the new government started implementing economic reforms such as decontrolling of prices, trade liberalization and privatizing state owned enterprises. On the fiscal front the government introduced cash budget as well as started undertaking tax administration reforms to enhance revenue collection. The effect of these reforms included an improvement in key macroeconomic variables: the economy returned to positive growth of 2.8% while per capita income grew by 0.1% over the 1996 to 2000 period; and inflation declined to an average of 29.0% (see table1, above).

The impact of earlier economic reforms boosted by booming copper prices on the international market as well as reduced indebtedness has seen a marked turn around in economic performance. Since 2001, both per capita income and real GDP growth have grown at positive rates averaging 2.8% and 5.6%, respectively. Good economic performance helped to improve government revenues over the same period, boosting spending on both economic and social infrastructure such as roads, schools, and hospitals. For example, government revenues grew to 22.2% of GDP in 2013 from less than 19% in 2001.

4. Methodology

4.1 Baseline Structural Vector Auto-regression Specification

This study adapts the methodology used by Blanchard and Perotti (2002), Perotti (2002) and Giordano *et al.* (2005) but extended to incorporate exogenous variables. The reasons for inclusion of such variables have been documented in literature over the years. Sims (1992) argues that the inclusion of such variables would help to reduce the possibility of the occurrence of "economic puzzles" in which economic variables are found to respond to shocks in a counter-intuitive manner. The Benchmark VAR includes the following six endogenous variables: real GDP (y_t) [as a proxy for economic activity], the consumer price index (p_t), average nominal lending rate (r_t), real government spending on goods and services (g_t), real public sector wage bill (w_t) and real tax revenue (T_t) and two exogenous variables, commodity price index ($pcom_t$), and US Federal Funds rate (FFR_t).

The reduced form VAR is given by the following specification:

$$Y_t = B(L)Y_{t-1} + C(L)X_t + U_t \quad (1)$$

Y_t in equation 1 above is an *kx1* vector of endogenous variables while X_{t-1} is an *mx1* vector of exogenous variables, *B(L)* and *C(L)* are the reduced form autoregressive lag polynomials and U_t is a *kx1* vector of reduced form innovations. The choice of the lag structure is made using the Akaike Information Criterion (*AIC*) and Final Prediction Error procedures.

4.2 The Blanchard-Perotti Identification Methodology

Identification is a necessary step in order to ensure that impulse response functions yield economically reasonable interpretations and this is done by imposing appropriate restrictions on the reduced form residuals . In this case, the study borrows from works by Blanchard and Perotti (2002), Perotti (2002) and Giordano *et al.* (2006). In these studies, fiscal shocks are identified by imposing contemporaneous restrictions on the vector , so as to derive a vector of 'structural' fiscal shocks, orthogonal to each other and to the variables of the model.

The structural shocks and reduced form residuals are linked by the structure:

$$AU_t = Be_t \quad (2)$$

Where the shocks are independent and identically distributed with covariance matrix equal to the identity one. In the above equation 2, matrix A links contemporaneously the reduced form residuals while the matrix B defines how structural shocks affect the variables of the VAR. Given the reduced form VAR and equation 2, the structural VAR can be obtained by pre multiply equation 1 by A:

$$AY_t = AB(L)Y_{t-1} + AC(L)X_t + AU_t = AB(L)Y_{t-1} + AC(L)X_t + Be_t \quad (3)$$

In order to clearly identify the fiscal shocks Giordano *et al.* (2006) assume that only fiscal shocks have a clear economic interpretation in studying macroeconomic effects of fiscal policies.

Following Blanchard and Perotti (2002) and Giordano *et al.* (2006), we express the reduced form innovations of government spending on goods and services, government wage bill and tax revenue as linear combinations of the structural shocks e^s_t, e^w_t and e^T_t to these variables and innovations to the other variables of the VAR:

$$\begin{aligned} u_t^g &= \alpha_y^g u_t^y + \alpha_p^g u_t^p + \alpha_r^g u_t^r + \beta_T^g e_t^T + \beta_w^g e_t^w + e_t^g \\ u_t^T &= \alpha_y^T u_t^y + \alpha_p^T u_t^p + \alpha_r^T u_t^r + \beta_g^T e_t^g + \beta_w^T e_t^w + e_t^w \\ u_t^w &= \alpha_y^w u_t^y + \alpha_p^w u_t^p + \alpha_r^w u_t^r + \beta_T^w e_t^T + \beta_g^w e_t^g + e_t^w \end{aligned} \quad (4)$$

α^i_j captures both the automatic elasticity of fiscal variable *i* to macroeconomic variable *j(y,p,r)* and discretionary change in variable *i* enacted by policy makers in response to innovations in macroeconomic variables. The coefficient β^i_j measure how the structural shock to the fiscal variable contemporaneously affect variable *i*.

In the system of equations in 4, the interest is in estimating the shocks e^g_t, e^w_t and e^T_t and the response of the macroeconomic variables to these shocks. However, without restrictions it is not possible to estimate the effects in the above system. As in Blanchard and Perotti (2002) and Perotti (2002) we achieve identifications by exploiting lags in fiscal policy response to changes in economic environment and also utilising institutional informational about the automatic elasticity of fiscal variables to economic activity and price level.

We start by assuming that policy makers do not react to changes in the macroeconomic variables within a shorter period of time such as a quarter or a month. For example, government would only enact changes to fiscal policy after approval by Parliament which may take more than a quarter, in some instances parliament may be on recess when the macroeconomic environment changes. Thus with monthly data as used in this study, the α^i_j captures only the automatic elasticity of the fiscal variable *i* to the macro variable *j*: due to decision and implementation lags the contemporaneous, discretionary change in variable *i* in response to an innovation in variable *j* is zero. However, even with these assumptions we need further restrictions to identify the coefficients α^i_j. In order to identify the system, we need an external estimate of the automatic contemporaneous elasticities $\alpha\chi^i_j$.

These elasticities are computed on the basis of institutional information as explained in the following section. Using these values for contemporaneous elasticities we can estimate the structural shocks.

Using the elasticities described below, we construct the cyclically adjusted (CA) residuals for fiscal variables:

$$
\begin{aligned}
u_t^{w,CA} &= u_t^w - \alpha_y^w u_t^y - \alpha_p^w u_t^p - \alpha_r^w u_t^r = \beta_T^w e_t^T + \beta_g^w e_t^g + e_t^w \\
u_t^{g,CA} &= u_t^g - \alpha_y^g u_t^y - \alpha_p^g u_t^p - \alpha_r^g u_t^r = \beta_T^g e_t^T + \beta_w^g e_t^w + e_t^g \\
u_t^{T,CA} &= u_t^T - \alpha_y^T u_t^y - \alpha_p^T u_t^p - \alpha_r^T u_t^r = \beta_g^T e_t^g + \beta_w^T e_t^w + e_t^w
\end{aligned}
\qquad 5
$$

Since we have six $\beta^i_j s$ and only three equations, we cannot estimate all of them. Thus, we need to take a stance on the ordering of the fiscal shocks, that is which fiscal variable contemporaneously react to others. In the benchmark model, we assume that public wage bill does not react to changes in other fiscal variables (they come first in ordering). This is equivalent to setting β^w_T and β^w_g to zero. Further, we assume that government expenditure is decided before tax revenue is decided, implying that $\beta^g_T = 0$. Therefore, the system in 5 above reduces to:

$$
\begin{aligned}
u_t^{w,CA} &= e_t^w \\
u_t^{g,CA} &= \beta_w^g e_t^w + e_t^g \\
u_t^{T,CA} &= \beta_g^T e_t^g + \beta_w^T e_t^w + e_t^w
\end{aligned}
\qquad 6
$$

Under these assumptions, the wages shock is equal to cyclically adjusted residuals of the corresponding equation: $u^{w,CA}_t = e^w_t$. Since we assume that government recurrent expenditure is only undertaken after wages have been paid, then the coefficient β^g_w can be estimated by simple OLS regression of $u^{g,CA}_t$ on estimate of the wages shock, e^w_t. Finally, the coefficient β^T_g and β^T_w can be estimated by an OLS regression of $u^{g,CA}_t$ on government spending and government wages shocks.

Lastly, in addition to equations for real economic activity, CPI and short-term interest rates (91-day Treasury bill rates) can be expressed as follows:

$$u^y_t = \alpha^y_g u^g_t + \alpha^y_w u^w_t + \alpha^y_r u^r_t + \alpha^y_T e^T_t + e^y_t$$
$$u^i_t = \alpha^i_g u^g_t + \alpha^i_w u^w_t + \alpha^i_T u^T_t + \alpha^i_y e^y_t + \alpha^i_p e^p_t + e^i_t$$
$$u^p_t = \alpha^p_g u^g_t + \alpha^p_w u^w_t + \alpha^p_T u^r_t + \alpha^p_y u^y_t + e^p_t \qquad 7$$

Thus from equation systems 6 and 7 we can construct A and B matrices in equation 2 above:

$$\begin{bmatrix} 1 & 0 & 0 & \alpha^y_g & -\alpha^y_w & -\alpha^y_T \\ -\alpha^p_y & 1 & 0 & -\alpha^p_g & -\alpha^p_w & -\alpha^p_T \\ -\alpha^i_y & -\alpha^i_p & 1 & -\alpha^i_g & -\alpha^i_w & -\alpha^i_T \\ 0 & -\alpha^g_p & 0 & 1 & 0 & 0 \\ 0 & -\alpha^g_w & 0 & 0 & 1 & 0 \\ -\alpha^T_y & -\alpha^T_p & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u^y_t \\ u^p_t \\ u^i_t \\ u^g_t \\ u^w_t \\ u^T_t \end{bmatrix} = \begin{bmatrix} \beta^y_y & 0 & 0 & 0 & 0 & 0 \\ 0 & \beta^p_p & 0 & 0 & 0 & 0 \\ 0 & 0 & \beta^i_i & 0 & 0 & 0 \\ 0 & 0 & 0 & \beta^g_g & \beta^g_w & 0 \\ 0 & 0 & 0 & 0 & \beta^w_w & 0 \\ 0 & 0 & 0 & \beta^T_w & \beta^T_g & \beta^T_T \end{bmatrix} \begin{bmatrix} e^y_t \\ e^p_t \\ e^i_t \\ e^g_t \\ e^w_t \\ e^T_t \end{bmatrix} \qquad 8$$

To identify the system of equations in 8, $2k^2 - {}^1/_2 k(k+1)$ restrictions must be imposed on both matrices (that is a total of 51 constraints). To start with, matrix B has a total of 27 coefficients that are equal to zero, while the main diagonal of matrix A adds 6 restrictions. In addition, matrix A has 14 coefficients that are equal to zero. This brings the total number of restrictions in the system to 47 and thus we need an additional 4 restrictions for the system to be just identified.

The four restrictions are obtained by assuming that government wage bill does not contemporaneously respond to changes in prices while government spending on goods and services respond to changes in prices. The reasoning for these assumptions is that in most cases wages are not inflation indexed while the purchase value of goods and services changes with changing prices. Following Blanchard and Perotti (2002) and Ravnik and Zilic (2010), we assume that the impact of inflation on government spending on goods and services (α^g_p) has an elasticity between 0.1 and 0.5, while the response of government spending to all innovations are set to zero. In this study, just like in Giordano *et al.* (2006), we use the upper bound of 0.5. It is assumed that government expenditures on goods and services are determined at the start of the fiscal year and government can't respond to changes in the economy in the same period. Furthermore, using institutional information we estimate the impact of income and inflation on taxes using the exogenous elasticities obtained using information outside the model as explained in below, are 1.16 and 0.81. The exogenous elasticities are estimated by using outside information using the following formula:

$$\alpha^T_y = \sum_{i=1}^{n} \varepsilon^{T_i}_{B_i} * \varepsilon^{B_i}_{Y} * \frac{T_i}{T} \qquad and \; \alpha^T_p = \sum_{i=1}^{n} \varepsilon^{T_i}_{B_i} * \varepsilon^{B_i}_{p} * \frac{T_i}{T}$$

Where ε^{Ti}_{Bi} is the elasticity of each tax category to its base, ε^{Bi}_{Y} is the elasticity of each tax base to GDP, while $^{Ti}/_{T}$ is the weight of tax in total revenues. On the hand, ε^{Bi}_{p} is the responsiveness of tax base to inflation. We do not use this methodology to estimate α^{T}_{y} and α^{T}_{p}, but we adopt elasticities estimated by Phiri (2006) that uses comprehensive data.

Lastly, the impact of government expenditure on revenues is modelled through matrix B with structural innovations, the relationship in matrix A is assumed to be none-existence.

Thus the just identified equation system is given by;

$$\begin{bmatrix} 1 & 0 & 0 & \alpha_g^y & -\alpha_w^y & -\alpha_T^y \\ -\alpha_y^p & 1 & 0 & -\alpha_g^p & -\alpha_w^p & -\alpha_T^p \\ -\alpha_y^i & -\alpha_p^i & 1 & -\alpha_g^i & -\alpha_w^i & -\alpha_T^i \\ 0 & 0.5 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 1.16 & 0.81 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^y \\ u_t^p \\ u_t^i \\ u_t^g \\ u_t^w \\ u_t^T \end{bmatrix} = \begin{bmatrix} \beta_y^y & 0 & 0 & 0 & 0 & 0 \\ 0 & \beta_p^p & 0 & 0 & 0 & 0 \\ 0 & 0 & \beta_i^i & 0 & 0 & 0 \\ 0 & 0 & 0 & \beta_g^g & \beta_w^g & 0 \\ 0 & 0 & 0 & 0 & \beta_w^w & 0 \\ 0 & 0 & 0 & \beta_w^T & \beta_g^T & \beta_T^T \end{bmatrix} \begin{bmatrix} e_t^y \\ e_t^p \\ e_t^i \\ e_t^g \\ e_t^w \\ e_t^T \end{bmatrix} \qquad 9$$

Once the SVAR is identified and estimated, we compute impulse responses to evaluate the effects of a structural shock. Impulses are computed using the structural moving average representation of the reduced form VAR in equation 1 above:

$$Y_t = [I - B(L)]^{-1}A^{-1}C(L)X_t + [I - B(L)]^{-1}A^{-1}Be_t \qquad 10$$

In which the polynomial comes from the OLS estimation of the reduced form VAR and matrices A and B as defined in equation system 9. In addition, we present results of the variance decompositions to show the share of the variation in the macroeconomic variables represented by variation in fiscal variables.

In addition, to the impulse response functions the study also presents results on the Forecast Error Variance Decompositions to evaluate the importance of innovations in fiscal variables on inflation and economic activity.

4.3Data and Description of Variables

4.3.1 Data and its sources

This study uses monthly time series data for the period January 1995 to June 2015. The variables used include real GDP (a measure of economic activity) obtained from the Central Statistical Office (CSO); consumer price index (CPI) from CSO; 91-day TB rate obtained from Bank of Zambia database; expenditure on general goods and services, personal emoluments, and tax revenue are all obtained from the fiscal tables of government from the Ministry of Finance. In addition, we include the Federal Funds Rate from Federal Reserve Bank website; the prices of copper and crude oil from the IMF data base. All variables are seasonally adjusted using X_13 ARIMA method developed by the US Bureau of Labour Statistics, except the interest rates. Additionally, all variables are expressed in logs with an exception of TB-rate and the Federal Funds Rate.

4.3.2 Description of Variables

GDP

The economic activity variable used in this study is the real GDP. However, this series is available only at annual interval and it requires interpolation to monthly series. In the estimations, we use GDP figures generated by the Denton interpolation method. The related series which is the Index of Industrial Production (IIP) is only available at a quarterly basis. Hence, we interpolate GDP to a quarterly series using the IIP and then use a procedure provided in EVIEWS software to obtain the monthly series.

Consumer Price Index

The CPI is a composite measure of a country's price level. It is a weighted average of a basket of goods commonly consumed by an average household. The series used in this study has a base year of 2009 and is available on a monthly basis from 1994.

Short Term Interest Rate

The 91-day TB rate is used as a measure of short-term interest rates to gauge the impact of government fiscal activities on interest rates and the cost of credit in general. The direction of the effect of government fiscal operations on interest rates may further dampen economic activity through the role interest rate play on demand for credit and consequently investment.

Government Expenditure on Goods and Services

This refers to government expenditure for the use of goods and services for its own production of both market and non-market output. It excludes government expenditure on wages and salaries. This series is available on a monthly basis from 1994.

Government Wage Bill

This refers to wages and salaries paid by government for use of labour services of households. It is expected that positive innovations to public sector wage bill will raise aggregate demand and prices in the economy. This data is available on a monthly basis from 1994.

Tax Revenue

This refers to total tax revenue collected by Zambia Revenue Authority (ZRA) on income, consumption and trade. Positive innovations to taxes are expected to have deflationary effect on aggregate demand and consequently prices and output. This data series is available on a monthly basis from 1995 to June 2015.

5. Empirical Results

5.1 Diagnostic tests

5.1.1 Unit Root Test

Unit root testing is a standard procedure in any empirical analysis of time series data. This is because existence of non-stationarity in the data series can lead to spurious results. This study uses Augmented Dickey Fuller (ADF) and the Phillips-Peron (PP) test for the presence of unit roots. The results are indicated in the table 2 below:

Table 2: Unit root test

Variable	ADF			PP		
	Levels	Differences	Order	Levels	Differences	Order
Real GDP	-2.05	-3.48**	I(1)	-2.51	-10.26***	I(1)
CPI	-1.20	-11.75***	I(1)	-2.23	-11.53***	I(1)
3-month TB rate	-2.87	(10.24)***	I(1)	-2.98	-10.60***	I(1)
Expenditure on Goods	-2.19	-5.08***	I(1)	-2.37	-7.73***	I(1)
Wage Bill	-1.53	-10.73***	I(1)	-1.65	-12.97***	I(1)
Tax	-1.25	-4.10***	I(1)	-2.57	-4.38***	I(1)
Federal Funds Rate	-1.36	-5.60***	I(1)	-1.14	-7.45***	I(1)
Copper Price	-1.98	-10.45***	I(1)	-1.82	-10.44***	I(1)
Oil Price	-2.38	-13.17***	I(1)	-2.41	-13.15***	I(1)

Source: Author's computation

The results shown in the table 2 indicate that all the variables are integrated of order one, I(1). In the presence of unit roots, we also undertake a co-integration test. Although there are unit roots in the time series, we estimate the VAR in levels and not in differences following Sims (1980) who argues that estimating a VAR in levels helps to take care of the co-integrating relationship among the variables.

5.1.2 Lag-Length Selection

In determining the lag length, there is a trade-off between the degrees of freedom and model specification. Adding lags to an endogenous variable reduces the degrees of freedom, while adding less than optimal number of lags can lead to model misspecification. Thus, the choice of lags in this study is based on results of the Akaike Information Criterion (AIC) and the Final Prediction Error (FPE). These criteria suggest the optimal lag length of 4 as shown in Table 3.

Table 3: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	79.26710	NA	2.53e-08	-0.464429	-0.114284	-0.323315
1	1746.376	3194.125	2.82e-14	-14.17123	-13.29586*	-13.81844
2	1809.347	117.4763	2.25e-14	-14.39788	-12.99730	-13.83342
3	1873.091	115.7017	1.79e-14	-14.63101	-12.70522	-13.85488*
4	1913.661	71.59427	1.73e-14*	-14.66942*	-12.21840	-13.68161
5	1948.866	60.35265	1.75e-14	-14.66274	-11.68651	-13.46327
6	1981.362	54.06920	1.81e-14	-14.63330	-11.13185	-13.22215
7	2015.321	54.79062*	1.86e-14	-14.61614	-10.58948	-12.99333
8	2045.528	47.21452	1.98e-14	-14.56747	-10.01558	-12.73297

Sources: Authors Computation
*indicates lag order selected by the criterion

5.2 Results from Structural VAR analysis

The impulse response functions and the matrices with estimated parameters are discussed in this section. Table 4 below give the estimated matrices A and B.

Table 4: Estimates of Matrix A and B

Estimated A matrix:					
1.000000	0.000000	0.000000	-0.002028	0.000263	0.001497
0.275210	1.000000	0.000000	-0.001445	-0.001578	-0.000703
-1.019518	-0.161991	1.000000	0.013826	-0.014853	0.000111
0.000000	0.100000	0.000000	1.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	1.000000	0.000000
1.160000	0.810000	0.000000	0.000000	0.000000	1.000000
Estimated B matrix:					
0.001940	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.007579	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.019027	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.106430	0.181453	0.000000
0.000000	0.000000	0.000000	0.000000	0.187060	0.000000
0.000000	0.000000	0.000000	0.002323	0.100808	0.265396

Sources: Authors Computation

Impulse Response Analysis

Figure 2 shows responses of macroeconomic variables to a one standard deviation innovation in government expenditure on goods and services; government wages; and tax revenue. Dashed lines represent the two standard deviations, while the solid lines represent the impulse function. If the dashed lines also encompass a zero then we conclude that effect is not significant. We present the impulse response for a period of 36 months.

Effects of Shocks to Government Wage bill

The results in figure 2 below indicate that a one standard shock to government wage-bill significantly increases economic activity or aggregate demand, increasing by a maximum of 0.18% at months 9 (or three quarters). The effect of this shock is remarkably persistent showing that government wages are an important tool for economic stabilisation. Our results are similar to Giordano et al. (2006) and are consistent with the Keynesian macroeconomic theory. From a theoretical perspective, an increase in wages represents a permanent increase in the purchasing power of a large number of economic agents', thereby increasing aggregate demand and consequently economic activity. In addition, the sustained increase in economic activity is due to the fact that public sector wage increase represents a permanent shift in people's purchasing power. The accumulated response shows that the cumulative effect of wage shocks on GDP is 0.59% after six months, 1.69% after one year, 4.18% after two years, and 6.94% after a three year horizon (see table 6 below).

Furthermore, a shock to government wage bill is followed by an increase in inflation which peaks after 6 months with an increase in 0.04% and stays permanently at this level, though this result is not significant. The positive effect of wage shocks on prices is consistent with Giordano et al. (2006); as well as textbook conclusions of the flexible price IS-LM models under both the new Keynesian and Classical paradigms. Specifically, an increase in wages of public sector workers raises aggregate demand thereby pushing prices upwards. The cumulative response of the consumer price index after a wage shock is 1.17% after 6 months, 3.81% after one year, 8.17% after a two year horizon, and 11.58% after a three year period.

Finally, a positive shock to government wage-bill leads to a rise in the short term interest

rates immediately, though not significant. However, cumulatively the impact of the shock is 0.30% after 6 months, 0.96% after a year, 1.84% after two years and nearly 2.07% after a two year horizon.

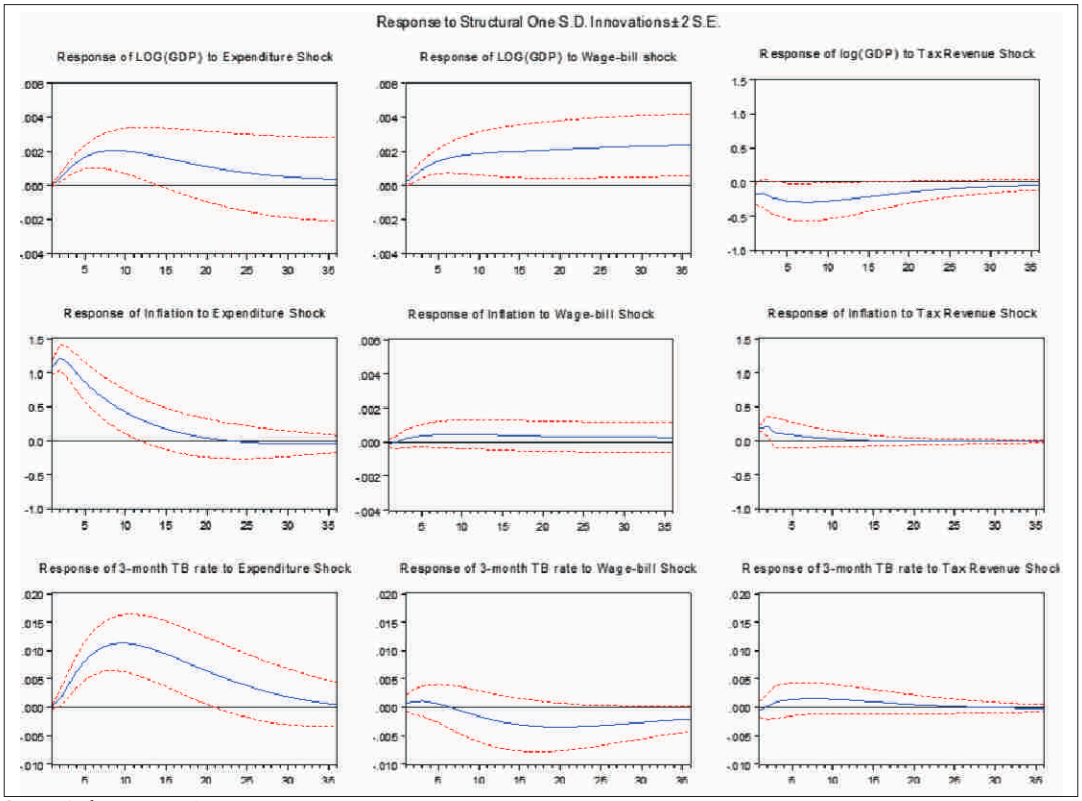
Effects of Shocks to Tax Revenue

A positive shock to tax revenue, equal to one standard deviation, is followed by an immediate fall in the level of economic activity, which bottoms out at 0.19% after 9 months. This result is similar to those found by others (Blanchard and Perroti, 2002; Jemec et al., 2013) as well as textbook expectations but differs from those by Giordano et al., 2006. An increase in taxation affects economic activity through reduced aggregate spending by economic agents, forcing companies to scale down their production activities. In addition, high taxes on businesses increase their operating costs making them to cut production even further. Cumulatively, the impact of tax revenue shocks on economic activity is -1.39% after 6 months, -3.08% after a year, -5.14% at the two year horizon and -5.93% after the two year horizon (see table 5).

In addition, the impact of a shock to tax revenue is followed by an immediate rise in the consumer price index which reaches a maximum in 2 months and starts returning to equilibrium. However, this result is at variant with those obtained by Giordano et al. (2006) and Akpan et al. (2015) who find that a shock to tax revenue has deflationary impact on consumer price index. Our results could imply that firms in Zambia interpret higher taxes as a cost of production and hence pass-on taxes to consumers through increased prices. This is expected especially in an economy, such as Zambia, dominated by monopolistic markets as well as a large share in the CPI of staple foods which are mostly inelastic. As for inflation the cumulative effect of tax revenue shocks to inflation is 0.86% at the 6 month horizon, 2.48% at the one year horizon, and 6.67% after the two year horizon (see table 5).

Finally, positive shocks to tax revenue lead the Treasury bill rate to peak after eight months before slowly returning to its steady state, though this result is not significant. The cumulative effects of tax revenue impulses are 0.05%, 0.13%, 0.21% and 0.21% at the 6 month, 1 year, 2 year, and three year horizons, respectively.

Figure 2: Impulse response functions of the SVAR model



Source: Authors computation

Effects of Shocks to Government Expenditure

Figure 2 indicates that positive shock to government expenditure was found to have effect on consumer prices, economic activity and interest rates. The response of economic activity or aggregate demand is bell-shaped showing the short term nature of aggregate demand management policies on economic growth. Specifically, a positive innovation to expenditure will lead to an increase in economic activity or aggregate demand reaching a maximum after 9 months. This implies that positive shocks to government expenditure will lead to an increase in aggregate demand prompting an increase in economic activity. These results are similar to those obtained by others (Giordano et al., 2006; Rafaella et al., 2008; Akpan et al., 2015). Interestingly, our results do not show that government spending has a persistent effect on economic activity as in other studies; rather the response of economic activity dies out. Clearly, these results indicate that government spending is an important tool for short term macroeconomic stabilisation. Cumulatively the impact of this shock is 0.63% at 6 months, 1.82% at one year and 3.94% at the 3-year horizons (see table 5).

In addition, a positive shock to expenditure leads to an immediate increase in consumer prices which then dies out slowly to the steady state. This result is similar to Rafaella et al. (2008) who also find that shocks to government expenditure leads to a significant rise in inflation. These results are expected from theory in that increasing government expenditure increases aggregate demand resulting in higher prices. This result also imply that the positive relationship with between government spending and economic activity in the short run come at a cost of higher prices. The cumulative effects of tax revenue impulses are

1.08%, 8.86%, 9.95% and 9.46% at the 6 month, 1 year, 2 year, and three year horizon, respectively (see table 5).

Finally, the impulse response function indicate that a positive shock to expenditure leads to a rise in interest rates, reaching a maximum impact after 9 months then start returning to equilibrium. Cumulatively, the effects of tax revenue impulses are 0.30%, 0.96%, 1.84% and 2.07% at the 6 month; 1 year, 2 year, and three year horizon, respectively (see Table 5).

Table 5: Accumulated response of economic variables

	Accumulated Response of Log(GDP)		
Period	**Expenditure Shock**	**Wage Bill Shock**	**Tax Revenue Shock**
1	0.00	0.02	-0.18
6	0.63	0.59	-1.39
12	1.82	1.69	-3.08
18	2.75	2.89	-4.34
24	3.34	4.18	-5.14
30	3.70	5.53	-5.62
36	3.94	6.94	-5.93
Accumulated Response of Inflation			
1	1.08	-0.06	1.86
6	6.06	1.17	7.57
12	8.86	3.81	9.48
18	9.84	6.18	9.40
24	9.95	8.17	8.67
30	9.74	9.92	7.85
36	9.46	11.58	7.16
Accumulated Response of 3-month TB rate			
1	0.00	0.01	0.00
6	0.30	0.05	0.05
12	0.96	-0.03	0.13
18	1.50	-0.22	0.19
24	1.84	-0.42	0.21
30	2.01	-0.60	0.22
36	2.07	-0.74	0.21
Factorisation: Structural			

Source: author computations

Importance of Fiscal Shocks in Macroeconomic Variables

To evaluate the role that fiscal shocks play in macroeconomic fluctuations, we use the Forecast Error Variance Decompositions (FEVD) at the 6-month, 12-month, 18-month, 24-month, 30-month and the 36-month horizon. Although the FEVD does not show the direction of the effect of shocks, it helps to uncover the extent to which variations in a variable affects another at different time horizons. These results are presented in table 6 below.

The results from the forecast error decompositions indicate that at the 1 month horizon the major fluctuations in output are explained by own shocks (92.21%); tax revenue shocks (3.95%); expenditure shocks (3.13%), and wage bill (0.71%). At the 12 month horizon, own shocks account for 51.56%; inflation (11.85%); expenditure shock (6.27%); wage shocks account for 6.31%; TB rate (1.20%) and Tax Revenue (11.98%). However, at the two year horizon own shocks account for nearly 44.29%; Inflation shocks (22.52%); TB rate shocks

(3.49%); expenditure (10.07%); wage bill (8.27%); Tax Revenue (11.36%) while at the 3-year or 36- month horizon wage shocks account for 10.52%; expenditure 9.06% and Tax Revenue shocks account for 11.51%. These results clearly show that fiscal shocks account for a progressively large proportions in the fluctuations of output.

Table 6: Forecast Error Variance Decompositions

Variance Decomposition of GDP							
			Inflation		**Expenditure**	**Wage**	**Revenue**
Period	**S.E.**	**GDP shocks**	**Shoks**	**TB rate Shocks**	**Shocks**	**Shocks**	**Shocks**
1	0.00	92.21	0.00	0.00	3.13	0.71	3.95
6	0.01	62.38	11.85	1.20	6.27	6.31	11.98
12	0.01	51.56	18.73	2.19	7.10	7.48	12.94
18	0.02	46.39	21.30	3.11	9.08	8.14	11.97
24	0.02	44.29	22.52	3.49	10.07	8.27	11.36
30	0.03	43.83	22.45	3.80	9.06	9.97	10.89
36	0.03	41.57	23.33	4.07	9.01	11.51	10.52
Variance Decomposition of Inflation							
1	0.01	2.50	93.75	0.00	3.02	0.58	0.15
6	0.02	6.24	76.84	0.10	9.07	5.23	2.53
12	0.03	8.25	66.66	0.12	13.18	8.37	3.43
18	0.04	9.60	61.40	0.23	16.21	9.54	3.04
24	0.04	13.04	52.19	0.26	20.21	11.61	2.68
30	0.04	16.49	44.29	0.26	23.21	13.36	2.39
36	0.04	17.97	37.48	0.26	25.21	16.91	2.17
Variance Decomposition of 3-month TB rate							
1	0.02	0.97	0.42	98.08	0.07	0.42	0.04
6	0.06	7.82	2.57	78.54	6.43	0.23	4.41
12	0.08	9.02	2.89	65.07	17.01	0.26	5.76
18	0.08	8.62	2.78	61.84	19.81	0.24	6.71
24	0.08	8.51	2.86	60.89	20.19	0.23	7.32
30	0.09	8.63	2.83	60.52	20.35	0.23	7.45
36	0.09	8.86	2.79	60.25	20.46	0.22	7.43
Factorization: Structural							

Source: author computations

In case of inflation, expenditure and wage bill shocks account for progressively larger component of fluctuations apart from own shocks while wage shocks account for very small proportion of the fluctuations. Specifically, expenditure shocks account for 13.18%; 20.21% and 25.21% at the 1-year, 2-year 3-year horizon respectively. On the other hand, wage shocks account for 8.37%; 11.61%; and 16.91% at the 1-year, 2-year and 3-year horizons respectively. However, tax revenue shocks accounts 3.43%, 2.68%, 2.17% at similar horizons. It is clear that fiscal shocks, especially expenditure and wage shocks are important in explaining variations in inflation.

The short-term interest rates fluctuations are mostly explained by innovations in the expenditure and tax revenue shocks. At the one year horizon, 17.01% of the variations in the TB rate are explained by shocks to expenditure while 5.76% are due to innovations in the tax revenue whereas innovations to the wage bill accounted for 0.26%.

6. Conclusions

The aim of this paper was to evaluate the effect on macroeconomic variables such as output, inflation and interest rates of shocks to fiscal variables such as government expenditure on goods and services, government wage bill and the tax revenue. Using an SVAR, we estimate impulse response functions as well variance decompositions to show the impact of fiscal variables upon macroeconomic variables in Zambia using monthly time series data collected from 1994 to 2015.

The results of this study show that innovations to fiscal policy variables have significant effects on real variables of output, interest rates and prices in Zambia. Specifically, we find similar to other studies that shocks to expenditure on goods and services have significant effects on economic activity, inflation and short term interest rates. However, shocks to the wage bill are found to have significant and persistent effects on economic activity only and insignificant on others. Finally, innovations to tax revenue are also found to have significant negative effects on economic activity while having positive effects on inflation.

The results obtained from study have implications for macroeconomic system stability in Zambia. They clearly show that prudent fiscal discipline can create an impetus for general macroeconomic stability in the country.

References

Blanchard, O. and R. Perotti (2002), "An empirical characterisation of the dynamic effects of changes in government spending and taxes on output", *Quartely Journal of Economics*, Vol. 117, No. 4, pp. 1329-68.

Fatas, A. and I. Mihov (2002), "The effects of fiscal policy on consumption and employment: Theory and Evidence", *Center for Economic policy research*, Discussion Paper, No. 2760.

Fernholz, Fernando (2004), 'Debt Management and Debt Relief during the 1990s', in Hill, C. & McPherson, M. (eds.), *Promoting and Sustaining Economic Reform in Zambia*, Harvard University
Press, Cambridge, Massachusetts.

Giordano, R., S. Momigliano, S. Neri and R. Perotti (2005), "The effects on the economy of shocks to different government expenditure items: Estimates with a SVAR model", in Banca d'Italia (ed.), *Public Expenditure*, Roma, Banca d'Italia.

Heppke-Falk, K., J. Tenhofen and G.B.Wolf (2006), "The macroeconomic effects of exogenous fiscal policy shocks in Germany: a disaggregated SVAR analysis", *Deutsche Bundesbank Discussion paper series 1: Economic Studies*, No 41/2006.

Martin, Antony (1972), '*Minding Their Own Business: Zambia's Struggle against Western Control*', Hutchinson, London.

Perotti, R. (2002), "What do we know about the effects of fiscal policy?", in M. Bordignon and D. da Empoli (eds), *Politica fiscal: flessibilita dei mercati e crescita*, Milano, Franco Angeli.

Phiri E., (2006). "Elasticity and Bouyancy of the Zambian Tax system", Unpublished M.A. Dissertation, University of Dar es Saalam.

Ravnik R. and I. Zilic (2010), "The use of SVAR analysis in determining the effects of fiscal shocks in Crotia", *Finance Theory and Practice*, Vol. 35, No. 1, pp. 25-58.

Rezk E., M. Avramovich and M. Basso, (2006), "Dynamic effects of fiscal shocks upon diverse macroeconomic variables: A structural VAR analysis for Argentina", *Annals of the Public Finance Workshop on Fiscal Indicators.*

Whitworth, Alan (2013), 'Creating and Wasting Fiscal Space: Zambian Fiscal Performance, 2002 - 2011', ZIPAR Working Paper, Lusaka.

Whitworth, Alan (2013). "Explaining Zambian Poverty: A History of (non-agriculture) Economic Policy since Independence" unpublished. Available at www.thezambiavoice.org/*2013/.../explaining-zambian-poverty-a-history-of-non-agriculture-economic-policy-since-independence*

CHAPTER THREE

Exchange Rate Pass-through to Domestic Prices in Zambia

*Peter Zgambo**

Abstract

This paper investigates exchange rate pass-through to domestic prices in Zambia using the structural vector auto-regression (SVAR) framework. Empirical evidence from the models estimated over the period 1993Q1 – 2014Q4 suggest an incomplete, persistent and low to moderate exchange rate pass-through to prices. The impact of shocks to the exchange rate exerts more influence on food prices than on non-food and overall prices. The estimated dynamic pass-through elasticities, which range between 0.41 and 0.49 indicate that it takes about 4 quarters, 15 quarters and 26 quarters for shocks to the exchange rate to fully impact food prices, non-food prices and overall prices, respectively. The paper also shows evidence of a low exchange rate pass-through, particularly during the period of single digit and stable inflation (2004-2014), with the estimated dynamic pass-through elasticity of 0.20. Policy implications from this study include the need for authorities to pursue prudent monetary and fiscal policies aimed at fostering macroeconomic stability, reflected in low and stable inflation in order to anchor inflation expectations and minimise exchange rate pass-through.

Key words: Exchange rate pass-through, Domestic prices, Structural VAR, Zambia
JEL Classification Numbers: F31, F41, E31, E41

1. Introduction

The Zambian economy is characterised as a small open economy with a flexible exchange rate regime. In such economies, an understanding of the effect of exchange rate changes on inflation in particular and economic activity in general is important. For an economy with a relatively large import component[1], changes in the exchange rate will impact the domestic economy in three ways. Firstly, the weakening of the domestic currency will raise the domestic cost of production through increased cost of imported intermediate goods, which will eventually be reflected in higher prices of domestically produced finished products. Secondly, a depreciated exchange rate will directly lead to increased prices of imported goods and services. Thirdly, a weaker exchange rate, however, makes exports cheaper in foreign currency and thereby increases the domestic economy's international price competitiveness. This may ultimately have consequences for the balance of payment, especially the balance of trade component.

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[1] In 2014, total import of goods were estimated to be 32.8% of Gross Domestic Product (GDP).

For central banks, the exchange rate is an important price given the impact of the changes in the exchange rate on the inflation objective. The extent to which changes in the exchange rate will impact domestic prices depends on the size or magnitude of the exchange rate pass-through (ERPT). Hence, for policy makers in small open economies to respond effectively to the challenges posed by changes in the exchange rate, there is a need to know whether the pass-through is low or high and its impact on domestic prices and general economic activity. In general, a low exchange rate pass-through will not only provide the central bank with more freedom in conducting an independent monetary policy, but also makes it easier to implement an inflation targeting monetary policy framework (Choudhri and Hakura, 2001). Conversely, a high exchange rate pass-through will constrain the conduct of independent monetary policies as monetary authorities may be forced to react too frequently to dampen exchange rate induced inflationary pressures. In this regard, monetary policy actions taken to dampen exchange rate generated inflationary pressures, such as the increase in interest rates, may in turn impact adversely on economic performance through higher variability of output and inflation. Estimating the magnitude of the exchange rate pass-through is therefore important to formulate and implement appropriate monetary policies.

In the Zambian case, there is limited evidence on the magnitude of exchange rate pass-through (ERPT) to domestic prices. The implication of this is that Bank of Zambia's reactions to changes in the exchange rate, particularly the depreciation of the domestic currency may be sub-optimal. To the best of the author's knowledge, there is no country specific published study done on Zambia that addresses ERPT. However, the macroeconometric model used by BoZ in forecasting and monetary policy analysis estimates exchange rate pass-through to be around 0.16 in the short-run while long-run pass-through is estimated to be at about 0.48 (Akram et al., 2012). Nonetheless, there are a couple of published studies of ERPT involving a group of countries in which Zambia is included (see Choaudhri and Hakura (2001); Razafimahefa (2012)). In a study by Choaudhri et al., (2001) which covered the period 1979 - 2000, and where Zambia was characterised as a high inflation economy, empirical results suggest high pass-through which tended to increase with time. In a more recent study on ERPT in Sub-Sahara African (SSA) economies by Razafimahefa (2012), the degree of ERPT was found to have declined since the mid-1990s, a result attributed to improvements in macroeconomic and political environments. For Zambia, Razafimahefa (2012) finds evidence of moderate pass-through to prices during the period 1985 to 2008.

This study aims to add to the limited empirical literature on ERPT in Zambia given the importance of the exchange rate in price dynamics. Empirical studies on the Zambian economy aimed at identifying key drivers of inflation have identified the exchange rate as a critical factor (see Simatele (2004); Mutoti (2006); Bova (2009). For instance, Mutoti (2006) notes that “excess demand for foreign exchange, reflected in the depreciation of the exchange rate significantly increase inflation”, with the response of inflation to an exchange rate shock being immediate and the effects lasting for up to 3 years. Bova (2009) also established the importance of the exchange rate in price developments with changes in the exchange rate significantly influencing changes in food prices. Some empirical studies have also found the exchange rate to play an important role in the transmission of monetary policy in the Zambian economy (Mutoti (2006); Chileshe et al., (2014). Overall, the dominant role of the exchange rate in inflation dynamics and the transmission of monetary policy suggest a relatively high exchange rate pass-through to domestic prices, a situation that may present a challenge to effective implementation of monetary policy. Hence, the main motivation underlying this study is to discern the implications of the size of exchange rate pass-through on the conduct of monetary policy in Zambia.

This study estimates the magnitude of ERPT to domestic prices in Zambia, focusing on the

response of consumer prices to shocks to the exchange rate. Empirical results suggest that exchange rate pass-through to domestic prices is incomplete, persistent and moderate to low, with the impact of shocks to the exchange rate exerting more influence on food prices than on overall and non-food prices. The estimated dynamic pass-through elasticities range between 0.41 and 0.49, consistent with the findings in several African countries (Aliyu et al.., 2009: Bwile et al.., 2013; Chaoudhri et al.., 2001). Empirical evidence also shows a decline in exchange rate pass-through, particularly during the period of single digit and stable inflation as evidenced by the estimated dynamic pass-through elasticity of 0.20. Evidence from variance decompositions suggest inertia in domestic prices as variations in all the three measures of prices investigated are driven mainly by own shocks. Aggregate demand pressures and exchange rate shocks are also important factors in explaining dynamics in domestic price developments.

Policy implications drawn from this study include the need for authorities to pursue prudent monetary and fiscal policies aimed at maintaining low and stable inflation. This would help in stabilising the exchange rate and minimise its pass-through to prices in the medium to long-term.

The rest of the paper's structure is as follows. Literature review is presented in Section 2 while Section 3 outlines the analytical framework used in the study. Data, preliminary analysis and empirical results are presented in Section 4, and the paper ends with the conclusions in Section 5.

2. Literature Review

Studies of the exchange rate pass-through (ERPT) have tended to focus on import prices or consumer prices. These studies attempt to empirically investigate the responses of import or consumer prices to changes in the exchange rate. As indicated earlier, the focus of this study is on the response of consumer prices to changes in the exchange rate. In this regard, ERPT "is defined as the accumulated percentage responses of prices to a one percent shock on the exchange rate…" (Liang, 2007). Exchange rate pass-through to prices can be either complete, where a given change in the exchange rate results in a similar change in prices[2], or incomplete in which case a one percent change in the exchange rate leads to a less than one percent change in prices.

Prior to the 1980s, exchange rate pass-through to prices was generally considered to be complete. The complete pass-through view was based on the law of one price or purchasing power parity (PPP) in traditional open-economy macroeconomic models. Under the PPP assumption, "exchange rate pass-through to domestic prices is always immediate and complete…" (Khundrakpan, 2008). In this regard, any changes in the exchange rate were expected to be completely reflected in changes in domestic prices. However, from the 1980s, empirical evidence started to emerge that supported the incomplete pass-through view that took into account imperfect competition and pricing-to-market (Dornbusch, 1987; Krugman, 1987). The notion underlying imperfect competition and pricing-to-market is that because firms want to maintain market share, changes in the exchange rate will cause them to adjust mark-ups rather than fully passing on the changes in the exchange rate to prices (Goldberg et al., 1996; Krugman et al., 1987). Further, incomplete pass-through can be attributed to product differentiation, cross-border production and the effects of trade barriers (Liang, 2007).

Some empirical studies have analysed the role of macroeconomic variables such as inflation, level of income and monetary policy in ERPT. As regards the role of inflation, high

[2]In the case of complete pass-through a 1 percent change in the exchange rate would result in a 1 percent change in prices.

inflationary environments tend to be associated with high pass-through than low inflation environments (Taylor, 2000; Choudhri et al., 2001). Furthermore, Gagnon et al., (2004) find the link between monetary policy and ERPT to consumer prices, and suggest that the rate of exchange rate pass-through falls (rises) as mean inflation declines (increases). Ca'Zorzi et al., (2007) also presents empirical evidence which suggests that economies with single digit inflation rates tend to have low ERPT compared to economies with double or triple-digit inflation rates. The implication of these findings is that loose monetary policy that leads to an increase in inflation tend to increase the pass-through to prices, and vice versa.

Choudhri *et al*., (2001), Taylor (2000) and Takhatamanova (2008) provide evidence that links low inflation to low ERPT, contending that the low inflationary environment that has prevailed since the 1990s, particularly in advanced economies explains the low and decreasing pass-through. However, the empirical evidence advanced by Campa and Goldberg (2002) on 25 Organisation for Economic Cooperation and Development (OECD) countries suggest that "higher inflation is weakly associated with a large pass-through and that the type of products and their share in the country's import bundle are the most important determinants of the pass-through". Thus, countries with a relatively high proportion of imported consumer and intermediate goods are likely to have high pass-through compared to those with a low proportion of imported consumer and intermediate goods.

In the new open-economy macroeconomic models, the firms pricing strategy is considered key to the determination of pass-through (Obsfeld and Rogoff, 1995; Devereux et al., 1996, 2000). In these models, a distinction is made between producer currency pricing (PCP) and local currency pricing (LCP). Under producer currency pricing, "the home currency price of foreign goods will move one-for-one with changes in the exchange rate, i.e. pass-through is complete…" (Khundrakpan, 2008). With local currency pricing, Khundrakpan (2008) notes the absence of pass-through since there is no change in short-term prices faced by consumers. In this regard, aggregate pass-through will depend upon the combination of firms that are practicing producer currency pricing and those using local currency pricing.

Studies of exchange rate pass-through in African economies are scant. A few empirical studies done on Sub-Sahara African (SSA) economies have generally found ERPT to be low and incomplete (see Devereux and Yetman, 2003; Mwase, 2006; Anguyo, 2008; Frimpong and Adam, 2010; Bwire at al., 2013). Most of these studies have found ERPT whose elasticities ranges from 0.14 to 0.75, which suggests some degree of insulation with regard to changes in the exchange rate and their impact on domestic prices. For instance, a more recent study on Uganda by Bwire *et al*., (2013) found the ERPT to be "fairly modest, persistent and incomplete…", with a pass-through elasticity of 0.48. This finding is close to Chaoudhri and Hakura (2001) finding of 0.39 for Kenya and Cameroon and 0.46 for Zambia. Another study on ERPT by Razafimahefa (2012) on Sub-Sahara African economies, which included Zambia, finds evidence of exchange rate pass-through to domestic prices to be partial and incomplete. The study established that "on average, a 10 percent depreciation of the local currency brings about a 4 percent increase in domestic prices". In addition, the study finds the depreciation of the local currency to be associated with a larger pass-through than the appreciation of the local currency.

3. Analytical Framework - Vector Autoregression Approach

Studies of exchange rate pass-through tend to use two standard approaches, which include single-equation regression analysis based on the Phillips curve and vector autoregression (VAR) analysis. Single-equation regression analysis usually involve the estimation of the price equation with the aim of determining the response of domestic prices to changes in the

exchange rate, among other explanatory variables (Campa and Goldberg, 2005; Olivei, 2002; Otani, Shiratuka and Shirota, 2005).

However, the single-equation approach has been criticized on the basis that it ignores the possibility of domestic inflation affecting the exchange rate. Hence, to examine a possible reinforcing mechanism between domestic prices and the exchange rate, a VAR approach is preferred (Hahn, 2003; Faruqee, 2006; McCarthy, 2000). The system can be estimated as an unrestricted VAR, structural VAR or a vector error correction mechanism (VECM). Preference for the VAR approach is due to its ability to account for the dynamic effects that may exist between the exchange rate and domestic prices. *Ceteris paribus*, high inflation rates vis-à-vis trading partner countries tend to lead to the depreciation of the exchange rate, which may in turn push inflation higher. As a result of this, an analysis of the interaction between the exchange rate and domestic prices should allow for a bi-directional causal relationship from the exchange rate to domestic prices and vice versa (Ito and Sato, 2008). Hence, it is appropriate to estimate a system that treats both variables as endogenous.

In a VAR framework, the economy is assumed to be described by the following structural model:

$$AY_t = B(L)Y_{t-1} + C(L)X_t + \varepsilon_t;\ \varepsilon_t \sim iid\ (0, \Lambda) \qquad 1$$

Where Y_t is an $n\,x\,1$ vector of endogenous variables while X_t is an $m\,x\,1$ vector of exogenous variables, and ε_t is an $n\,x\,1$ vector of structural disturbances with a zero mean and constant variance, Λ. In the specification given in Equation *(1)*, A is an $n\,x\,n$ matrix of contemporaneous coefficients of the interaction of variables in Y_t while B is the matrix of lagged coefficients of interactions in Y_t.

However, since the structural model given above cannot be estimated directly due to inadequate information, the existence of the inverse of the matrix A, A^{-1} allows us to have a reduced-form of the structural model, which can be specified as follows (Maturu, 2014):

$$Y_t = A^{-1}B(L)Y_{t-1} + A^{-1}C(L)X_t + A^{-1}\varepsilon_{t_t} \qquad 2$$

Or

$$Y_t = D(L)Y_{t-1} + \delta X_t + u_t;\ u_t \sim iid\ (0, \Sigma) \qquad 3$$

Where: $D(L) = A^{-1}B(L);\ \delta = A^{-1}C(L);\ u_t = A^{-1}\varepsilon_{t_t}$

Following Cheng (2006) and using Equations *(1)* and *(3)*, structural and reduced-form equations can be related through Equation *(4)* while the disturbances are related through Equation *(5)*:

$$D(L) = -A^{-1}B(L) \text{ and } \delta = -A^{-1}C(L) \qquad 4$$

$$u_t = A^{-1}\varepsilon_t \text{ or } \varepsilon_t = Au_t \qquad 5$$

This paper uses the structural VAR approach to the analysis of ERPT in Zambia. The choice of this approach is motivated by the need to analyse the impact of innovations or shocks to

the exchange rate on developments in domestic prices. The VAR approach to the analysis of ERPT used in this paper follows the works of McCarthy (2000); Hahn (2003); Faruqee (2006); Ito *et al.*, (2006); and, Mwase (2006). Following this literature, we can specify as:

$$Y_t = (poil_t, ygap_t, mon_t, exr_t, p_t) \qquad 6$$

Where: $poil_t$ represents the US dollar price of crude oil, $ygap_t$ represents the output gap, mon_t represents monetary policy variable (money supply or interest rate), exr_t represents the nominal exchange rate (Kwacha per US dollar) and p_t represents the domestic price level: overall consumer price index, food price index or non-food price index. All the variables are in logs, with an exception of interest rates and the output gap[3].

Underlying the model of variables specified in Equation (6) is a structural model of the form given in Equation (1), while its reduced form is represented by Equations (3) - (5).

An important issue in VAR analysis is the ordering of the variables in order to identify structural shocks. In this regard, identification can be done through the imposition of restrictions on the short or long-run behavior of the system. Alternatively, the systematic ordering of the endogenous variables can be used as the basis for capturing structural shocks in a VAR (Zubair et al., 2013). This alternative approach is what is used in capturing structural shocks embedded in Equation (3). In this case, the price of crude oil is ordered first on the assumption that reduced-form residuals of crude oil prices are unlikely to be affected contemporaneously by other shocks, except the oil price (supply) shocks while crude oil price shocks are likely to impact all the variables in the system contemporaneously, particularly for an oil importing economy like Zambia. The output gap is ordered second as this can be considered to be impacted contemporaneously by oil prices only while the output gap (demand shock) can have contemporaneous effects on other variables in the system with an exception of oil prices. Next in the ordering is the monetary policy variable, money supply or interest rate, followed by the exchange rate and the price variable. In the literature on ERPT, the price variable is put last in the ordering on the assumption that it can be contemporaneously affected by all other shocks in the system (Leigh and Rossi, 2002; Hahn, 2003; Belaisch, 2003; and Faruqee, 2006).

Given the ordering in the unrestricted model, the relationship between reduced-form VAR residuals, u_t and the structural shocks, ε_t can be then be represented by the following:

$$\begin{bmatrix} u_t^{poil} \\ u_t^{ygap} \\ u_t^{mon} \\ u_t^{exr} \\ u_t^{p} \end{bmatrix} = \begin{bmatrix} S_{11} & 0 & 0 & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 & 0 \\ S_{31} & S_{32} & S_{33} & 0 & 0 \\ S_{41} & S_{42} & S_{43} & S_{44} & 0 \\ S_{51} & S_{52} & S_{53} & S_{54} & S_{55} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{poil} \\ \varepsilon_t^{ygap} \\ \varepsilon_t^{mon} \\ \varepsilon_t^{exr} \\ \varepsilon_t^{p} \end{bmatrix} \qquad 7$$

Where: ε_t^{poil} represents oil price (supply) shock, ε_t^{ygap} represents the output gap (demand) shock, ε_t^{mon} represents the money supply or interest rate shock, ε_t^{exr} represents the exchange rate shock and ε_t^{p} represents the price shock.

It should be noted that the structural model presented above is identified through the imposition of $k(k - 1)/2$ restrictions on the matrix S as zero restrictions on the upper part of

[3]The output gap is computed as a difference between the log of GDP and the log of trend GDP.

the matrix, where k denotes the number of endogenous variables. The imposition of restrictions yields a lower-triangular matrix *S*, which implies that some structural shocks have no contemporaneous effect on some endogenous variables given the ordering of the variables.

The framework outlined above is used to analyse the dynamic interactions between the exchange rate and price levels as well as the timing of the pass-through, that is, the time at which changes in the exchange rate have the most impact on prices. In addition, the empirical approach is used to provide an insight into the relative contributions of structural shocks to variables, particularly the exchange rate, in explaining variations in prices through variance decompositions. Moreover, impulse response functions are used to establish whether changes in the exchange rate have a temporary or permanent effect on domestic prices.

4. Data and Empirical Results

4.1 Data

The variables used to investigate ERPT in this study are defined in Table A1 in the Appendix. Quarterly data collected over the period 1992 to 2014 is used in empirical analysis, and most of it is sourced from the Bank of Zambia and the Central Statistical Office (CSO). However, quarterly data series on real GDP is not available in Zambia. Hence, to compute the output gap, annual real GDP data is decomposed using the index of industrial production, which is available on quarterly basis using the Denton Method. After decomposing annual GDP data into quarterly, trend or potential output is generated using the Hodrick-Prescott (HP) filter. The output gap is then computed as the difference between actual output and trend or potential output, with a positive number indicating "excess demand" relative to potential output.

Plots of the variables in levels and first differences are presented in Figure A1 in the Appendix. From the plots of the variables in levels, the data series seem to be non-stationary in levels, with the exception of the output gap *(ygap)*. However, plots of the series in first differences seem to suggest that all the variables are mean-reverting, that is stationary. Formal tests for unit roots in the data series are undertaken below.

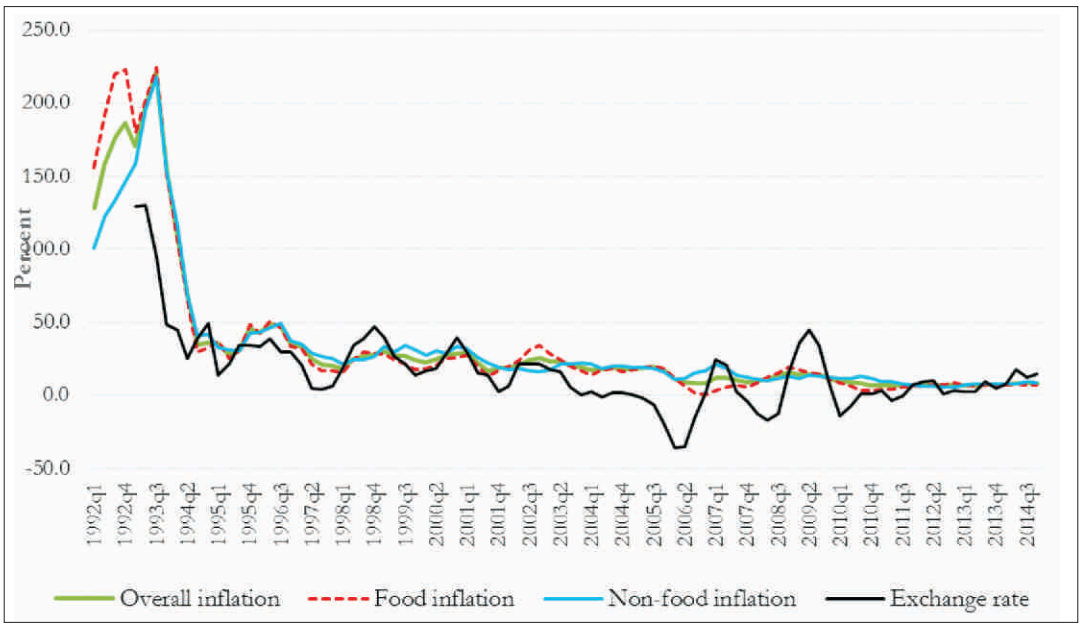
4.2 Preliminary Analysis of Changes in Exchange Rates and Prices

The preliminary analysis of the relationship between annualised changes in the exchange rate and prices presented here identifies relationships between changes in the exchange rate and measures of inflation, which include overall inflation, food inflation and non-food inflation. Plots of annualised changes in the exchange rate and changes in the overall consumer price index, food price index and non-food price index are used in the preliminary analysis. In addition, simple correlation analysis and bi-variate cross plots of the three measures of inflation and nominal exchange rate changes are used to assess the extent of correlation.

A plot of the changes in the exchange rate and the overall consumer price index, food price index as well as non-food price index depict a fairly close relationship between changes in the exchange rate and the three measures of inflation between the period 1992 to 2003 (see Figure 1). During this period (1992 to 2003), a depreciation in the exchange rate is closely associated with an increase in overall inflation, food inflation and non-food inflation. However, from about 2004 to 2014, this relationship weakened with changes in the exchange rate associated with less pronounced changes in the three measures of inflation, particularly during the period 2004 to 2010.

The graphical illustration is supported by simple correlation analysis. While correlation coefficients for the entire sample period are quite high at 0.80, 0.79 and 0.81 for changes in the exchange rate and overall consumer price index, non-food price index and food price index, correspondingly, they differ substantially across periods. For the period 1992 to 2003, the correlation coefficients are 0.86, 0.84 and 0.87 between changes in the exchange rate and overall inflation, non-food inflation and food inflation, respectively. For the period 2004 to 2014, correlation coefficients between changes in the exchange rate and overall consumer price index, non-food price index and food price index were estimated to be substantially lower at 0.08, 0.06 and 0.08, respectively. This suggests a decline in exchange rate pass-through to domestic prices in the recent past.

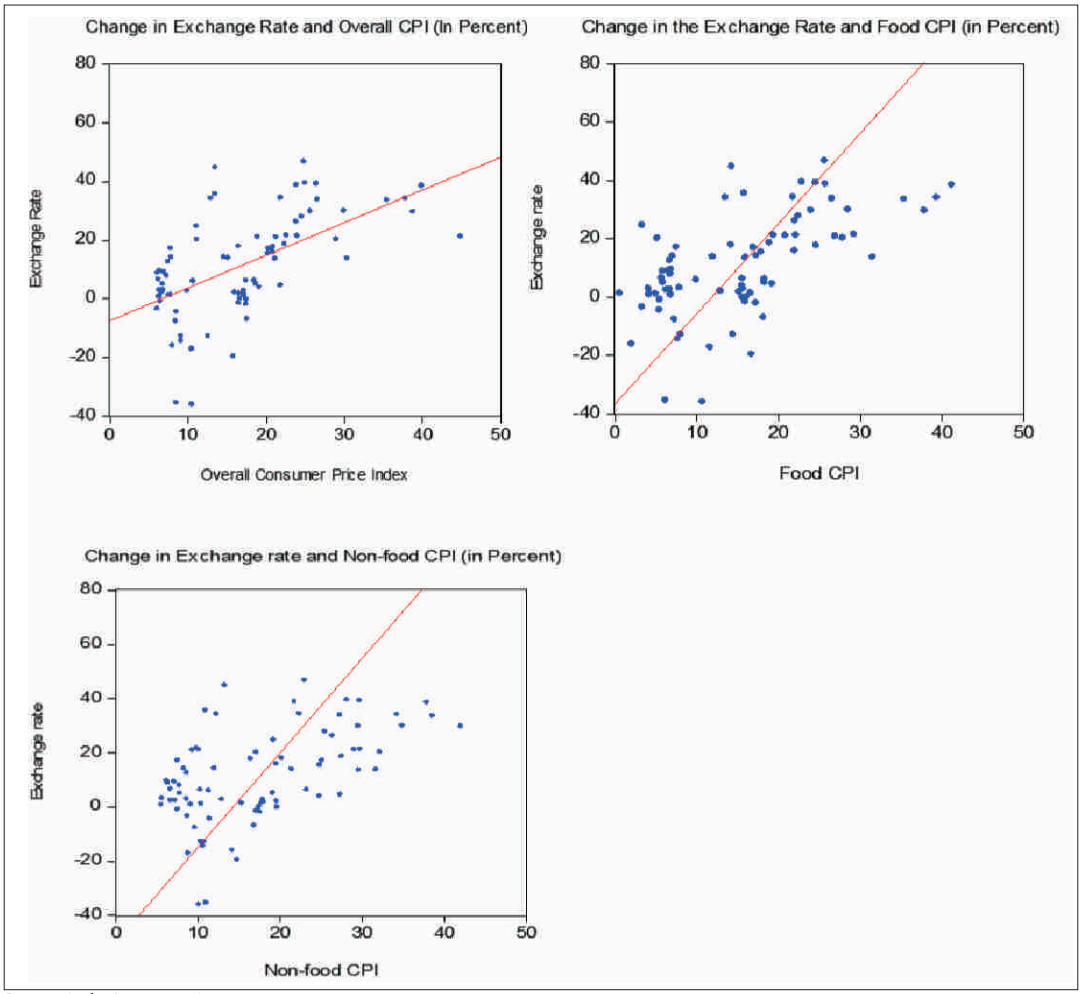
Figure1: Changes in the Exchange Rate, Overall CPI, Food and Non-food CPI



Source: Bank of Zambia

Bi-variate cross plots of changes in the nominal exchange rate and the three measures of inflation are also presented in Figure 2 to demonstrate the extent of the relationships or degree of correlation. The plots, which cover the period 1992 to 2014, bring out the positive relationship between annualised changes in the exchange rate and the three measures of inflation. From the three plots, the slope of the regression line for changes in the exchange rate and food inflation is steeper than that of changes in the exchange rate and overall as well as non-food inflation. This suggests that changes in the exchange rate impact food inflation more than the other two measures of inflation. Scatter plots for the period 2004 – 2014 depict a much weaker relationship between changes in the exchange rate and domestic prices (see Figure A2 in the Appendix).

Figure 2: Scatter Plots of Changes in the Exchange and Consumer Price Indices



Source: Author's computations

Following Mwase (2006), a further review of how changes in the exchange rate may be associated with changes in inflation is done by assessing the average changes in the exchange rate in relation to average changes in inflation and their volatilities. Table 1 shows that higher average changes in the exchange rate seem to be associated with higher average changes in inflation and vice versa. The implication of this is that higher average changes in the exchange rate tend to be reflected in higher average changes in prices, and vice versa. Furthermore, higher exchange rate volatility seems to be associated with higher inflation volatility. However, during periods of relatively low inflation, relatively high exchange rate volatility appears to be associated with low inflation volatility. This may imply that during periods of relatively low inflation, there seems to be a weaker relationship between exchange rate volatility and the variation in inflation, suggesting reduced exchange rate pass-through in a relatively low inflation environment. We also note from Table 1 that the volatility of food inflation is relatively higher than that of non-food inflation, suggesting that food inflation may be strongly associated with changes in the exchange rate than non-food inflation.

Table 1: Average Inflation, Exchange Rate and Volatilities[4]

Period	Average overall inflation	Overall Inflation Volatility	Average Food Inflation	Food Inflation Volatility	Average Non-food Inflation	Non-food Inflation Volatility	Average Exchange Rate Change	Exchange Rate volatility
1992 – 2003	54.6	57.8	56.9	64.5	52.5	50.5	30.5	27.6
2004 – 2014	10.7	4.3	9.5	5.5	12.1	4.6	2.3	15.8
1992 – 2014	33.6	46.7	34.3	52.3	33.2	41.7	16.4	26.5

Source: Author's computations

The descriptive evidence presented above points to three issues. Firstly, changes in the exchange rate clearly influence developments in inflation dynamics. Secondly, the strength of the relationship between changes in the exchange rate and inflation has declined in the recent past. Thirdly, changes in the exchange rate impact food inflation more than non-food inflation.

4.3 Unit Root and Cointegration Tests

Times series data may have different levels of integration, and it is therefore imperative to check for the existence of unit roots in the data. The importance of checking for unit roots is to avoid spurious results that may arise from the regression of differently integrated time series. Before testing for unit roots in the data series, a visual inspection of the series is done through the plots (see Figure A1 in the Appendix). From the plots, most of the variables are non-stationary in levels. The results of unit root tests using the Augmented Dickey-Fuller (ADF) and the Phillip-Perron (PP) tests are presented in Table 2.

Both the ADF and PP test results suggest that most of the data series are non-stationary in levels, with the exception of the output gap. We also note some conflicting results regarding the overall consumer price index *(Lcpi)*, with the ADF test suggesting the presence of a unit root in levels while the PP test indicates the absence of a unit root. Borderline results are also obtained with regard to the exchange rate, with both the ADF and PP tests suggesting that the data series could be stationary in levels. However, stationarity in the exchange rate is established when the series are differenced. Moreover, the ADF test suggests that money supply is non-stationary in levels while the PP test indicates that the variable is stationary. Overall, the plots of the variables coupled with formal tests for unit roots leads to the conclusion that all the variables, save for the output gap, are non-stationary in levels.

[4]Volatility is computed as the standard deviation of the growth rates of the variables, using annual percent growth.

Table 2: Unit Root Test Results

Variables	Augmented Dickey-Fuller Test	Phillips-Perron Test
	P-Value	P-Value
Variables in Levels		
Lcpi	0.87	0.00
Lcpif	0.12	0.69
Lcpixf	0.26	0.27
Lexr	0.02	0.04
LM2	0.21	0.00
Lpoil	0.09	0.19
TBR91	0.33	0.17
Ygap	0.00	0.00
Variables in First Differences		
D(Lcpi)	0.00	0.00
D(Lcpif)	0.00	0.00
D(Lcpixf)	0.00	0.00
D(Lexr)	0.00	0.00
D(LM2)	0.00	0.00
D(Lpoil)	0.00	0.00
D(TBR91)	0.00	0.00
D(Lcpi)	0.00	0.00

Source: author computations

Having established that the variables are non-stationary, with an exception of the output gap, the next step is to test for cointegration using the Johansen multivariate cointegration framework. All the variables that are found to be non-stationary are included in cointegration tests. Using trace and maximum eigenvalue statistics, the cointegration test results presented in Tables A3 to A5 in the Appendix suggests the existence of at most two (2) cointegrating relationships between the price of crude oil, the 91-day Treasury bill rate, the exchange rate and the three different price indices (overall CPI, food CPI and non-food CPI).

Given evidence of cointegrating relationships, we can estimate VECMs with variables in levels, including the stationary output gap. However, since the key purpose of this study is to analyse the pass-through effects of changes in the exchange rate to domestic prices and not the long-run relationships among the variables, it is prudent to estimate SVARs. The SVAR framework is considered appropriate as it provides an opportunity to analyse the impact of exchange rate shocks on domestic prices through imposition of contemporaneous structural restrictions consistent with a priori theoretical expectations to identify the impact of various shocks (Sims, 1986).

4.4 Empirical Results and Discussion

4.4.1 Overall Consumer Prices

We start with the estimation of a five-variable unrestricted VAR comprising the crude oil price, output gap, a monetary policy variable (91-days Treasury bill rate), the nominal exchange rate and overall consumer prices over the period 1993Q1 – 2014Q4. Following the standard procedures in VAR estimation, the statistical properties of the estimated VAR are checked. The VAR estimated with 5 lags indicate the absence of serial correlation (see Table A2 in Appendix for multivariate diagnostic test results). The estimated model is stable as the calculated roots of the characteristic polynomial are all located within the unit circle (see

Figure A3 in the Appendix). A visual inspection of the residuals from the estimations suggests the presence of a number of outliers, a situation that may point to non-normality of the residuals as confirmed by the residual test results in Table A2. The test results also indicate that the residuals are homoscedastic.

The estimated residuals from the unrestricted VAR are then used to extract an estimated system of shocks from the SVAR, which are presented in equations 8 – 12.

$$\varepsilon_1 = 0.798u_1 \quad (\mathbf{0.0}) \qquad 8$$

$$\varepsilon_2 = 0.01\varepsilon_1 + 0.467u_2 \quad (0.37)\ (\mathbf{0.0}) \qquad 9$$

$$\varepsilon_3 = -0.04\varepsilon_1 - 0.69\varepsilon_2 + 0.881u_3 \quad (0.38)\ (0.44)\ (\mathbf{0.0}) \qquad 10$$

$$\varepsilon_4 = -0.003\varepsilon_1 - 0.03\varepsilon_2 + 0.002\varepsilon_3 + 0.054u_4 \quad (\mathbf{0.0})\ (\mathbf{0.0})\ (0.09)\ (\mathbf{0.0}) \qquad 11$$

$$\varepsilon_5 = 0.012\varepsilon_1 - 0.014\varepsilon_2 - 0.002\varepsilon_3 + 0.095\varepsilon_4 + 0.021u_5 \quad (0.90)\ (0.34)\ (\mathbf{0.01})\ (\mathbf{0.02})\ (\mathbf{0.0}) \qquad 12$$

Note: Figures presented in parenthesis are p-values.

An important coefficient from the estimated system of shocks above is the coefficient on ε4 in equation (12), which shows the impact of changes in the exchange rate on the price level. The coefficient is statistically significant and correctly signed, implying that a positive shock to the exchange rate increases overall consumer prices.

To assess exchange rate pass-through and formally estimate its magnitude, impulse response functions (IRFs) are used. IRFs help in tracing the impact of shocks arising from endogenous variables to other variables within the system through the dynamic structure of the VAR (Sims, 1986). In addition, we employ variance decompositions to get a sense of the forecast variance in endogenous variables attributed to shocks to variables in the system.

Following Sanusi (2010), exchange rate pass-through is "defined as the accumulated effect of a structural one standard deviation shock to nominal exchange rate in period t on domestic prices in period T". In this case, the accumulated response measures the impact of changes in the exchange rate on consumer prices. Using IRFs, the dynamic pass-through elasticity is estimated as the ratio of the percentage change in the price level between period 0, the time when the initial exchange rate shock hits, and the percentage change in the exchange rate at time 0 (Zubair, at al., 2013). The formula used for the computation of dynamic pass-through elasticity is as follows:

$$PT_t = \%\Delta p_t / \%\Delta e_0 \qquad 13$$

Where: PT_t is the pass-through at time t; $\%\Delta p_t$ is percentage change in price level and is provided by IRFs and $\%\Delta e_0$ is percentage change in the exchange rate, which is the standard

deviation of the exchange rate obtained from the estimated system of shocks (Sanusi, 2010; Zubair, *et al.*, 2013).

Table 3 presents the accumulated impulse response of consumer prices following one standard deviation shocks to endogenous variables in the model. Since the VAR is estimated with data in first differences of the logarithms, the IRFs derived should be considered to be measuring the proportionate change in prices following a shock to the exchange rate. From the Table 3, it should be noted that the impact of a structural one standard deviation shock of 0.054 (from equation 11) to the exchange rate is an increase in the price level of approximately 0.0051. In other words, an exchange rate depreciation of 5.4 percent raises the price level by only 0.51 percent. Using equation (13), the implied dynamic pass-through elasticity at impact is computed to be 0.09. The full impact of the exchange rate shock is realised after 26 periods, when an exchange rate depreciation of 5.4 percent results in an increase of 2.2 percent in the price level. At full impact, the dynamic pass-through elasticity is estimated to be around 0.41, implying that a positive shock of 5.4 percent to the exchange rate results in an increase in consumer prices of about 4.1 percent in the long-run. A plot of the accumulated response of overall consumer prices to an exchange rate shock shows that the impact is fairly gradual and persistence, taking a long time before the full effect comes through (see Figure 3).

The results suggests that exchange rate pass-through in Zambia is incomplete and low to moderate. The estimated dynamic pass-through elasticity of 0.41 computed in this paper is close to 0.46 and 0.39 estimated for Zambia and Kenya by Chaoudhri et al.., (2001) in a panel study. In addition, the estimated dynamic pass-through elasticity in this study is lower than 0.48 estimated by Bwile et al.., (2013) for Uganda that was characterised as moderate. Further, it should be noted that in a study by Chaoudhri et al.., (2001) Zambia was characterised as a high inflation country. Therefore, the decline in the estimated dynamic pass-through in this paper could be a reflection of the relatively low inflation environment that prevailed in the country from the mid-2000s through to end of the sample period. Overall, evidence of incomplete, low and declining exchange rate pass-through is in line with the empirical findings in other SSA countries (Aliyu, *et al.*, 2009; Zubair, et al.., 2013).

Table 3: Accumulated Impulse Response of Prices to Structural One SD Shocks

Structural One Standard Deviation Shock to:					
Period	**Crude oil price**	**Output gap**	**91-day TB rate**	**Exchange rate**	**Overall CPI**
T=1	-0.0023	-0.0086	-0.0046	0.0051	0.0206
T=4	-0.0013	-0.0020	0.0009	0.0177	0.0198
T=8	-0.0033	-0.0041	-0.0102	0.0197	0.0319
T=12	-0.0047	-0.0054	-0.0136	0.0182	0.0039
T=16	-0.0045	-0.0052	-0.0159	0.0196	0.0453
T=20	-0.0055	-0.0058	-0.0177	0.0206	0.0479
T=26	-0.0055	-0.0062	-0.0188	0.0221	0.0508
SD	0.798	0.467	0.881	0.054	0.021

Note: SD refers to the structural Standard Deviation and is obtained from the estimated system of shocks while T refers to the time period.

To get further insights on the decline in ERPT, the model is re-estimated over the sample period 2004Q1 to 2014Q4 (see Table 6A in Appendix). The estimated structural one standard deviation shock on the exchange rate is 0.049 while the accumulated impulse response of changes in prices to a shock in the exchange rate at impact is 0.004, implying a dynamic pass-through of 0.08. From the accumulated impulse response, the full impact of the exchange rate shock is estimated at 0.010 and comes through after 3 quarters. In this regard, the estimated dynamic pass-through elasticity is 0.20, which is much lower than

0.41 estimated for the entire sample (1993Q1 – 2014Q4). This result supports the assertion of lower exchange rate pass-through, particularly during the period of low and stable inflation.

Figure 3: Accumulated Impulse Response of Prices to a Structural SD Shock to Exchange Rate

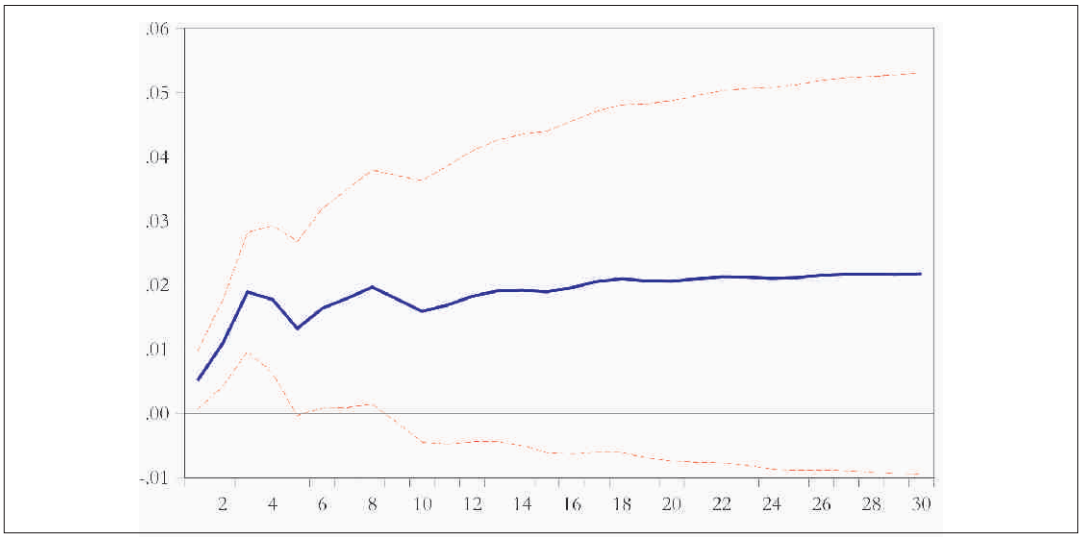


Table 4 presents variance decompositions aimed at exploring the relative contribution of the structural shocks to variations in prices. The findings suggest that changes in prices are mainly driven by shocks to consumer prices, with such shocks explaining more than 50 percent of the variation in the short to medium term. This result suggests inflation persistence or inertia, and underscores the importance of other factors in the economy such as supply-side factors in the inflationary process in Zambia. Supply-side factors, particularly those that affect food production tend to impact significantly on developments in food prices, and ultimately overall prices. Shocks to the exchange rate explain a maximum of 16 percent of the variation in consumer prices after one year (four quarters) following the shock. The findings also suggest that shocks to the output gap (aggregate demand) explain a larger proportion of the variations in consumer prices than shocks to the exchange rate. Interest rates also play an important role in explaining changes in consumer prices.

One issue worth pointing out regarding the results of the IRFs in Table 2 relate to the response of prices to crude oil prices. In this regard, the response of prices to shocks to crude oil prices is counter-intuitive as it suggests that an increase in crude oil prices leads to a decline in consumer prices. One of the plausible reasons to explain this response is that crude oil prices may have no direct influence on domestic prices, particularly given that fuel pump prices are administered in Zambia. Domestic fuel pump prices may remain static for a long period of time notwithstanding changes in crude oil prices in international markets. The almost negligible contribution of crude oil prices to explaining variations in consumer prices as indicated by variance decompositions could also be confirmation of the counter intuitive response of consumer prices to crude oil prices. However, the variable was retained in the estimations as the other variable that was tried, copper prices, did not yield satisfactory results.

Table 4: Variance Decomposition in Model with Overall Consumer Prices

Period	S.E.	Crude oil price	Output gap	91-day TB rate	Exchange rate	Consumer Prices
T=1	0.022	1.076	2.143	4.412	5.366	87.004
T=4	0.028	1.040	21.276	5.211	15.678	56.795
T=8	0.032	0.950	21.255	10.717	15.514	51.563
T=12	0.033	0.991	21.467	11.211	15.684	50.646
T=16	0.033	1.015	21.413	11.342	15.520	50.709
T=20	0.033	1.036	21.330	11.440	15.551	50.643
T=24	0.033	1.035	21.310	11.441	15.550	50.664

Note: S.E. refers to the standard error of estimation

4.4.2 Food Prices

To assess ERPT to food prices, a five variable VAR that include food CPI is estimated with 2 lags. The estimated model exhibited stability with all the calculated roots of the characteristic polynomial lying within the unit circle (see Figure A4 in the Appendix). Multivariate diagnostic residual tests results for the estimated VAR are in Table A7 in the Appendix. The estimated system of shocks from the SVAR extracted from the estimated residuals of the unrestricted VAR are presented in the Figure A5 in the Appendix.

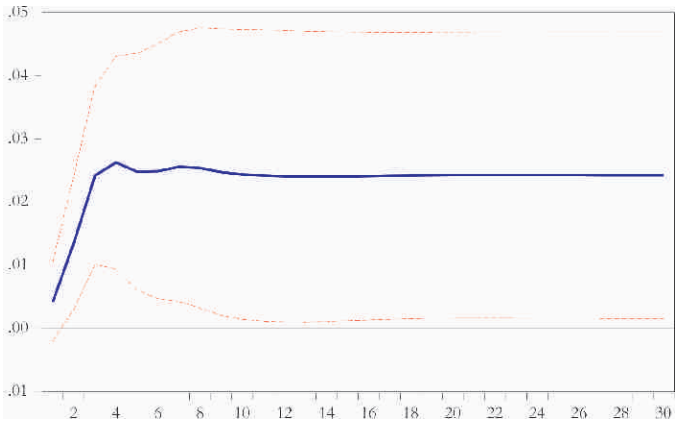
The accumulated impulse response of food prices following a shock to the exchange rate suggest that an exchange rate depreciation of 5.3 percent increases food prices by 0.4 percent at impact (see Table 5 and Figure 4). This suggests a dynamic pass-through of 0.08. The results also show that exchange rate pass-through to food prices is quicker when compared to overall prices, with the full effect coming through within one year. In this regard, an exchange rate depreciation of 5.3 percent raises food prices by a maximum of 2.6 percent within a year. At full impact, the dynamic pass-through elasticity is estimated at 0.49. The dynamic pass-through in the medium to long-term remains high at around 0.45. This result of a significant influence of changes in the exchange rate on food prices in Zambia is in line the findings of Bova (2009), who attributed the result to a relatively large component of processed imported food items in the country, particularly from South Africa. The result underscores the need to enhance domestic food production and value addition in order to insulate food prices from exchange rate shocks.

Table 5 Accumulated Impulse Response of Food Prices to Structural One SD Shocks

Structural One Standard Deviation Shock to:					
Period	**Crude oil price**	**Output gap**	**91-day TB rate**	**Exchange rate**	**Food Prices**
T=1	0.0023	0.0018	-0.0053	0.0043	0.0279
T=4	-0.0003	-0.0095	-0.0056	0.0262	0.0373
T=8	-0.0033	-0.0208	-0.0058	0.0254	0.0389
T=12	-0.0037	-0.0214	-0.0053	0.0241	0.0383
T=16	-0.0034	-0.0199	-0.0053	0.0241	0.0385
T=20	-0.0033	-0.0198	0.0053	0.0242	0.0386
T=26	-0.0033	-0.0199	-0.0054	0.0243	0.0386
SD	0.135	0.376	0.737	0.053	0.028

Note: T refers to a quarter since the model is estimated using quarterly data

Figure 4: Accumulated Impulse Response of Food Prices to a Structural SD Shock to Exchange Rate



The variance decomposition results presented in Table 6 suggest that changes in food prices are mainly driven by own shocks, which explain more than 70 percent of variations in food prices over the short to the medium term. Shocks to the exchange rate are also important in explaining changes in food prices, with the exchange rate explaining close to one fifth of changes in food prices in the short to medium term. When compared to the results presented in Table 5, changes in the exchange rate appear to have more influence on food prices than on overall consumer prices.

Table 6: Variance Decomposition in Model with Food Prices

Period	S.E.	Crude oil price	Output gap	91-day TB rate	Exchange rate	Food Prices
T=1	0.029	0.654	0.393	3.324	2.150	93.479
T=4	0.034	0.764	4.192	2.510	19.302	73.232
T=8	0.035	0.969	6.886	2.412	18.695	71.038
T=12	0.035	0.992	6.945	2.413	18.716	70.933
T=16	0.035	0.995	6.989	2.412	18.707	70.898
T=20	0.035	0.994	6.991	2.412	18.706	70.895
T=24	0.036	0.995	6.992	2.412	18.709	70.894

Note: S.E. refers to the standard error of estimation

4.4.2 Non-Food Prices

A five variable VAR that include non-food prices is estimated to examine exchange rate pass-through to non-food prices. The unrestricted VAR estimated with 2 lags is found to be free of serial correlation and exhibits stability (see Table A8 and Figure A5 in the Appendix). Using the estimated residuals of the unrestricted VAR, the system of shocks from the SVAR were extracted and presented in Figure A6 in the Appendix.

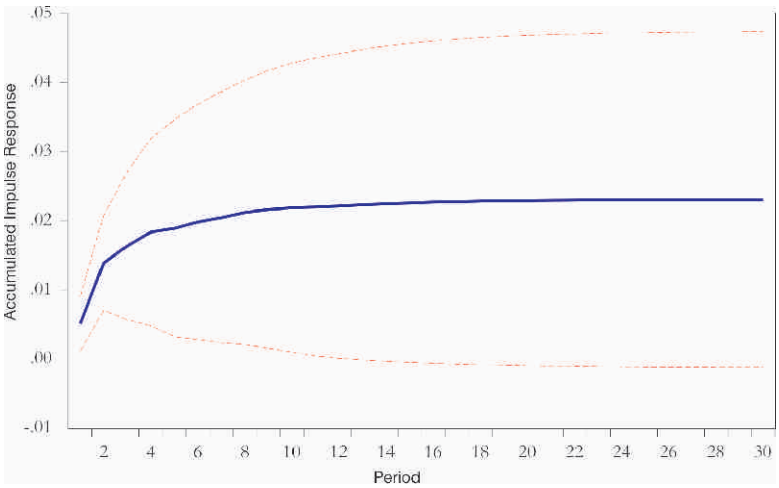
Table 7 contains the accumulated impulse response of non-food prices following shocks to endogenous variables within the system. Of particular interest is column 5 in the Table, which indicates that a positive shock of 0.054 increases non-food prices by 0.005 in the next period following the shock. In other words, an exchange rate depreciation of 5.4 percent will lead to an increase in non-food prices of 0.5 percent, implying a dynamic pass-through elasticity of 0.09 at impact. A plot of the accumulated response of non-food prices to an exchange rate shock shows that the impact is fairly gradual with the full impact coming through after 15 periods (see Table 7 and Figure 5). At full impact, the computed dynamic pass-through elasticity is 0.43, implying that an exchange rate depreciation of 5.4 percent will increase non-food prices by 4.3 percent in the long run. Given the magnitude of the

estimated dynamic pass-through elasticity, this result suggests a relatively lower exchange rate pass-through to non-food prices than to food prices.

Table 7: Accumulated Impulse Response of Non-food Prices to Structural One SD Shocks

Structural One Standard Deviation Shock to:					
Period	**Crude oil price**	**Output gap**	**91-day TB rate**	**Exchange rate**	**Non-food Prices**
T=1	0.0004	0.0062	-0.0012	0.0051	0.0173
T=4	0.0032	0.0094	-0.0056	0.0183	0.0347
T=8	0.0029	0.0007	-0.0003	0.0212	0.0463
T=12	0.0021	-0.0046	-0.0008	0.0221	0.0506
T=15	0.0022	-0.0052	-0.0009	0.0230	0.0524
T=20	0.0023	-0.0051	-0.0010	0.0229	0.0531
T=25	0.0023	-0.0053	-0.0010	0.0230	0.0534
SD	0.140	0.369	0.731	0.054	0.017

Figure 4: Accumulated Impulse Response of Non-food Prices to a Structural SD Shock to Exchange Rate



Analysis of variance decomposition shows that variations in non-food prices are mainly explained by own shocks in the short to medium-term, with own shocks explaining more than 80 percent of the variation in the period immediately following the shock (see Table 8). From the estimated results, the exchange rate seem to be the second most important variable in explaining variations in non-food inflation, accounting for between 7 to 19 percent of the variation in the short to medium-term.

Table 8: Variance Decomposition in Model with Non-food Prices

Period	S.E.	Crude oil price	Output gap	91-day TB rate	Exchange rate	Food Prices
T=1	0.019	0.047	10.608	0.423	7.014	81.912
T=4	0.024	0.613	8.326	1.923	19.028	70.109
T=8	0.026	0.626	10.497	1.849	17.592	69.435
T=12	0.026	0.649	11.456	1.822	17.279	68.793
T=16	0.026	0.649	11.463	1.820	17.263	69.805
T=20	0.026	0.649	11.460	1.820	17.261	68.809
T=24	0.026	0.649	11.461	1.819	17.260	68.808

5.0 Conclusions

This study attempted to estimate the magnitude and timing of exchange rate pass-through to domestic prices in Zambia. Empirical evidence suggest an incomplete, persistent and moderate to low exchange rate pass-through, with the impact of shocks to the exchange rate exerting more influence on food prices than on overall and non-food prices. The estimated dynamic pass-through elasticities range between 0.41 and 0.49 and are in line with the findings in several African countries. The paper also shows evidence of a declining exchange rate pass-through. In particular, the period of single digit and stable inflation is characterised by low ERPT as evidenced by the estimated dynamic pass-through elasticity of 0.20. The decline in exchange rate pass-through during the period of low inflationary environment is also in line with several empirical findings on the subject. From the policy perspective, evidence of low exchange rate pass-through in the latter half of the sample period lends support to the Bank's strategic decision to move toward the adoption of an inflation targeting monetary policy framework.

Results from variance decompositions suggest inertia in domestic prices as variations in all the three measures of prices investigated are driven mainly by own shocks. On the whole, variance decomposition results suggest that exchange rate shocks accounts for relatively smaller proportions of changes in food, non-food and overall consumer prices, reinforcing the evidence that exchange rate pass-through to prices in Zambia is incomplete and low. The results also indicate that apart from own shocks to prices, aggregate demand pressures and exchange rate shocks are important factors in explaining dynamics in domestic price developments.

Policy implications arising from this study include the need for authorities to pursue prudent monetary and fiscal policies aimed at promoting macroeconomic stability, reflected in low and stable inflation in order to anchor inflation expectations. Low and stable inflation levels are also important in minimising exchange rate pass-through to domestic prices, thereby enhancing the central bank's conduct of monetary policy.

References

Aliyu, S.U.R., Yakub, M.U., Sanni, K., and Duke, O.O. (2009) "Exchange rate pass-through in Nigeria: Evidence from a Vector Error Correction Model", paper presented at EDIA conference

Akram, F. and Gronvik, G (2012), IMF/Norges Bank Aide Memoire on Project on Inflation Targeting.

Anguyo, L.F. (2008)."Exchange rate pass-through to inflation in Uganda: Evidence from a Vector Error Correction Model"", the Bank of Uganda Staff Papers J. 2(2): 80-102.
Bank of Zambia (forthcoming), Zambia Quarterly Model, Bank of Zambia (BOZ) Reader Working Papers Series

Bwire, T., Anguyo, L.F, Opolot, J., (2013) "Exchange Rate pass-Through to Domestic Prices in Uganda: Evidence from a Structural Vector Auto-regression", Journal of Statistical and Econometric Methods, Vol. 2, No. 4, 2013, 41 - 68

Bova, E., (2009), "Money and exchange rate channels for food and non-food inflation: a cointegrated VAR for Zambia", Swiss National Centre of Competence in Research.
Belaisch A (2003) "Exchange Rate Pass-Through in Brazil", IMF Working Paper, WP/03/141, International Monetary Fund

Campa J and Goldberg L (2001), "Exchange Rate Pass-Through into Import Prices: A Macro or Micro Phenomenon?", mimeo, Federal Reserve Bank of New York.

Campa J and Goldberg L (2005), "Exchange Rate Pass-Through into Import Prices," *Review of Economics and Statistics*, 87, 679-90

Ca'Zorzi, M., Hahn, E. and Sanchez, M. (2007), "Exchange Rate Pass-Through in Emerging Markets," Working Paper Series No. 739, European Central Bank.

Choudhri E.U. and Hakura D.S. (2001), "Exchange Rate Pass-Through to Domestic Prices: Does the Inflation Environment Matter?", IMF Working Paper 01/194

Daboussi O.M. and Thameur N (2014), "Inflation Targeting and Exchange Rate Pass-Through: A Comparative Study in Emerging Markets", International Journal of Innovation and Applied Studies, Vol. 9 No. 1 Nov. 2014

Dornbusch R (1987), "Exchange Rate and Prices," *American Economic Review*, Vol. 77

Devereux M and Charles E (2001), "Endogenous Currency of Price Setting in a Dynamic Open Economy Model," mimeo

Devereux, M. B. and Yetman, J., (2003) *Price Setting and Exchange Rate pass-through: Theory and Evidence.* Hong Kong, School of Economics and Finance, University of Hong Kong

Faruqee H (2006), "Exchange Rate Pass-Through in the Euro Area," IMF Staff Papers, 53, 63-88

Frimpong, S. and Adam, S. (2010) "Exchange rate pass-through in Ghana", International Business Research, 3 (2).
Gagnon J and Ihrig J (2001), "Monetary Policy and Exchange Rate Pass-Through", Board of

Governors of the Federal Reserve System International Finance Discussion Paper No. 704.

Goldberg P and Knetter M (1997), "Goods Prices and Exchange Rates: What have we learnt?" *Journal of Economic Literature*, Vol. 35, pp. 1243 -92

Hahn E (2003), "Pass-Through of External Shocks to Euro Area Inflation," ECB Working Paper No. 243, European Central Bank.

Ito T and Sato K (2008), "Exchange Rate Changes and Inflation in Post-Crisis Asian Economies: Vector Autoregression Analysis of the Exchange Rate Pass-Through," *Journal of Money, Credit and Banking,* Vol. 40, No.7

Jombo W, Simwaka K and Chiumia A (2014), "Exchange Rate Pass-Through in Malawi: Evidence from Augmented Phillips Curve and Vector Autoregressive Approaches", Standard Global Journal of Business Management, Vol 1 (2), March 2014

Khundrakpam J.K. (2008), "Have Economic Reforms Affected Exchange Rate Pass-Through to Prices in India?," Economic and Political Weekly, April 19, 2008

Krugman P (1987), "Pricing to Market when the Exchange Rate Changes," in Sven Arndt and

J. David Richardson, eds., *Real Financial Linkages Among Open Economies*, MIT Press: Cambridge, pp. 49 - 70

Leigh D and Rossi M (2002) "Exchange Rate Pass-Through in Turkey", IMF Working Paper, WP/02/204, International Monetary Fund.

Maturu, O.B., 2014, "Short-term Capital Flows and Pressure on the Exchange Rate in Kenya," Paper presented at the Centre for Studies of African Economies (CSAE) Annual Conference, 23 – 25th March, 2014.

McCarthy J (2000), "Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialised Economies," mimeo, Federal Reserve Bank of New York.

Mutoti, N., (2006), "Monetary Transmission Mechanism in Zambia", Bank of Zambia Working Paper 06/2006

Mwase, N. (2006), "An Empirical Investigation of Exchange Rate Pass-Through to Inflation in Tanzania", IMF Working Paper, WP/06/150, International Monetary Fund.

Obstfeld M and Rogoff K (1995), "Exchange Rate Dynamics Redux," *Journal of Political Economy*, Vol. 103, pp. 624 - 660

Olivei G.P. (2002), "Exchange Rates and Prices of Manufacturing Products Imported into the United States," *New England Economic Review,* Federal Reserve Bank of Boston, First Quarter, 3 - 18

Otani A, Shiratsuka S and Shirota T (2005), "Revisiting the Decline in the Exchange Rate Pass-Through: Further Evidence from Japan's Import Prices," IMES Discussion Paper, No. 2005-E-6, Institute for Monetary and Economic Studies, Bank of Japan.

Rasmussen, T., Mwansa, L., Mbao, F.Z., M., Chileshe, P., Mwanza, B., and Zgambo, P. (2014), "Monetary Policy Transmission in Zambia", Bank of Zambia Working Paper, WP/01/2014

Razafimahefa IF (2012), "Exchange Rate Pass-Through in Sub-Saharan African Economies and its Determinants", IMF Working Paper 12/141

Sanusi, A. R. (2010) "Exchange rate pass-through to consumer prices in Ghana: Evidence from structural vector auto-regression", Munich Personal RePEc Archive.

Simatele, M.C.H. (2004), Financial Sector Reforms and Monetary Policy in Zambia, Gothenburg University, Economics Studies Series, n. 133

Sims, C.A. (1986) "Are Forecasting Models Usable for Policy Analysis?', Federal Reserve Bank of Minneapolis Quarterly Review (Winter 1986), pp. 2 -16

Takhtamanova YF (2008), "Understanding Changes in Exchange Rate Pass-Through," Federal Reserve Bank of San Francisco.

Taylor A (2000), "A Century of Purchasing-Power Parity," National Bureau of Economic Research Working Paper No. 8012 (Massachusetts: NBER)

Taylor J (2000), "Low Inflation, Pass-through and the Pricing Power of Firms," *European Economic Review*, Vol. 44, pp. 1389-1408

Zubair, A., Okorie, G. and Sanusi, A. (2013) "Exchange rate pass-through in Nigeria: An Empirical Investigation", Central Bank of Nigeria Economic and Financial Review, Vol. 51, No. 1

Table A1: Definition of Data

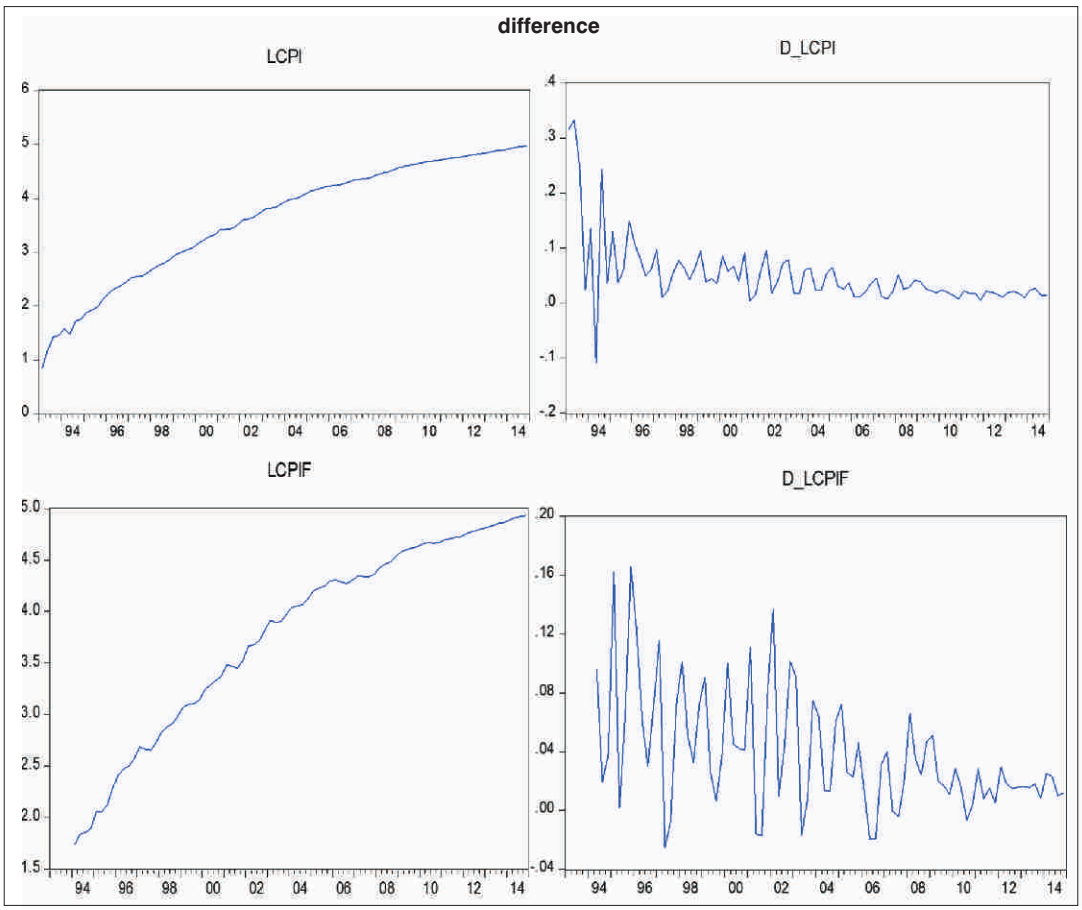
Abbreviation	Description
LCPI	Log of overall consumer price index
LCPIF	Log of food consumer price index
LCPIXF	Log of non-food consumer price index
LEXR	Log of nominal exchange rate (Kwacha per US dollar)
LPOIL	Log of crude oil price in US dollars
YGAP	Output gap – log of real GDP minus log of trend real GDP
TBR91	91-day Treasury bill yield rate (short-term interest rate)
Lm2	Log of Money supply – broad measure

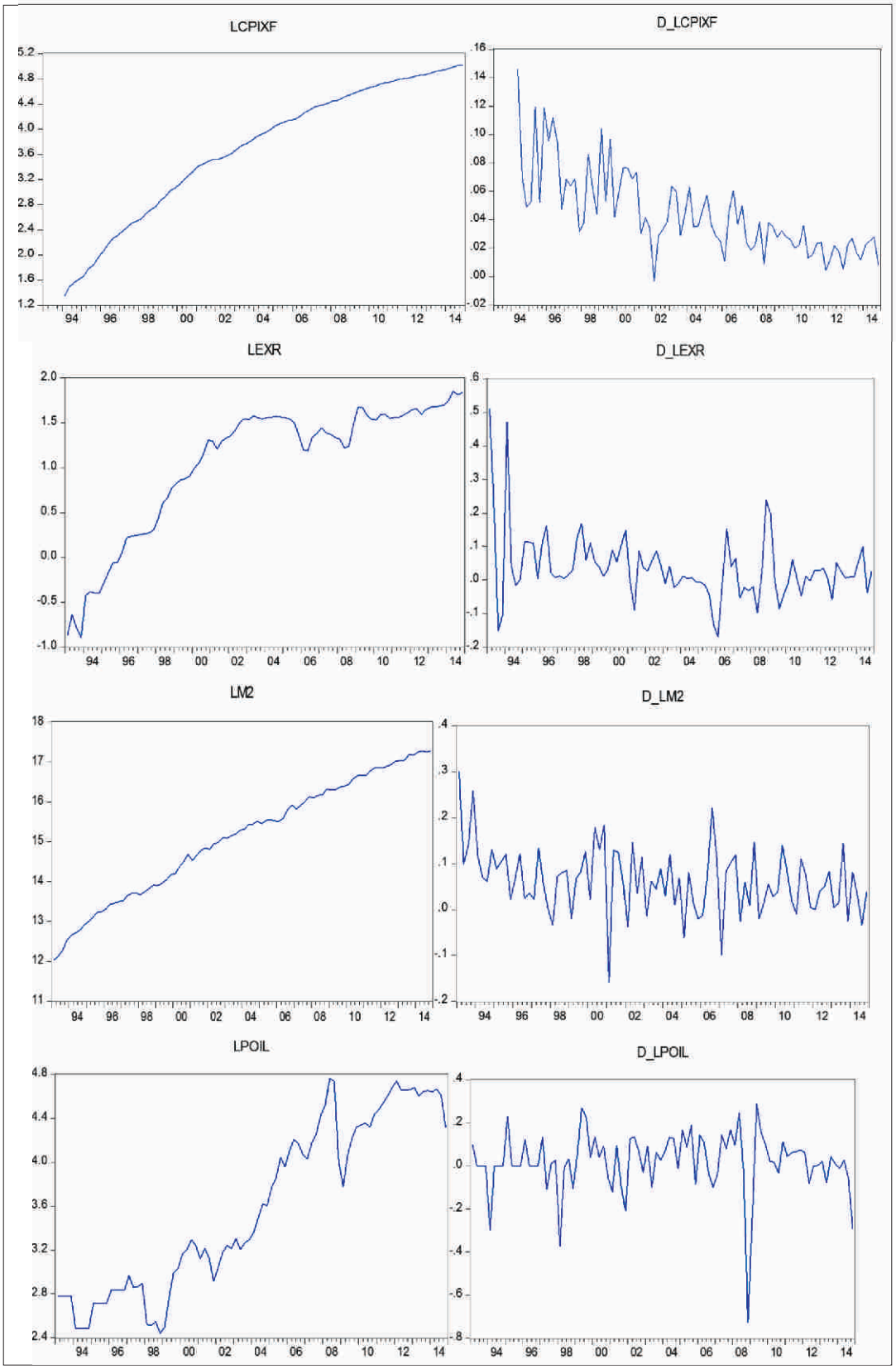
Source: CSO, Prices Statistics, 2014

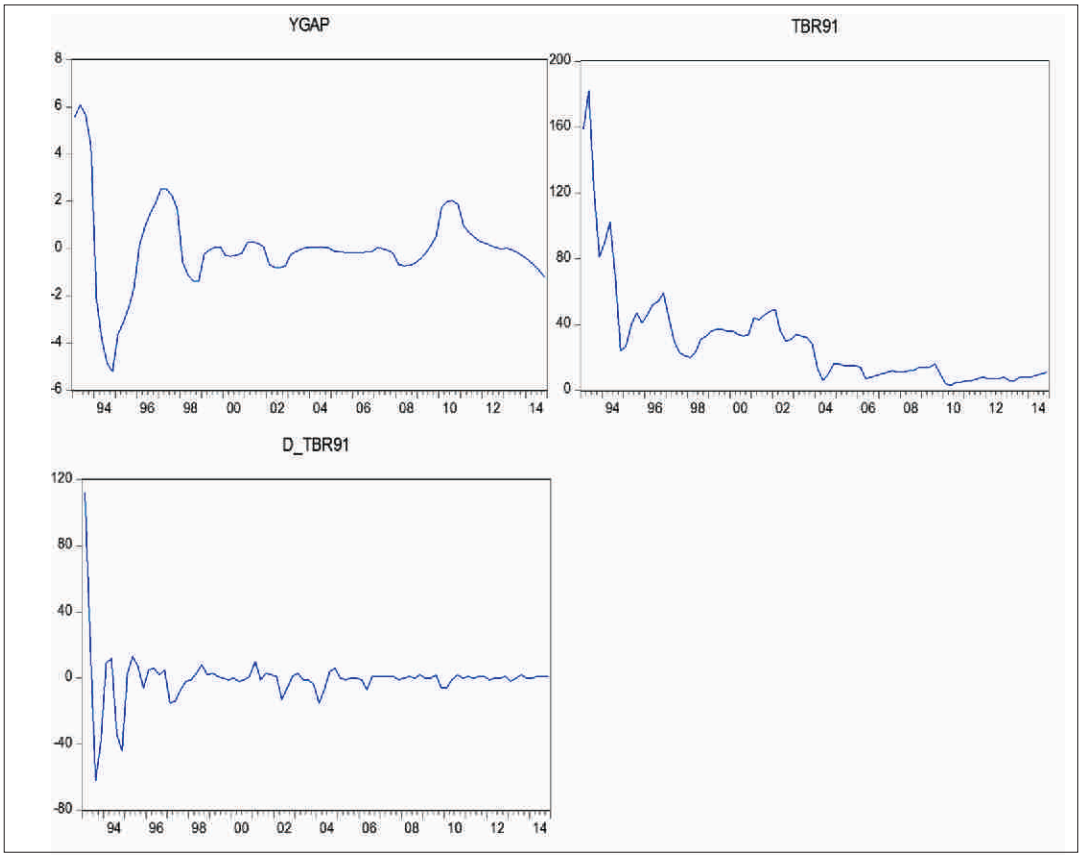
Table A2: Multivariate Diagnostic Residual Tests Results*

Residual Test	Test Statistic	P-Value
Serial correlation (LM test)	29.48	0.24
Normality (Jarque-Bera)	596.18	0.00
Homoskedasticity	750.82	0.48

*Autocorrelation test is based on Breusch-Godfrey and the null hypothesis is no serial correlation. Null hypothesis for normality test is that residuals are multivariate normal while the null hypothesis for heteroskedasticity is that residuals are homoscedastic. P-values greater than 0.05 suggest non-rejection of the null hypothesis.




LCPIXF
D_LCPIXF
LEXR
D_LEXR
LM2
D_LM2
LPOIL
D_LPOIL


YGAP
8
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94 96 98 00 02 04 06 08 10 12 14
TBR91
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94 96 98 00 02 04 06 08 10 12 14
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Figure A2: Scatter Plots of variations in the Exchange rate and Consumer prices (2004 – 2014)

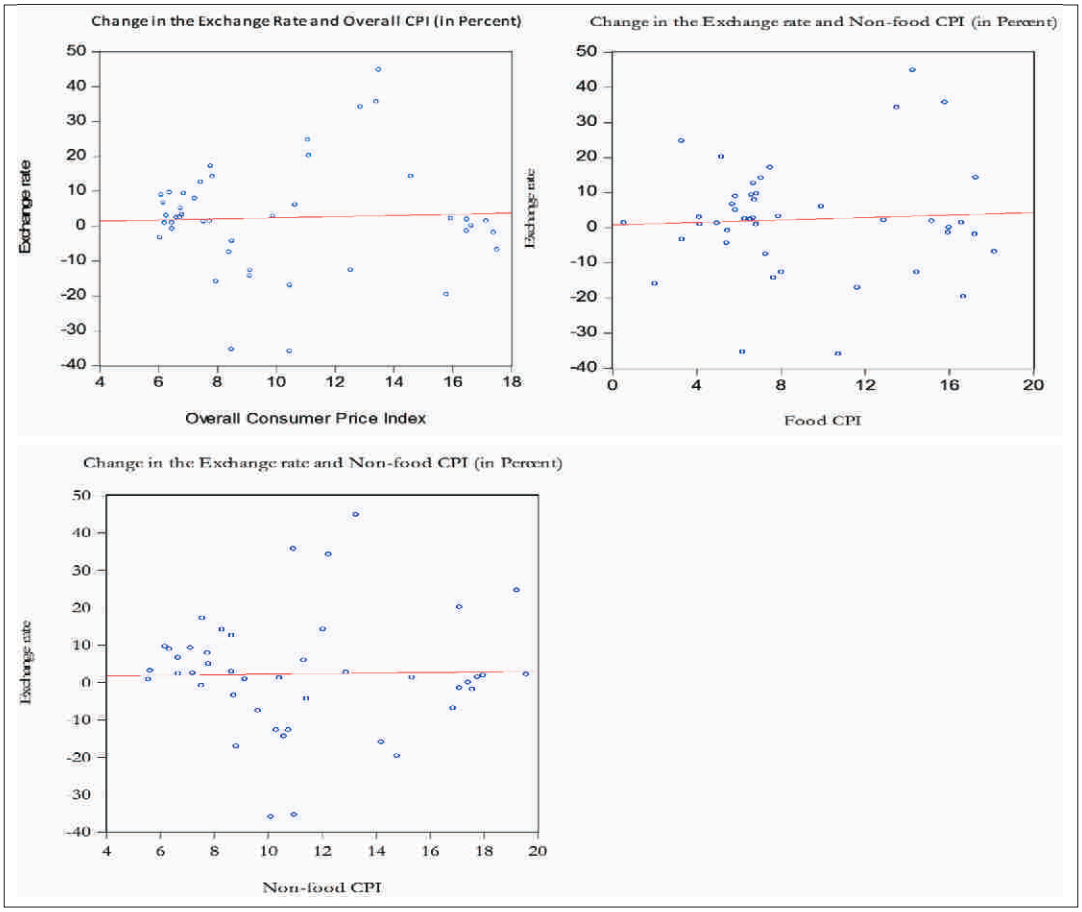


Table A3: Johansen Cointegration Tests with Overall CPI

Maximum Eigenvalues (λmax)				
No. of CE (s)	**None**	**At most 1**	**At most 2**	**At most 3**
Eigen value	0.4096	0.3298	0.1184	0.0395
(λmax) Statistic	46.895	36.618	11.220	3.589
Critical value	27.584	21.132	14.265	3.841
Trace (λrace)				
No. of CE (s)	None	At most 1	At most 2	At most 3
Eigen value	0.409	0.3298	0.1184	0.0395
(λtrace) Statistic	97.323	50.428	14.809	3.589
Critical value	47.856	29.797	15.495	3.841

Table A4: Johansen Cointegration Tests with Food CPI

Maximum Eigenvalues (λmax)				
No. of CE (s)	**None**	**At most 1**	**At most 2**	**At most 3**
Eigen value	0.4322	0.2476	0.1072	0.0516
(λmax) Statistic	45.849	23.039	9.184	4.295
Critical value	27.584	21.132	14.265	3.841
Trace (λtrace)				
No. of CE (s)	None	At most 1	At most 2	At most 3
Eigen value	0.4322	0.2476	0.1072	0.0516
(λtrace) Statistic	82.368	36.518	13.479	4.295
Critical value	47.856	29.797	15.495	3.841

Table A5: Johansen Cointegration Tests with Non-food CPI

Maximum Eigenvalues (λmax)				
No. of CE (s)	**None**	**At most 1**	**At most 2**	**At most 3**
Eigen value	0.3192	0.2315	0.1253	0.0441
(λmax) Statistic	31.141	21.328	10.841	3.656
Critical value	27.584	21.132	14.265	3.841
Trace (λtrace)				
No. of CE (s)	None	At most 1	At most 2	At most 3
Eigen value	0.3192	0.2315	0.1253	0.0441
(λtrace) Statistic	66.967	35.826	14.497	3.656
Critical value	47.856	29.797	15.495	3.841

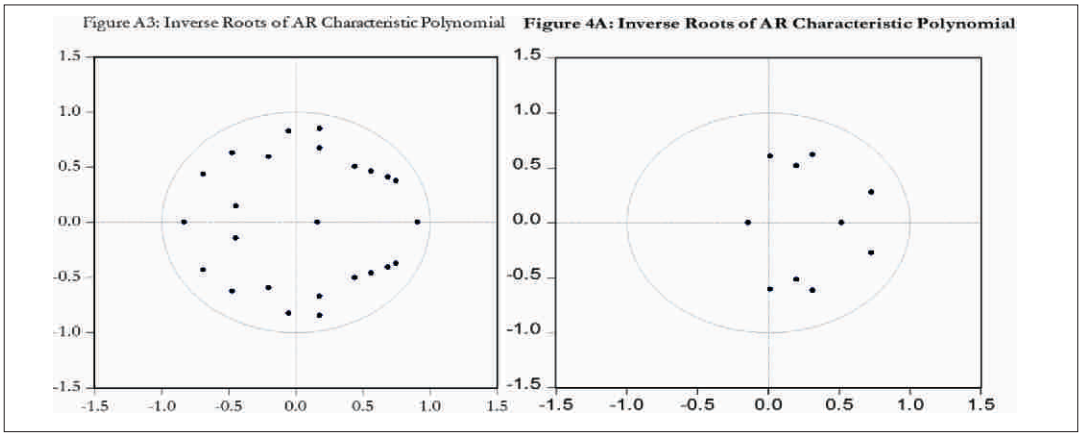


Figure A4: Estimated System of Structural Shocks from SVAR with Overall CPI: 2004Q1 – 2014Q4

$$\varepsilon_1 = 0.147 u_1$$
$$\quad\quad \textbf{(0.0)}$$

$$\varepsilon_2 = 0.218\varepsilon_1 + 0.251 u_2$$
$$\quad\quad (0.39) \quad \textbf{(0.0)}$$

$$\varepsilon_3 = -2.852\varepsilon_1 - 2.507\varepsilon_2 + 0.728 u_3$$
$$\quad\quad (0.31) \quad (0.13) \quad \textbf{(0.0)}$$

$$\varepsilon_4 = -0.227\varepsilon_1 - 0.025\varepsilon_2 + 0.001\varepsilon_3 + 0.049 u_4$$
$$\quad\quad \textbf{(0.0)} \quad (0.41) \quad (0.82) \quad \textbf{(0.0)}$$

$$\varepsilon_5 = 0.003\varepsilon_1 - 0.004\varepsilon_2 - 0.001\varepsilon_3 + 0.082\varepsilon_4 + 0.011 u_5$$
$$\quad\quad (0.79) \quad (0.58) \quad (0.15) \quad \textbf{(0.01)} \quad \textbf{(0.0)}$$

Note: the figures in parenthesis are p-values.

Table 6A: Accumulated Impulse Response of Prices to Structural One SD Shocks (2004Q1– 2014Q4)

Structural One Standard Deviation Shock to:					
Period	**Crude oil price**	**Output gap**	**91-day TB rate**	**Exchange rate**	**Overall CPI**
T=1	-0.0019	-0.0001	-0.0022	0.0041	0.0109
T=3	0.0011	-0.0021	-0.0001	0.0102	0.0173
T=8	0.0003	-0.0115	-0.0013	0.0077	0.0164
T=12	-0.0009	-0.0149	-0.0015	0.0066	0.0154
T=16	-0.0011	-0.0151	-0.0016	0.0064	0.0151
T=20	-0.0011	-0.0146	-0.0016	0.0065	0.0152
T=24	-0.0011	-0.0143	-0.0016	0.0065	0.0152
SD	0.147	0.251	0.728	0.049	0.011

Note: SD refers to the structural Standard Deviation and is obtained from the estimated system of shocks while T refers to the time period

Table A7: Multivariate Diagnostic Residual Tests Results for VAR with Food CPI

	Test Statistic	**P-Value**
Autocorrelation (LM test)	19.92	0.75
Normality (Jarque-Bera)	244.89	0.00
Heteroskedasticity	438.87	0.00

Figure A5: Estimated System of Structural Shocks from SVAR with Food CPI

$$\varepsilon_1 = 0.135u_1$$
(0.0)

$$\varepsilon_2 = 0.890\varepsilon_1 + 0.376u_2$$
(0.0) (0.0)

$$\varepsilon_3 = -7.564\varepsilon_1 + 4.288\varepsilon_2 + 0.737u_3$$
(0.06) **(0.0) (0.0)**

$$\varepsilon_4 = -0.185\varepsilon_1 - 0.011\varepsilon_2 + 0.003\varepsilon_3 + 0.053u_4$$
(0.91) (0.49) **(0.04) (0.0)**

$$\varepsilon_5 = 0.036\varepsilon_1 + 0.001\varepsilon_2 + 0.001\varepsilon_3 + 0.080\varepsilon_4 + 0.028u_5$$
(0.18) (0.91) (0.17) **(0.03) (0.0)**

Table A8: Multivariate Diagnostic Residual Tests Results for VAR with Non-food CPI

	Test Statistic	**P-Value**
Autocorrelation (LM test)	31.74	0.17
Normality (Jarque-Bera)	251.59	0.00
Heteroskedasticity	344.58	0.04

Figure A5: Inverse Roots of AR Characteristic Polynomial

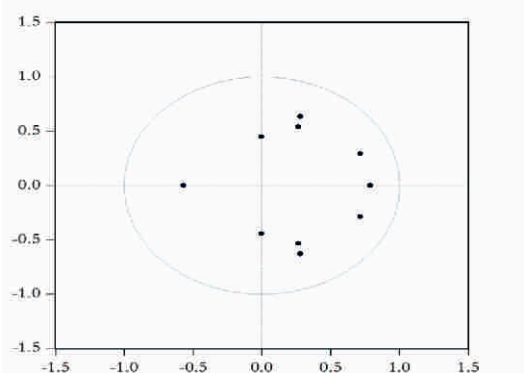


Figure A6: Estimated System of Structural Shocks from SVAR with Non-food Prices

$$\varepsilon_1 = 0.140 u_1$$
(0.0)

$$\varepsilon_2 = 0.807\varepsilon_1 + 0.369 u_2$$
(0.0) (0.0)

$$\varepsilon_3 = -4.050\varepsilon_1 + 0.295\varepsilon_2 + 0.731 u_3$$
(0.30) **(0.02)** **(0.0)**

$$\varepsilon_4 = -0.192\varepsilon_1 - 0.003\varepsilon_2 + 0.002\varepsilon_3 + 0.054 u_4$$
(0.0) (0.87) **(0.08)** **(0.0)**

$$\varepsilon_5 = 0.006\varepsilon_1 + 0.018\varepsilon_2 - 0.004\varepsilon_3 + 0.093\varepsilon_4 + 0.017 u_5$$
(0.69) **(0.0)** (0.25) **(0.0)** **(0.0)**

Note: the figures in parenthesis are p-values.

CHAPTER FOUR

The Zambian Quarterly Macroeconometric Model (ZQM)[1]

Farooq Akram
Patrick Chileshe
Peter Zgambo
Francis Mbao
Francis Muma

Abstract

This paper documents the Zambian Quarterly Macroeconomic Model (ZQM) developed in the Bank of Zambia (BoZ) for use in forecasting key macroeconomic variables as well as policy analysis. The model consists of five behavioural equations that reflect the key determinants of inflation, the exchange rate, broad money, lending rates and aggregate demand. A simple econometric modelling strategy based on relevant economic theories is used to develop the various components of the model. The model also captures the important channels through which monetary policy is transmitted in the economy. All the behavioural equations are estimated using an error correction framework. The paper also demonstrates the use of the model in undertaking short to medium-term forecasting and policy analysis. Overall, the performance of the model both for forecasting and policy analysis is deemed to be satisfactory. Hence, the ZQM is currently considered to be the core model used by BoZ in its forward-looking monetary policy framework. As a simple representation of reality, the model documented in this paper will require regular updating and development in order to remain relevant to monetary policy formulation and implementation.

1. Background

Macroeconomic models have been instrumental tools in policy analysis for many decades now. One of the first known macroeconomic models was developed by Tinbergen in 1936 for the Dutch economy (Whitley, 1994; James et al., 2012). Since then, several macroeconomic models have been developed by economists especially following Hicks' reformulation of Keynes ideas into a mathematical model of the system of national accounts, which still provide the backbone for macroeconomic modelling.

Macroeconomic modelling is useful in several ways; these include analysing the economy, evaluating macroeconomic policies and making predictions about the likely future behaviour of key economic variables (Whitley; 1994). Macroeconomic models have become even more important as many central banks move toward forward-looking monetary policy frameworks such as inflation targeting (IT). Under inflation targeting, forecasting is a key ingredient in formulating monetary policy stance as these forecasts help the central bank

[1]This paper documents the macroeconomic model developed at the Bank of Zambia. The development of the model was spearheaded by Farook Akram under the IMF-Norges Bank Technical Assistance program on broad-based modernisation of the Bank of Zambia.

with information on whether to change it or not. In most cases, policy makers use a suite of models to make forecasts for a particular economy as a means of dealing with complexities and constant changes in fundamentals. George (1999) noted that "In an ever-changing economy, no single model can possibly assimilate in a comprehensive way all the factors that matter for policy". As result, very few economists rely on a single model to undertake forecasts of key macroeconomic variables as well as policy analysis.

Many countries including Zambia are moving towards inflation targeting frameworks. This shift has been motivated by several factors but most importantly, it is the recognition that the primary role of monetary policy is price stability (IMF, 2005). Furthermore, the shift has been motivated by the weakening or breakdown in the relationship between monetary aggregates and inflation and the need to focus directly on inflation in the conduct of monetary policy. From the early 1990s to 2012, the conduct of monetary policy in Zambia was based on the monetary aggregate targeting framework. The assumption underlying the conduct of monetary policy using the monetary aggregate framework is the existence of a predictable and stable relationship between the monetary aggregate and inflation (Handa, 2009; Bank of Zambia, 2010). However, it has been observed that overtime, the relationship between monetary aggregates and inflation tended to weaken due to financial innovation and deepening, thereby making it difficult to target money supply to control inflation in the economy. In Zambia, the weakening or breakdown of the relationship between money supply and inflation from the early 2000 (see Chileshe et al., 2014) prompted the Bank of Zambia (BoZ) to consider adopting an IT framework in the conduct of monetary policy. In transition to the IT framework, the Bank in April 2012 migrated from the use of monetary aggregates, specifically reserve money, as a nominal anchor for monetary policy to the use of short-term interest rate. To this effect, BoZ introduced the Policy Rate as the key rate for signalling monetary policy stance and anchoring inflation expectations.

One of the key steps in the adoption and implementation of an IT framework is the development of macroeconomic models useful in forecasting key macroeconomic variables and undertaking policy analysis. The Bank of England (1999), points out three important ways in which models assist the monetary policy committee (MPC): First, the models assist the MPC in forecasting inflation and growth; second, models are used to analyse the impact of various shocks; finally, models are helpful in addressing economic puzzles arising from apparent differences between recent economic behaviour and average relationships overtime.

Following BoZ's decision to move toward an IT framework in the conduct of monetary policy, measures were initiated that will culminate in the adoption of a fully-fledged IT framework. These measures include the development of various types of models for use in inflation forecasting and policy analysis. In line with the Bank of England and several central banks that use IT frameworks, the BoZ's expectation is that models will play key roles in the decision making process of the MPC. Therefore, BoZ developed the Zambia Quarterly Model (ZQM) under the IMF Norges Bank Technical Assistance Program. The ZQM serves as a primary model for analysing and forecasting macroeconomic variables as part of the move towards full implementation of inflation targeting.

The main objective of the paper is to document the ZQM. Specifically, the paper discusses the key components of the model and the usefulness of the model. The usefulness of the model is demonstrated by conducting forecasting and policy analysis.

The rest of the paper is organised as follows: the next Section presents a description of the model, outlining the key equations that constitute the model; Section 3 outlines monetary policy in the ZQM while Section 4 discusses the use of the model for policy analyses and forecasting. The paper concludes in Section 5.

2. Behavioural Equations of the ZQM: Description of the Model

2.1 Introduction

The ZQM consists of five behavioural equations, estimated independently as well as a Taylor-type monetary policy rule. In this section, we describe the components of the model and attempt to explain the theoretical foundations of each of the behavioural equations. In addition, the key determinants of each of the endogenous variables represented by a unique behavioural equation are outlined.

2.2 Data and Diagnostic Tests

The ZQM is developed using quarterly time series data, covering the period Q1 1992 to Q4 2014. Data on endogenous variables are obtained from the BoZ database and Central Statistical Office (CSO) publications. Endogenous variables include; the average nominal exchange rate (K/USD), the average consumer price index (CPI), the average broad money (M2), real GDP (Y), and the average lending rates. At the time of developing the model, Zambia did not have quarterly GDP data and hence the Index of Industrial Production was used to decompose the annual GDP figures into quarterly GDP data. Exogenous variables in the model include; copper prices in US dollars, the US Federal Funds rate, crude oil prices in US dollars, Reserve Money, US Consumer Price Index, and South African Consumer Price Index. Data on exogenous variables was obtained from the IMF, the US Bureau of Labour Statistics, the US Federal Reserve System, Statistics South Africa, BoZ and World Bank databases.

It is standard practice in empirical analysis involving time series data to check for the stationarity of the series. This is because estimating equations with time series that are differently integrated lead to spurious results. The tests for stationarity of the time series used in the ZQM are undertaken using the Augmented Dickey Fuller (ADF). Since most of the time series are integrated of order 1, the equations are estimated in first differences.

2.3 Determinants of CPI Inflation in Zambia

2.3.1 Theoretical and Empirical Literature Review

In theory, there are two main sources of inflation which are prominent namely; demand and supply-side factors. Demand-side sources of inflation have been identified as being loose (expansionary) monetary and fiscal operations while supply-side factors are predominantly related to the costs of production. However, Ubide (1997) identifies three theories, namely: (i) external sector theory; (ii) the monetary theory (quantity theory); and (iii) the mark-up theory.

Debate on the causes of inflation has been dominated by the monetarists and the structuralists with the former arguing that inflation is basically a monetary phenomenon while the latter have been arguing that inflation is essentially an outcome of supply-side constraints (bottlenecks) in a given economy. The monetarists base their argument on the belief that an increase in money supply will positively affect the general prices leaving output and real money balances unaffected. The rise in general prices manifests itself in inflation. From the structuralists' perspective, the non-responsiveness of supply in the short-run leads to shortages that exert an upward pressure on prices, leading to inflation.

In empirical literature, researchers make distinctions with regard to the determinants of inflation. They have generally focused on distinguishing between supply-side factors, demand-side issues, external sector impulses and second round effects as well as the role of inflation expectations in domestic price dynamics (Kandil and Morsy, 2011).

In empirical literature, the estimation of the determinants of inflation in several countries has yielded mixed results, particularly for money supply. For instance, while Khan and Gill (2010) do not find money supply to be significant in Pakistan's inflationary process, Ahmed *et al.* (2014) on the same country finds money supply to play a significant role in inflation dynamics. Basher and Elsamadisy (2012) findings on the Gulf Cooperation Council (GCC) also supports the significant role of money supply in causing inflation although Kandil and Morsy (2011) shows contradicting results for some GCC member countries' on the role of money supply in the formation of inflation. For Sri Lanka, Bandara (2011) found money supply as one of the factors determining inflation and this is similar to Nguyen et al. (2012) on Vietnam.

In Africa, Simwaka et al. (2012) show that money supply has an important role in explaining inflation developments in Malawi and this is true for Tanzania as well (see Adam *et al.*, 2012), Uganda (Kabundi, 2012), Sierra Leone (Gottschalk, 2008), and Mali (Diouf, 2007). In South Africa, inflation is influenced by money supply only in the short-run (Akinboade et al., 2004). In Zambia, Simatele (2004) as well as Pamu and Simuchile (2004) find money supply to have a significant effect on inflation. A recent study by Mutoti *et al.* (2011) confirms the significant role of money supply in inflation determination in Zambia.

With regard to the impact of the exchange rate on inflation, empirical literature is consistent for many countries. Ahmed et al. (2014) found the exchange rate depreciation to be the most significant factor in causing inflation in Pakistan and this is consistent with the findings by Khan and Gill (2010). Bandara (2011) reports similar results on Sri Lanka. Elsewhere, Basher and Elsamadisy (2012) found the exchange rate to be an important factor in explaining inflation in the GCC block, a result that is similar to Kandil and Morsy (2008) on some GCC countries. But Nguyen et al.., (2012) does not find conclusive results on the role of the exchange rate in influencing inflation in Vietnam. Nonetheless, the literature on some African countries also shows that inflation is greatly influenced by exchange rate dynamics. These include Malawi (see Simwaka, et al. 2012); Sierra Leone (Gottschalk, 2008); South Africa (Akinboade, 2004); Chad (Kinda, 2011); and Mali (Diouf, 2007). Past studies on Zambia also confirm the significant effect of changes in the exchange rate on inflation (see for instance Mutoti *et al.*, 2011; Mutoti, 2006; and Simatale, 2004).

The other determinant of inflation in the empirical literature is one representing fiscal performance. Theoretically, persistent fiscal deficits are regarded to be inflationary but empirical evidence is inconclusive on this (Catao and Terrones, 2005). In their paper "Fiscal deficits and inflation", Catao and Terrones (2005) sought to test this mixed understanding using alternative modelling techniques and a broader database for 107 countries. They found a strong association between inflation and fiscal deficits among high-inflation prone and developing countries but this was not the case for low-inflation and advanced economies. Lin and Chu (2013) finds similar results for a long data set covering 91 countries. However, Khan and Gill (2010) and Ackay (2003) in their individual country studies did not find high budget deficit to be inflationary in Pakistan and Turkey, respectively, mostly as a result of the deficit being financed by way of borrowings. However, Ahmed *et al..*, (2014) contradict the earlier findings by Khan and Gill (2010). Sowa (1994) also finds periods of inconsistency in the fiscal deficit to be associated with high inflation in Ghana as Kinda (2011) confirms the adverse effect of expansionary fiscal policy on inflation in Chad.

Interest rates are also one of the determinants of inflation. For instance, a rise in lending rates is expected to lower inflationary pressures by reducing private sector credit that in turn is anticipated to reduce aggregate demand and thus, prices. However, Tillmann (2008) provides empirical evidence that changes in interest rates have an adverse effect on firms' marginal costs and, thus, on inflation within a forward-looking Phillips curve framework. This is consistent with the findings by Chowdhury et al., (2006) who empirically

demonstrated that changes in interest rate (when they are policy induced) can even lead to inverse inflation responses (rise in inflation with the increase in interest rates), when the cost channel is – relative to the demand channel – sufficiently strong. In view of this, there is a possibility of finding mixed outcomes with regard to the relationship between inflation and interest rates in empirical literature. Diouf (2007) finds a significant negative relationship between a discount interest rates and inflation in Mali. This is also true with South Africa (Akinboade, 2004). Similarly, Khan and Gill (2010) finds similar result for Pakistan were the relationship between the two variables is negative and significant. But this is not the case with Nguyen *et al.*, (2012)'s findings on Vietnam were interest rates are seen not to play any role in the inflation formation process. Simwaka et al., (2012) results on Malawi are similar to Nguyen et al. (2012).

In the determination of domestic inflation, the role of foreign prices (imported inflation) is important. Researchers use different measures of foreign prices with some using commodity prices as a proxy while others construct an index of foreign prices. Kandil and Morsy (2011) confirms the adverse impact of foreign prices on inflation in the long-run in all the GCC countries except for Bahrain, Oman and Qatar. This is also consistent with the findings by Basher and Elsamadesy (2012). Ahmed *et al.*, (2014) finds Pakistan's inflation to be also influenced by foreign prices in the long- run with Nguyen (2012) finding similar results on the role of foreign prices in Vietnam's inflation dynamics. In South Africa, foreign prices have also been found to adversely influence inflation in the long-run (Akinboade, 2004), and this is also the case with Sierra Leone where Gottschalk (2008) found an increase in oil prices to adversely feed into the domestic inflationary process. Simwaka *et al.*, (2012) also confirms the impact of foreign prices on Malawi's inflation but only in the short-run.

From the empirical perspective, inflation inertia/persistence (lagged inflation, which is also sometimes used to proxy inflation expectation) is found to be one of the significant factors in the determination of inflation (see Khan and Gill, 2010; Kandil and Morsy, 2011; Nguyen (2012); Simwaka et al. (2012 and Akinboade et al., 2004). The literature surveyed generally shows consistent results with regard to all the possible determinants of inflation with the exception of money supply, interest rates and fiscal deficit were divergent findings have been recorded. Some empirical results show money supply to be significant while others do not. This is also the issue with fiscal deficit and interest rates.

2.3.2 Theoretical and Empirical Framework

The theoretical framework underlying the inflation process in the ZQM is borrowed from Ubide (1997). In this regard, inflation in Zambia could be explained using three theories, namely: (i) external sector theory; (ii) the monetary theory (quantity theory); and (iii) the mark-up theory.

In developing a theoretical framework for inflation in Zambia, the ZQM relies on the first two theories (external sector theory and monetary theory) as the third one relies on the domestic labour market dis-equilibrium on which data is difficult to find. Furthermore, labour markets in Zambia are full of market distortions such as employment contract and labour unions such that wages do not respond to changes in market conditions.

In applying the Mundell-Fleming model to a small open economy, the requirement is that the general price level be weighted average prices of tradable and non-tradable goods:

$$p_t = \delta p_t^T + (1 - \delta) p_t^{NT} \qquad 1$$

Where all variables are in logs, δ is the share of tradable goods in the consumption basket.

Assuming that the prices for tradable goods are determined in the international market and also that purchasing power parity (PPP) holds, then the price for tradable goods is given by;

$$p_t^T = p_t^* + e_t \quad (2)$$

In equation 2, P^*_t is the price in a foreign country and e_t is the exchange of the country's currency.

On the other hand, the prices for non-tradable goods depend on the domestic level of aggregate demand. Assuming that, the price for non-tradable goods is determined by equilibrium in the money market;

$$\frac{M^s}{P_t} = \frac{M^d}{P_t} \; or \; in \; logs \; as \; m_t - p_t = m_t^d - p_t \quad (3)$$

Where: $m_t - p_t$ is real money supply while $m^d_t - p_t$ is real money demand, and p_t is the general price level given by the CPI.

Representing the relationship between the price of non-tradable goods and aggregate demand by ω, the price for non-tradable goods is;

$$p_t^{NT} = \omega\left(m_t - \left(m_t^d - p_t\right)\right) \quad (4)$$

Assuming the demand for real money balances ($m^d_t - p_t$) is of the Keynesian form with inflation expectations, the real demand for money is a function of real income ($y_t - p_t$), interest rates (r_t), and inflation expectations (E(π)).

$$\left(m_t^d - p_t\right) = \alpha + \beta(y_t - p_t) + \rho r_t + \mu E(\pi) \quad (5)$$

Assuming that inflation expectations are formed on the basis of adaptive expectations, then expected inflation at any time period is the previous period inflation rate ($E(\pi_t) = \Delta p_t - 1$)

$$\left(m_t^d - p_t\right) = \alpha + \beta(y_t - p_t) + \rho r_t + \mu \Delta p_{t-1} \quad (6)$$

Replacing equation 6 in equation 4 we get;

$$p_t^{NT} = \omega\left(m_t - (\alpha + \beta(y_t - p_t) + \rho r_t + \mu \Delta p_{t-1} \ldots\ldots\ldots\ldots)\right) \quad (7)$$

Using equations 7 and 2, replacing them into equation 1;

$$p_t = \delta p_t^* + \delta e_t + \omega(1-\delta)\left(m_t - (\alpha + \beta(y_t - p_t) + \rho r_t + \mu \Delta p_{t-1} \ldots\ldots\ldots\ldots)\right) \quad (8)$$

Thus, in reduced form the CPI equation can be written as follows;

$$p_t = f(e_t, p_t^*, m_t, y_t, r_t, p_{t-1}) \quad 9$$

In equation 9, a depreciation of the exchange rate is expected to lead to an increase in inflation by increasing import prices. Higher prices in trading partners, money supply, and real income are also expected to increase inflation. A higher interest rate is expected to be associated with a decrease in money holding, thereby reducing inflation. The effect of past inflation on the current price level is undetermined. On the one hand, higher inflation expectations, resulting from higher inflation in the previous period, could reduce money demand and consequently increase prices. On the other hand, inflation could persist because of sluggish adjustment owing to rigidities and structural constraints, such as those associated with poor infrastructure. Further, assuming adaptive expectations we expect that previous period level of prices will have an impact on future prices as economic agents expect these prices to persist.

The empirical framework used in estimating behavioural equations in ZQM is the error correction framework, in which the Ordinary Least Squares (OLS) estimation methodology is employed. We estimate an ECM model to capture short-run and long-run dynamics of the model. The long-run relationship is captured through the error correction mechanism (ECM). Specifically, we estimate the following model;

$$\Delta cpi = ECM_{t-1} + \beta_2 \Delta usd_t + \beta_3 \Delta (y - y^*)_{t-4} + \beta_4 pcop_t + \beta_5 \Delta cpi_{t-4} + \beta_6 + \varepsilon \quad 10$$

Where the ECM is the error correction mechanism, *usd* is the natural log of Kwacha-US dollar exchange rate, y is the log quarterly decomposed GDP, y^* is potential GDP, *pcop* is log of copper prices in US dollars, βs are the estimated parameters and ε is the shock to inflation.

The estimated results for consumer prices suggest that in the long-run consumer price inflation in Zambia is determined by money supply, average lending rates, the exchange rate, and oil prices, which are captured in the ECM term in equation 10. In this regard, an increase in money supply, exchange rate and oil prices leads to a rise in consumer prices while an increases in average lending rates results in a decline in prices. These results are similar to those obtained by Akinboade *et al.*. (2004) on South Africa who also find that in the long-run the main determinants of prices are money supply, lending rates and nominal exchange rate.

In the short-run, the key determinants of inflation are changes in the nominal exchange, excess demand, and copper prices. Specifically, the estimated results indicate that exchange rate depreciation leads to an increase in consumer prices as does an increase in excess aggregate demand. Furthermore, the lagged effects of prices, which represent consumer inflation expectations, are found to play a key role in determining inflation. Finally, empirical findings also suggest that increase in economic activity denoted by copper prices leads to an increase in aggregate demand, and consequently rising consumer prices.

In the model, nominal exchange rate and crude oil prices represent the effects of import prices and external sector shocks on domestic consumer prices. Effects of import prices may be directly due to the presence of final imported goods in the consumer price index and indirectly through their cost-push effects on domestically produced goods and services.

2.4 Determinants of Broad Money in Zambia

2.4.1 Theoretical and Empirical Literature Review

There are a number of theories on the demand for money. In the classical tradition, cash balances are held primarily to undertake transactions, and therefore depend on the level of income. However, this position was changed in the 1930s when Keynes postulated three motives for holding real money balances: transactions; precautionary; and speculative demand for money. Transactions and precautionary motives of the demand for real money balances follow the classical tradition in that it depends on the level of income while the speculative demand for money departs from the classical tradition by arguing that the demand for real money balances depend on the interest rates.

Following Keynes liquidity preference theory, several authors have offered criticisms regarding Keynes rationale for a speculative demand for money and have contributed to the theoretical literature by distinguishing broadly between the transactions demand (Baumol, 1952; Tobin, 1956) and the asset motive (Tobin, 1956; Friedman, 1956). In general, all available theories portray that the demand for money depends positively on the real GDP and the price level due to the transactions motive while it is negatively related to interest rates due to the speculative motive.

In empirical literature, Goldfeld (1973) has led the works on this subject with his estimations on the stability of the money demand function for both short and long-run using interest rates and output as determinants. In line with new developments in econometrics, recent studies have employed cointegration techniques in estimating the money demand function (see Ball, 2012 and Jenkins, 1999 for instance). However, some researchers have used inflation as a proxy for opportunity cost instead of interest rates. Bahmani-Oskooee and Malixi (1991) justifies the use of inflation as a better opportunity cost for countries that have financial markets which are not well developed. Other studies have incorporated exchange rate or the real effective exchange rate as one of the determinants of the money demand function (see Bahmani-Oskooee, 1996; Bahmani-Oskooee and Tanku, 2006; and Valadkhani, 2008, for example). This followed Mundell (1963)'s postulation that the demand for money can be a function of exchange rate, besides income and interest rates.

Studies on money demand functions for developing and least developed countries (LDCs) have generally assumed a varied number of determinants labelled as either domestic variables (inflation, income, and interest rate) or openness or foreign variables (foreign interest rates, volatility of the real effective exchange rate, and or nominal exchange rate). For instance, see Hamori (2008) on Sub-Saharan Africa; Arize (1989) on Pakistan, the Philippines, South Korea, and Thailand; Khalid (2010) on Philippines, Singapore and South Korea; and Bahmani-Oskooee and Tanku (2006) that test the validity of the black market exchange rate as opposed to official rates for 25 LDCs.

In Africa, Jenkins (1999) reviews some evidence on money demand in which income, exchange rate, interest rates and volatility in inflation are used as determinants. Anoruo (2002) investigates the stability of the Nigerian money demand function during the structural adjustment era. A stable relationship among the variables is established. Kallon (1992) uses income, real money, Bank of Ghana discount rate, and inflation as determinants.

Adam (1999) explores money demand in Zambia in light of financial markets liberalisation. The choice of determinants include income, inflation, deposit rate and treasury bill rate as interest rates, and black market exchange rate depreciation, and concludes that financial markets liberalisation led to a permanent shift in the demand for narrow money. Pamu et al.., (2008) estimates the money demand function (M3) using non-traditional exports (as a proxy for real economic activity), measure of inflation (CPI), and copper prices (proxy for foreign variable). The study found exchange rate and inflation to be important determinants

of money demand in Zambia. A recent study by Chileshe and Zgambo (2014) estimates an Auto-Regressive Distributive Lag model to investigate the short-run and long-run determinants of money demand in Zambia. Their estimates using quarterly data indicate that in the long-run money demand is determined by income, exchange rate, inflation and domestic short-term interest rates. Furthermore, the error correction term indicate that disequilibrium among these variables is corrected at the rate of around 17.4 percent per quarter. Moreover, their results indicate that the demand for real money balances in the short-run is significantly influenced by nominal exchange rate, short-term interest rates, inflation, and income dynamics.

From the survey of literature, money demand functions are estimated for the purpose of determining stability of the money demand so as establish its suitability in stimulating real sector activities through monetary impulses. Alternatively, estimations of the money demand functions are aimed at establishing relevant variables that can be termed as determinants. Many variables are used as determinants with classical ones being income and interest rates. Inflation can also be used as an alternative to interest rates in an effort to capture opportunity cost. In addition, foreign exchange rate enters the model as a measure of currency substitutions with an option of using a black market rate for economies were the parallel market exists. Foreign interest rates and other outward looking or oriented variables can be incorporate in the modelling in order to capture openness or the external sector. Technological changes have also been considered in literature as one of the factors influencing demand for money.

2.4.2 Theoretical and Empirical Framework

In line with the general agreement, money demand in the ZQM is modelled as the demand for real cash balances (Nacega, 2001). In the absence of money illusion, an increase in the general prices will induce a proportionate increase in nominal demand for money, leaving the real balances unchanged.

The basic model underpinning the real money demand function is that in equilibrium;

$$\frac{M^s}{P} = \frac{M^a}{P} = f(Y,R) \qquad 11$$

Where M^s is money supply, M^d is money demand, Y is the price level, R is output or income and is the interest rate.

We can rewrite the above equilibrium condition as a demand for money function incorporating the money supply as follows;

$$M^d = \emptyset(Y,P,R,M^s) \qquad 12$$

Assuming that the money supply process is determined by the following mechanism:

$\mathrm{M^s} = \mathrm{mRM}$, equation 12 can be written as; $M^d = \emptyset(Y,P,R,RM)$ 13

We would expect that an increase in prices and income or wealth increases the demand for money as in the classical tradition. A rise in the opportunity cost of money (R) will lead to a

fall in the demand for money. If the central bank uses a bank rate to influence liquidity conditions in the money market, then an increase the bank rate reduces money supply indirectly reducing prices and hence the demand for money.

Based on the literature reviewed above, the estimated money demand function in ZQM is specified as follows;

$$\Delta m_t = \beta_{11}\left(m_{t-1} - (cpi_{t-1} + y_{t-1})\right) + \beta_{12}\Delta BOZR_t + \beta_{13}\Delta cpi_t + \beta_{14}\Delta rm_t + \beta_{15}Q1 + \beta_{16} + \varepsilon \quad 14$$

Where m is natural log of broad money excluding foreign currency deposits, $BOZR$ is the Bank of Zambia policy rate, cpi is the natural log of the consumer price index, rm is the log of reserve money and $Q1$ is a seasonal dummy variable for quarter one.

According to the classical theory of money demand, there exists a one-to-one positive relationship between broad money and the price level while there is a negative relationship with output. In the ZQM, we impose a long-run relationship between broad money demand on one side and prices as well as output on the other. The imposed theoretical relationship is then used to estimate the rate of adjustment to long-run equilibrium whenever there is disequilibrium in the short-run.

The results from the estimated model suggest that short-run determinants of money demand are the short-term interest rates (proxied by the BOZ Policy Rate), consumer prices, and reserve money. Specifically, broad money growth falls in response to higher interest rates, which is in line with the findings in Hamori (2008) on Sub-Sahara Africa and Chileshe and Zgambo (2014) on Zambia. Further, inflation is also found to negatively affect money demand, a result that is consistent with Jenkins (1999) findings on Zimbabwe and Chileshe and Zgambo (2014) on Zambia. Finally, the growth in reserve money leads to an increase in money demand. Although this finding is not common in empirical literature, it is consistent with the velocity approach to money demand.

2.5 Determinants of Nominal Lending Rates (interest rate pass-through)

2.5.1 Theoretical and Empirical Literature Review

It is generally accepted that the effectiveness of monetary policy action is dependent on its ability to affect the continuum of interest rates, ranging from the short- to long-term interest rates. The continuum of interest rates is better known as the term structure or yield curve (Bonga-Bonga, 2010). The term structure relates the short- and long-term rates, whose slope and dynamics can be explained by three theories, namely, the liquidity preference view, the market segmentation theory and the expectations theory (Balazs and Macdonald, 2009).

The liquidity preference view asserts that investors require a liquidity premium for holding less liquid assets. The market segmentation theory hypothesises that short- and long-term interest rates can be determined independently in segmented markets. Expectations hypothesis theory maintains that long-term interest rates are an average of future expected short-term interest rates plus a term premium. This hypothesis asserts that in the absence of a term premium, short- and long-term interest rates should be equal (Misati *et al*., 2011). The time preference theory of interest is concerned with the relationship between increase or decrease in the rate of interest with respect to time periods. According to this theory, the variation in the premium or the interest rate depends totally upon the risk of occurrence of an event. Therefore, the longer the expected date of loan settlement, the higher the rate of interest as risk increases with time. On the other hand, according to the liquidity preference theory the rate of interest is determined by two factors, which are the supply of money and liquidity preference (Millikan, 1938).

The above theories shed light on how interest rates with different maturities may be related to both short-term and long-term interest rates. The major question is on the speed and magnitude of these adjustments, better known as the interest rate pass-through (John and Pokhariyal, 2013). Interest rate pass-through refers to the measure of the size and speed of interest rate transmission from the policy rates through the short-term rates and eventually to the commercial bank deposit and lending rates. The size or degree of pass-through refers to the extent to which changes in the money market rates are passed through to the banking rates in the long-run. The speed of the pass-through refers to the length of time required for the adjustment to occur. The manner in which changes in central bank interest rates are passed through to changes in banks' yields determines the strength of these effects with a great magnitude (Amarasekara, 2005).

There are several pieces of empirical evidence on the determinants of nominal lending rates with various theoretical frameworks in mind. In this particular review, focus is on the empirical literature with regard to the interest rate pass-through. The interest rate pass-through literature focuses on the rate at which changes in short-term interest rates are passed on to the market rates in the short and long-runs.

Studies on most African countries have shown a consistent outcome that interest rate pass-through is incomplete (Makaambi et al.., 2013; Shefeni-Shefeni, 2013). Makaambi, Wawire, and Omolo (2013) investigate the nature and dynamics of speed of adjustment of bank retail rates in Kenya using both linear and non-linear error correction models. Using monthly time series data, they find that adjustments of lending rates to policy rates are sluggish and incomplete. Specifically, the speed of adjustment is between 0.05 - 0.15 per month, implying it would take 11 - 22 months for a complete pass-through. Another study using a similar approach and data by Shefeni-Shefeni (2013) on the size and speed of the pass-through in Namibia reach the same conclusions that the interest rate pass-through from policy rates to retail rates is incomplete, especially in the short-run. Specifically, they find that the speed of adjustment is 0.004 - 0.136 in short-run while it is between 0.739 - 0.762 in the long-run between money market rates and lending rates. Furthermore, they find that the rate of adjustment between policy rates and short-term money market rates is higher. In addition, Okello (2014) in his assessment of the effectiveness of the pass-through of interbank rates to market rates in Uganda using a bivariate co-integration method following Engel and Granger (1987) finds the long-run pass though from 7 day interbank rates to lending rates to be 0.43 while it is between 0.56 - 0.60 for deposit rates. Finally, in a comprehensive study, Sander and Kleimeir (2006) investigate interest pass-through in common market area of South African Customs Union (SACU) using the Auto-regressive Distributive Lag approach to co-integration. Their results show that the pass-through between short-term rates and lending rates in the Common Monetary Area (CMA) is homogenous, fast and complete while the pass-through to deposit rates is not.

A few studies on Zambia have examined the interest rate path-through (Chileshe et al.., 2014; Zgambo and Chileshe, 2014). They all conclude that interest rate pass-through is incomplete. Chileshe et al. (2014) and Zgambo et al. (2014) use similar approaches to investigate the interest rate path-through in Zambia. Specifically, using monthly data Chileshe et al. (2014) finds that the pass-through between interbank rates and lending rates is 0.02 and 0.13 in the short and long-run, respectively while using quarterly data Zgambo and Chileshe (2014) finds that it is 0.21 and 0.45.

2.5.2 Theoretical and Empirical Framework

The theoretical model for the interest rate equation is based on the portfolio effect of the term structure relations between the long and short-run interest rates within the

expectations theory. The portfolio effect occurs because money and other assets are seen as substitute forms of holding wealth. A change in the short-term interest rates occasioned by changes in the Bank Rate induces economic agents to change asset portfolio combinations. For example, a rise in short-term rates may have a "portfolio effect": that is, investors re-direct their funds to short-term money market instruments, and away from bonds, thus leading to a fall in bond prices and a rise in yields (i.e. long-term rates). Similarly, a fall in the short-term interest rate induces investors to move their funds into long-term instruments, away from short-term market instruments.

Thus, there is a positive relationship between long-term interest rates and short-term changes.

$$r_l = f(i_{int}) \; where \; \frac{\partial r_l}{\partial i_{int}} > 0 \qquad 15$$

This implies that an increase in the interbank rate (discount rate) will lead to increase in long-term rates following the expectations theory.

Following the literature, the empirical model estimated is an error correction model in which we impose a one to one long-run relationship between nominal average lending rates and policy rate. Specifically, the equation estimated is given below;

$$\Delta i^L{}_t = \beta_{17}[i^L - i]_{t-1} + \beta_{18}\Delta BOZR_t + \beta_{19}Dummy + \varepsilon \qquad 16$$

In equation 16, i^L is the average nominal lending rate, i is the policy rate proxied by interbank rate. β_{17} is the error correction coefficient with an imposed one-to-one long-run relationship between average lending rates and the policy rate. The sign on the error correction coefficient is expected to be negative, indicating the existence of a co-integrating relationship between short-term and long-term interest rates. β_{18} measures the contemporaneous effect of changes in the policy rate on lending rates and the dummy variable is an impulse dummy that captures the structural break in the lending rates data noted in 2001Q1.

The results from the estimated model suggest the existence of a long-run relationship between average nominal lending rates and the policy rate. Specifically, results show that the speed of adjustment between the policy rate and the lending rate is rather slow at 8 percent per quarter, a result which could point to a weak interest rate transmission channel in Zambia. The results also show that in the short-run, a rise in the policy rate will lead to an increase in the nominal lending rate.

Further, the empirical results indicate that the interest rate pass-through is incomplete in the short-run, but complete in the long-run due to the imposed relationship. We impose a one to one relationship between nominal lending rates and BoZ policy rate because in the current framework the policy rate is the base rate for all commercial bank lending. This result is similar to previous studies on Zambia and other African countries (Chileshe *et al.*, 2014; Makaambi *et al.*, 2013; Shefeni-Shefeni, 2013; Okello, 2014).

2.6 Determination of the Nominal Exchange Rate

2.6.1 Theoretical and Empirical Literature Review

There are fundamentally two main schools of thought addressing issues of the exchange rate determination. One school of thought is of the view that the demand and supply of

currencies determines equilibrium exchange rate and utilises the balance of payment information, while the other school holds the view that equilibrium values of financial assets determines the behaviour of the exchange rate (Saeed *et al.*, 2012). According to the later approach, it is the changes in the stock of assets which determines the equilibrium exchange rate.

Research based on the balance of payment approach rests mainly on the elasticity or absorption approach to examine the behaviour of exchange rates. On the other hand, research based on monetary approach uses purchasing power parity (PPP) condition, Quantity Theory of Money (QTM), interest rates parity, money demand function and cumulative current account position to examine the behaviour of the exchange rate.

Several pieces of empirical evidence exist on the factors determining the exchange rate. A study by Saeed et al. (2012) uses an ARDL approach to co-integration to investigate determinants of the exchange rate in a flexible exchange rate regime. Their results indicate that in the short- and long-run, the nominal exchange is determined by money supply, the level of foreign exchange reserves and the debt. In the long-run, they find that a 1% increase in the money supply, foreign reserves and debt increases the nominal exchange rate by 0.46%, 0.06%, and 0.53%, respectively. Further, they find that approximately 3.6% of disequilibrium in the short-run is corrected for every quarter. Bashir and Luqman (2012) investigate the long-run determinants of the real exchange rate in Pakistan using the Johansen's cointegration method. The results indicate that the real exchange rate is determined by terms of trade, trade restrictions, price level, and remittances of Pakistanis working abroad. They show that a 1% change in the terms of trade, trade restrictions, and remittances lead 0.29%, 0.28% and 0.35% change in the real exchange rate in the long-run. The error correction term shows that disequilibrium is corrected at the rate of 14% per year.

In the Sub-Saharan Africa region, a number of studies have been undertaken to investigate the determinants of the nominal exchange. Simwaka (2006) investigates the determinants of nominal exchange rate in Malawi using a blended version of the monetary and portfolio models. Using quarterly model, they find that in the short-run nominal exchange rates are determined by changes in current account balances, net external flows, growth in money supply and price differentials. However, the interest rate differential is found to have no effect on the nominal exchange rate. Furthermore, the error correction term shows that any disequilibrium is corrected for at the rate of 25% per quarter. Aron et al. (1997) present short-run and long-run influences in a model for the real exchange rate in South Africa. Using quarterly data from 1970 to 1995, the authors find that real exchange rate is influenced by factors such as terms of trade, real US dollar gold price, tariffs, capital flows, gross international reserves and government expenditure.

Mkenda (2001) analyses the main determinants of the real exchange rate in Zambia and estimated the degree of misalignment in the real exchange rate using a Johansen cointegration analysis on data for the period 1971 to 1993. The study establishes that terms of trade and government consumption tend to depreciate the real exchange rate while investment share, growth of real GDP, central bank reserves and trade taxes tend to appreciate the real exchange rate. Mungule (2004) investigates sources of movements in Zambia's real effective exchange rate using a VECM over the period 1971 to 1997. Empirical results suggest that the nominal effective exchange rate responds to shocks to copper prices while shocks to domestic prices have no effect. Furthermore, the VECM for the real exchange rate shows that the main determinants of the exchange rate in Zambia are terms of trade, excess credit growth and capital outflow while trade policies has very minimal effect. Weeks (2013) investigates the determinants of the exchange rate in the short-run using monthly time series data from 2005-2013. The results indicate that the key determinants of the nominal Kwacha-US dollar exchange rate in short-run are relative interest rates, the

trade balance and the BOZ foreign exchange interventions. Specifically, they find that a 1% rise in the trade balance leads to a 0.16% appreciation while a similar rise in relative short-term interest rates leads to 0.09% appreciation. However, they find that BOZ foreign exchange intervention leads to a marginal depreciation of 0.001%.

2.6.2 Theoretical and Empirical Framework

The theoretical framework used in the ZQM model for the determination of the nominal exchange rate follows the monetary approach, based on the following theories: 1) the uncovered interest parity theory; and 2) the exchange rate expectations theory.

The uncovered interest parity (UIP) theory operates well in a small open economy. The model assumes that the domestic economy is a price taker because it is small in the global financial markets. In this model, a reduction in the domestic interest rates will induce investors to move their assets out of the country to seek higher returns in other markets, thereby depreciating the currency. Furthermore, an increase in domestic interest rates will attract the inflow of foreign currency and thereby appreciate the exchange rate. In addition to the UIP, the model also notes that expectations about the exchange rate, general prices and the interest rates affects the exchange rate overtime. It is assumed that expectations are formed using the adaptive expectations hypothesis.

Based on these theories, the model for the nominal exchange rate estimated in the ZQM is specified as follows;

$$\Delta usd = \beta_1(usd_{t-1} - (cpi_{t-1} - uscpi_{t-1}) + \beta_2 pcop_{t-1})) + \beta_3 \Delta cpi_t + \beta_4 \Delta m2_t + \beta_5 \Delta pcop_t + \beta_6 \Delta(i_t - i_t^*) + \beta_7 \Delta(i_{t-1} - i_{t-1}^*) + \beta_8 \Delta usd_{t-1} + \beta_0 + \varepsilon_t \quad 17$$

where: *usd* is the natural log of the nominal Kwacha US dollar exchange rate; *pcop* is the natural log of copper prices in US dollars; *cpi* is the natural log of the consumer price index; *i-i** is the difference between the BOZ Policy Rate and the US Federal Funds rate, representing the interest rate parity condition; and, ε is an error term.

In the model, a long-run relationship between the real exchange rate and the price of copper is assumed. The results of the estimated model suggest the existence of a long-run relationship between copper prices and the real exchange rate, with an increase in the price of copper leading to an appreciation in the real exchange rate. In this regard, a rise in the price of copper, Zambia's major export, will improve the country's balance of payment position resulting in the appreciation of the real exchange rate in the long-run.

With regard to the determinants of the nominal exchange rate in the short-run, the results suggest that copper prices, inflation, money supply and interest rate differentials are key determinants. The results are similar to those obtained in Mungule (2004) and those which have included an indicator of terms of trade (Mkenda, 2001; Weeks, 2013). In addition, an increase in domestic interest rates relative to global (US) interest rates leads to an appreciation, similar to Weeks (2013). On the contrary, the results also suggest that growth in money supply and domestic prices leads to the depreciation of the exchange rate, similar to Mungule (2004) who shows that credit growth leads to depreciation.

2.7 Determination of Aggregate Demand

2.7.1 Theoretical and Empirical Literature Review

What makes an economy grow is the usual question that most people ask. Macroeconomic theory has identified various factors that influence the growth of an economy from the classical, neo-classical, new endogenous growth and Keynesian theories. According to growth theories with classical or neo-classical orientation, expansion in an economy's level of real output results from the expanding supply of inputs such as labour, capital and changes in technology (Solow, 1956; Fazzari *et al.*, 2012). Other factors that influence economic growth include natural resources, human capital, economic policies, foreign aid, trade openness, institutional framework, foreign direct investment, political factors, socio-cultural factors, geography as well as demography (Dodzi *et. al* 2013).

In the Keynesian orientation, fluctuations in economic growth are mainly induced by variations in the economy's aggregate demand. The argument is that the cause of economic stagnation is inadequate demand for society's output given the existence of nominal rigidities. Hence, with nominal rigidities demand management policies such as fiscal or monetary policy can be used to move the economy out of a recession or stagflation (Keynes, 1936).

Other theories of growth note that economic growth can be either extensive, enhanced through the accumulation of capital, or intensive, arising from more efficient use of existing capital and other resources (Gylfason and Hochreiterb, 2008). Among a number of various ways of increasing economic and social efficiency, one of the most obvious is the accumulation of human capital – through education, on-the-job training, and health care. In addition, there are several other ways of increasing efficiency and economic growth, such as technical progress and research and development.

Furthermore, trade has proved to be a very viable ingredient to economic growth. This can be by way of dynamic or static means, dynamic in the sense of exchange of technological progress and static in the sense of increased volume of goods and services. Smith (1776) and Ricardo (1817) showed how free trade can enable individuals and countries to break outside the production frontiers and increase their welfare than would be the case under a controlled economy, which would confine them to lower standards of life.

The past two decades have witnessed renewed interest in the main factors driving economic growth in many countries. Consequently, empirical literature on economic growth has grown and aggregate demand-oriented studies, in particular, have flourished in the past decade (see Temple, 1999 and Ahn and Hemmings, 2000 for surveys). Some studies have focused on single countries while others involve multiple countries. While determinants of economic growth in developed economies have long been established, the resurgence of empirical growth literature has tended to focus on developing and emerging economies with the view to understanding the factors driving economic growth, or the lack of it.

Among the recent empirical studies on the determinants of economic growth in emerging and developing economies include Gylfason *et al.*, (2008), who studied the determinants of long-run growth in Estonia and Georgia. The empirical findings from their study suggest that the determinants of growth in these countries include education, investment in physical capital and foreign direct investment, with a country that invested a proportionately higher amount in physical capital and education growing at a faster rate than the country with correspondingly lower amounts of investment in capital and education. Over the period 1989 to 2005, real GDP growth in Estonia averaged 6 percent while real GDP growth in Georgia averaged 2 percent over the same period. The differences in the growth rates were attributed to the fact that Estonia invested 29 percent of GDP in machinery and equipment on average from 1989 to 2005 compared with 20 percent in

Georgia while enrolment at primary school level in Estonia averaged 100 percent compared to 95 percent for Georgia (Gylfason et al., 2008). Furthermore, net inflows of foreign direct investment in Estonia averaged 7 percent of GDP between 1992 - 2005compared with an average of 4 percent in Georgia (Gylfason *et al.*., 2008).

In Africa, based on a panel data of 19 Sub-Saharan countries (SSA) for the years 1982 - 2000, the study conducted by Ndambiri et.al, (2012) explored the determinants of economic growth in the region. The study results indicate that physical capital formation, a vibrant export sector and human capital formation significantly contributed to the economic growth among Sub-Saharan countries. However, government expenditure, nominal discount rate and foreign aid significantly led to negative economic growth (Ndambiri *et. al,* 2012).

Tsangarides (2012) compares the determinants of growth in Africa with the rest of the world and examines the determinants of growth spells in Africa. The factors considered include physical and human capital, macroeconomic policy, and socio-political factors. The results show that the determinants of growth spells in Africa are different from those in the rest of the world. Specifically, in Africa the main determinants of growth were initial income, terms of trade, exchange rate under-valuation and inflation, while openness and droughts (seasonal effects). However, capital (human and physical) and world interest rates had marginal effects on growth.

Other empirical studies on the determinants of output growth carried in Africa include that on Horn of Africa and Ghana. The Horn of Africa countries had poor economic growth spanning many decades before the 2000's and the study by Abdi *et al.*, 2012 was aimed at unbundling the factors responsible for the poor economic performance and divergence from the developing regions. Their study revealed that among the factors responsible poor economic growth in the sub-region include limited access to finance (from both domestic and external sources), low domestic savings, weak infrastructure, and inadequate human capital and Governance issues. Havi et al.,(2013) find that the long-run determinants of growth include physical capital, labour force, foreign direct investment, foreign aid, inflation and government expenditure in Ghana. In the short-run, foreign direct investment and government expenditure were significant determinants of growth in real gross domestic product.

2.7.2 Theoretical and Empirical Framework

In ZQM, growth in the economy is modelled from the Keynesian perspective based on the assumption that fluctuations in the economy's aggregate demand are a result of deficient demand in the economy.

The model assumes that aggregate demand converges towards the trend in GDP, which represents aggregate supply. Aggregate demand is modelled as a gap that may be below or above the trend GDP. A positive output gap will lead to a fall in aggregate demand or output, while a negative output gap represents excess supply that leads to an increase in aggregate demand.

Higher real interest rate reduces aggregate demand while real exchange rate depreciations and real money growth increase aggregate demand, and hence output.

Borrowing from the literature review above, the output growth is assumed to be influenced by lagged output, real interest rates, real exchange rates and real money supply. Therefore, output growth equation is specified as follows;

$$\Delta_4 y_t = \beta_{41}\Delta_4 y_{t-1} + \beta_{42}[i^L - \Delta_4 p]_{t-2} + \beta_{43}\Delta[e-(p-p^f)]_{t-3} + \beta_{44}\Delta(m-p)_t + \beta_{45}\Delta(m-p)_{t-1} + \beta_{46}\text{Dummy} + \beta_{47} + \varepsilon_t \quad (18)$$

Where: y_t is output growth, $i^L - \Delta_4 p$ is the real interest rate, $[e-(p-p^f)]$ is the real exchange rate and $(m-p)_t$ is real money supply.

It should be noted that in the output equation specified above, quarterly data on GDP was interpolated from annual series. In this regard, annual GDP figures were decomposed using the Index of Industrial Production by following its seasonal pattern to get quarterly data.

The result of the estimated model shows that aggregate demand growth is determined by its previous growth, the real (lending) interest rate, the real exchange rate and real broad money growth. In particular, the results show that an increase in real lending rates leads to a decline in output growth while a depreciation in the real exchange rate boosts output growth. In addition, growth in real broad money leads to an increase in output growth, which is consistent with theory. Furthermore, the results obtained for Zambia seem to be consistent with those obtained for Ghana, where growth in output was found to be negatively influenced by real interest rates, and positively influenced by the depreciation in the real exchange rate and real money growth (Havi et al., 2013).

3. Monetary Policy in the ZQM

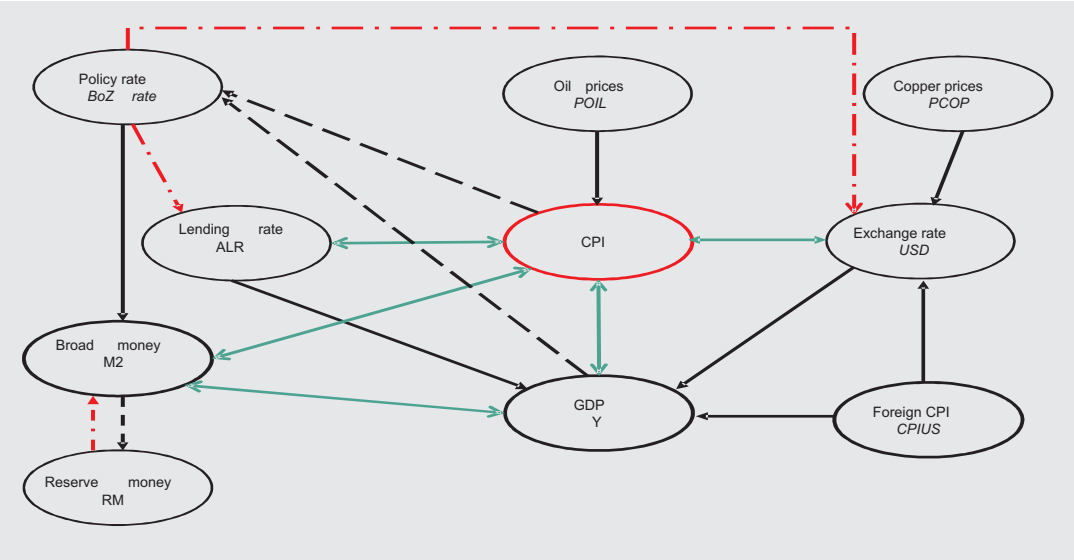
3.1 Monetary policy Transmission in the ZQM

In the ZQM, there are three monetary policy transmission channels, which include:

- Interest rate channel;
- Exchange rate channel; and,
- Expectations channel (included via the lags of macroeconomic variables or adaptive expectations).

The schematic representation of the transmission mechanism is given in the following diagram.

Figure 1: Schematic representation of monetary policy transmission



Interest rate channel – This operates through changes in the BoZ Policy Rate, which directly affects the lending rate given that the Policy Rate is the reference rate for banks' lending. In this case, an increase in the Policy Rate will lead to an upward adjustment in lending rates. Higher lending rates will constrain credit growth, dampen aggregate demand and ultimately lead to a reduction in inflation.

Exchange rate channel – The increase in the Policy Rate will also work through the exchange rate channel and is expected to lead to an appreciation in the exchange rate. An appreciation in the exchange rate will have a direct impact on consumer prices, which will decline. Exchange rate appreciation is also likely to impact output growth through a decline in net exports, with lower aggregate demand leading to a reduction in consumer prices.

Expectations channel – This works through the expectations economic agents form about key macroeconomic variables. For instance, expectations of a depreciation in the exchange rate is likely to result in upward revision of consumer prices, thereby exerting inflationary pressure on overall prices. An increase in consumer prices will result in economic agents' expectation of higher interest rates in the future to contain inflationary pressures, a situation which may lead to increased aggregate demand and heightened inflationary pressures.

3.2 Monetary Policy Rule

The model is closed by a Taylor rule type of policy reaction function. According to the policy reaction function, the Bank is assumed to respond to deviations of inflation from its target and to the output gap. Furthermore, the reaction function assumes that the central bank attempts to smoothen interest rates over the horizon in that the last period's policy stance may also affect the current policy stance. In the model, the monetary policy rule is specified as follows:

$$BOZRATE_t = \alpha\{\bar{\imath} + 1.5[\pi_t - \pi^*]_{t-1} + \beta y_t\} + \tau i_{t-1} + \delta_t, \text{ central bank responds.}$$

$$BOZRATE_t = BOZRATE_{t-1}, \text{ no response.}$$

Where BOZRATE is the Policy Rate, i is the domestic short-term nominal interest rate; π is year-on-year inflation; $\pi*$ is targeted year-on-year inflation; y_t is output gap, δ_t is a policy shock and α, β and τ are policy-determined parameters.

4. Use of ZQM in Forecasting and Policy Analysis

The principle uses of the ZQM are forecasting and policy analysis. The model is used to produce forecasts of key variables such as inflation, the exchange rate, growth in money supply and aggregate demand. The mode is also used to evaluate the impact of exogenous variables such as foreign prices, crude oil prices, reserve money and copper prices on key macroeconomic variables, which are important in formulating monetary policy stance.

4.1 Forecasting

In undertaking forecasting, there are three steps which must be followed. These include: updating all the series in data base; make key assumptions about the expected evolution of exogenous variables; and setting the forecasting horizon. The endogenous variables that have to be updated include the following:

- Domestic Consumer Price Index - Quarterly Average
- Mid-rate Kwacha/US Dollar exchange rate - Quarterly Average

- Average Commercial bank Lending rate - Quarterly Average
- Broad Money (M2) - Quarterly Average
- Quarterly GDP - Decomposed from the annual GDP

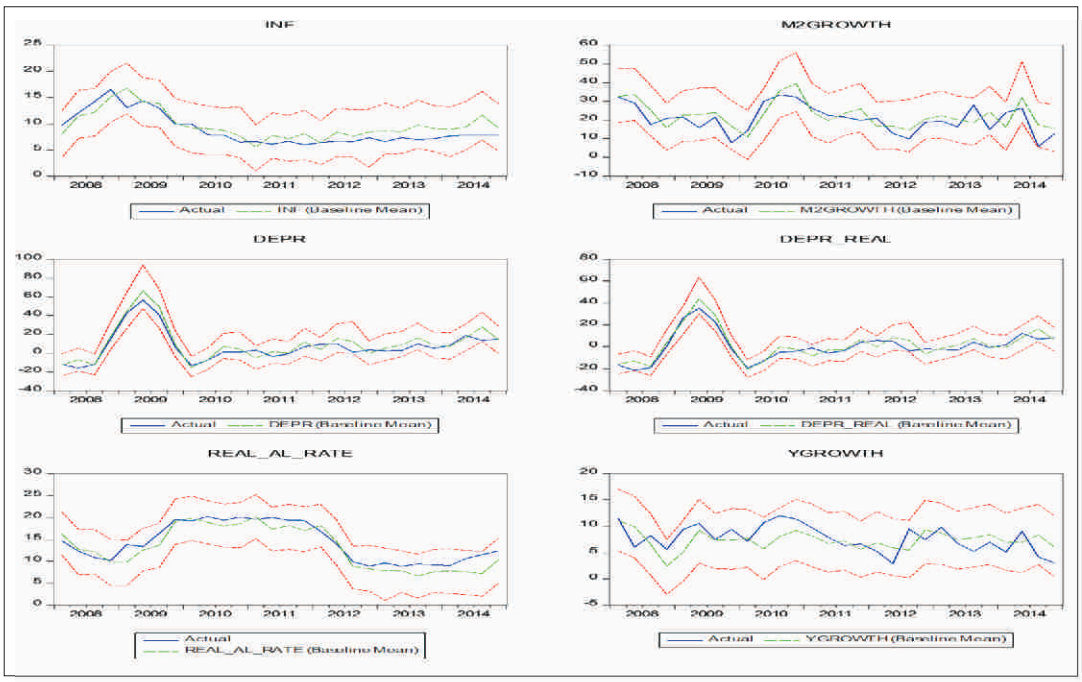
Exogenous variables which require assumptions before producing forecasts include the following:

- US Consumer Price Index - Quarterly Average
- South African Consumer Price Index - Quarterly Average
- US Federal Funds Rate - Quarterly Average
- Reserve Money - Quarterly Average
- Copper Prices - Quarterly Average
- Oil Prices - Quarterly Average

Once the data on endogenous variables has been updated and assumptions regarding the evolution of exogenous variables provide, the forecasts can be produced from the model.

Figure 2 presents the in-sample dynamic forecast of inflation, money supply (M2) growth, nominal and real exchange rate depreciation, banking lending margin, and output growth from the Zambian Quarterly Model. The in-sample dynamic forecasts are undertaken to assess the performance of the model using its own predicted values of the endogenous variables. The output from the model suggests that the in-sample dynamic forecast performance is reasonable. It is important to note that the forecasts are conditional upon assumption made regarding six exogenous variables noted above.

Figure 2: In-sample dynamic forecasts for the period 2008Q1 - 2014Q4



One of the key uses of the model is to produce out-of-sample forecasts of key macroeconomic variables to guide monetary policy formulation. The out-of-sample forecast of inflation, broad money growth, nominal and real exchange rate depreciation, commercial bank lending margins and aggregate demand reported here are based on the model estimated using data for the sample period ending in the third quarter of 2015.

Since, depending on the initial conditions as at the end of the third quarter of 2015, the solution of the model and hence the forecasts are only based on the assumptions about the exogenous variables stated above. In undertaking forecasting using the ZQM, there are two ways in which assumptions about the exogenous variables can be done. One way is to obtain the values forecasted by other organisations such as the IMF and World Bank for commodity prices, the US Federal Reserve for the US CPI and Federal Funds rate, South African Reserve Bank for the South African CPI, and the projected reserve money growth. Alternatively, one can make assumptions about the exogenous variables regarding the expected growth or evolution of these variables using equations. We use the latter to demonstrate out-of-sample forecasting; the assumptions are imbedded in the following equations:

$$LOG\,(CPIUS) = LOG(CPIUS(-4)) + 0.019$$

$$LOG\,(CPISA) = LOG\,(CPISA(-4)) + 0.058$$

$$LOG(POIL) = POIL\,(-1)$$

$$LOG\,(PCOP) = LOG\,(PCOP\,(-4)) - 0.05$$

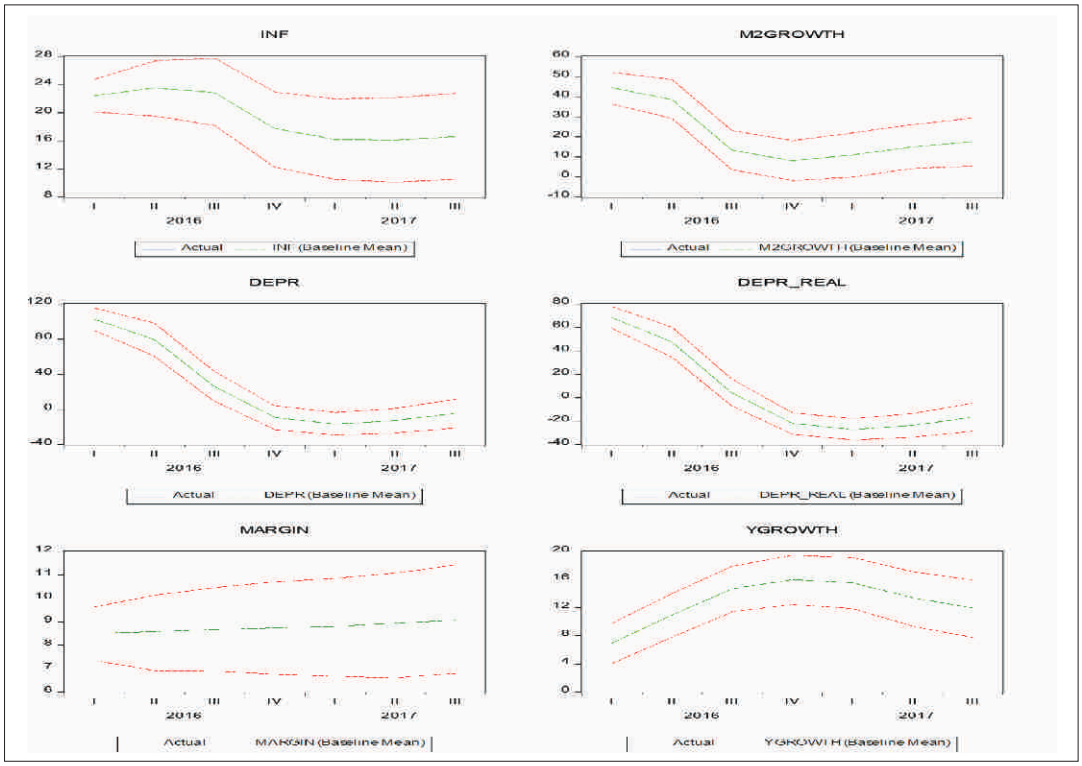
$$FFR = FFR\,(-1)$$

$$LOG\,(RM) = LOG\,(RM\,(-1))$$

From the equations, the assumptions state that: US Consumers prices will grow at a rate of 1.9% per annum over the forecast horizon while inflation in South Africa will be at 5.8%. In addition, we assume that crude oil prices will remain at the level prevailing at the end of the third quarter while copper prices will fall at the rate of 5% per annum over the forecast period. Further, we assume that the Federal Funds rate and reserve money growth will remain the same, that is, at levels prevailing at the end of the third quarter.

Given the assumptions, the dynamic forecasts of the growth rates in endogenous variables are given in Figure 3 below. The forecasts show that inflation will average 22.4% in the first quarter of 2016, then rising to 23.5% in the third quarter before starting a downward trend closing the year at 17.7%. In 2017, the forecast indicate that inflation will remain stable in the range of 16 - 16.5%. The inflation is projected at elevated levels on account of the falling copper prices which will lead to depreciation in the Zambian Kwacha. In addition, our assumption of stable crude oil prices in the wake of falling copper prices will worsen the country's current account, leading to a further depreciation of the domestic currency. Furthermore, the results indicate that the pace of depreciation of the exchange will fall over the forecast horizon while aggregate demand will rise through the first and second quarters and then start to fall in 2017.

Figure 3: Forecast of key macroeconomic variables for the period 2016Q1-2017Q3

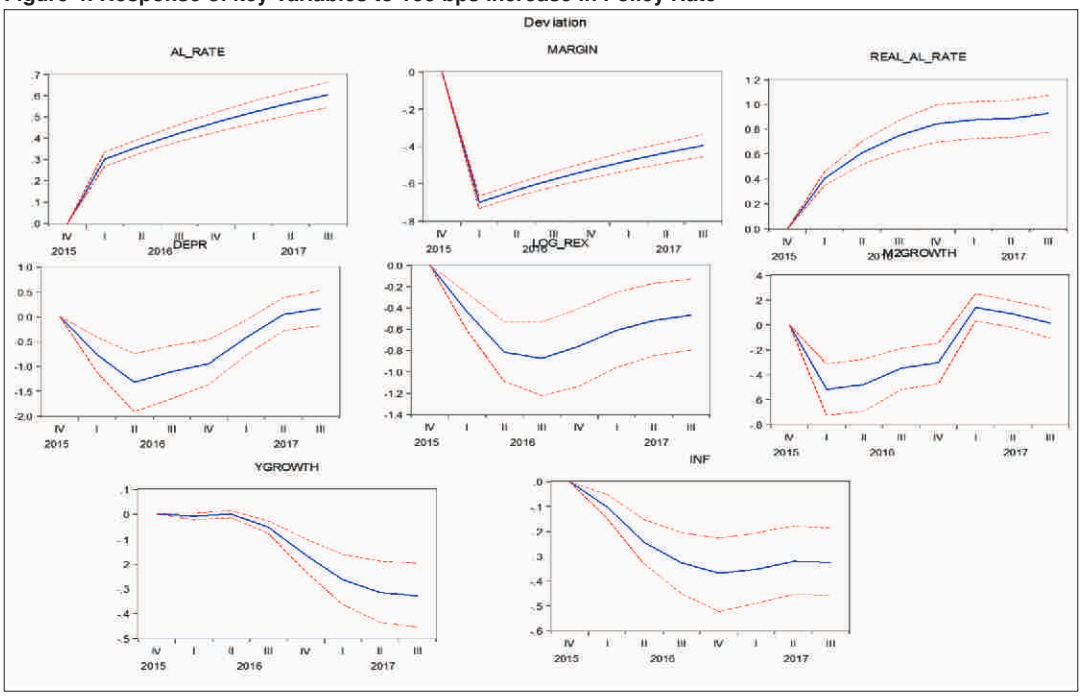


4.2 Policy Analysis

The ZQM is also useful in policy analysis aimed at understanding the response of key macroeconomic variables to domestic and external shocks. The model can be used to trace how inflation, for instance, responds to a shock, such as the decline in the price of copper, increase in the price of crude oil or the increase in the BOZ Policy Rate.

We start the demonstration of the use of the model for policy analysis by considering a shock to monetary policy involving the increase in the Policy Rate of 100 basis points (1 percentage point), which is effected in the fourth quarter of 2015 and maintained at this level until the third quarter of 2017. Figure 4 illustrates the response of the key variables to such a shock. In this case, an increase of 1 percentage point in the Policy Rate is expected to lead to a reduction in inflation, with the maximum effect coming through in the third quarter of 2016. This policy action works through two monetary policy transmission channels; the interest rate and exchange rate channels. Through the interest rate channel, an increase in the Policy Rate will push up average nominal and real lending rates, which will lead to a decline in demand for credit due to high lending rates. A decline in demand for credit results in a fall in money supply, as reflected in a decline in the growth of money supply and as well as a fall in aggregate demand in Figure 4. As growth in money supply and aggregate demand falls, inflation will trend downwards. The exchange rate channels works through the appreciation in the exchange rate resulting from an increase in the Policy Rate. In this case, a higher Policy Rate will lead to a rise in real interest rates which induce an inflow of foreign capital in search of higher yields on domestic assets. The resultant appreciation of the exchange rate due to capital inflows will help to lower the prices of imported goods, and consequently dampen inflation.

Figure 4: Response of key Variables to 100 bps increase in Policy Rate



The other shocks that are considered include shocks to exogenous variables on key macroeconomic variables such as reserve money, copper prices and foreign interest rates. These shocks are assumed to hit the economy over the period running from the first quarter of 2016 to the third quarter of 2017.

Analysis of Shocks to Reserve Money

The effects of 1 percent positive shock to reserve money on real interest rates, exchange rate, money supply, aggregate demand and inflation are presented in Figure 5.

Figure 5: Response of Key Variables to a 1% Shock to Reserve Money

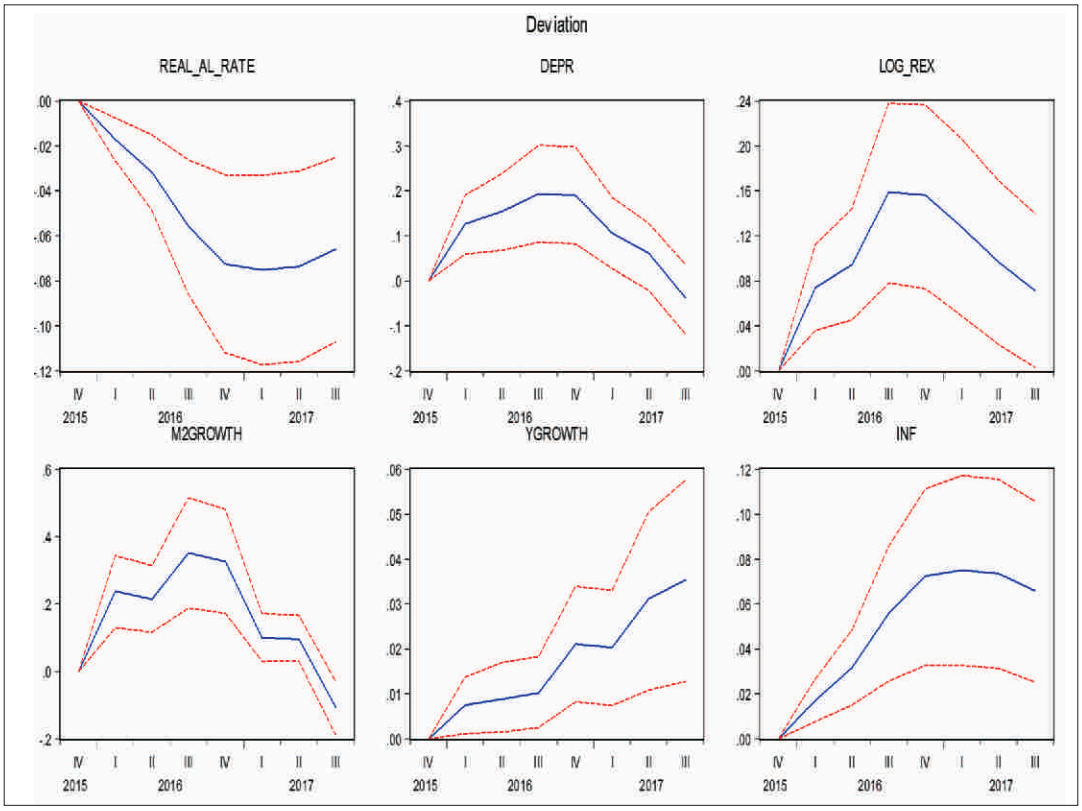
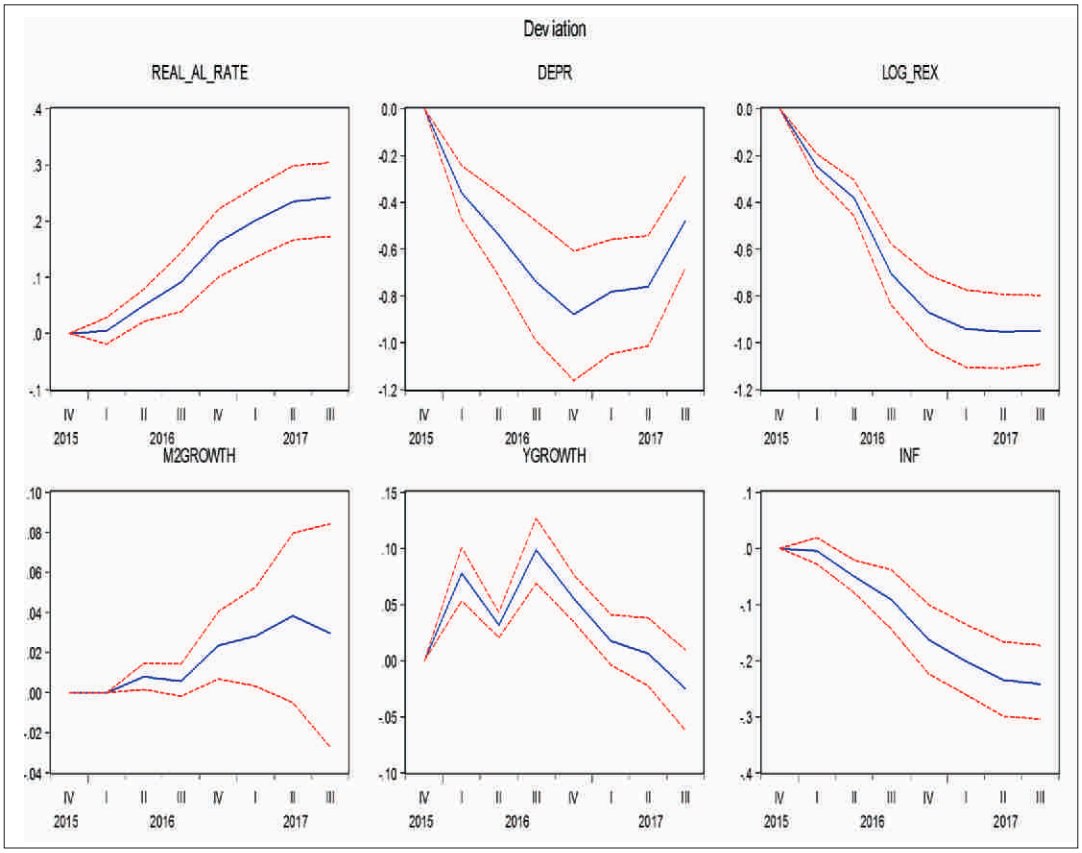


Figure 5 show that a 1 percent increase in reserve money will lead to a positive effect on money supply during the shock period. Growth in money supply will have a positive effect on inflation directly and indirectly through its effects on the exchange rate and aggregate demand. Specifically, growth in money supply will lead to rising prices through the liquidity effect. Further, growth in money supply will lead to growth in aggregate demand and consequently fuel inflation. In addition, higher money supply growth will lead to depreciation in the exchange rate as economic agents put excess money into foreign assets. The depreciation in the exchange rate will directly lead to an increase in the prices of imported goods and services, and consequently overall prices. As inflation rises, real interest rates decline.

Analysis of Shock to Copper Price

The responses of key variables to an increase (positive shock) of 1 percent in copper prices for the period starting from the first quarter of 2016 to the third quarter of 2017 are presented in Figure 6.

Figure 6: Response of Key Variables to a 1% increase in Copper Prices

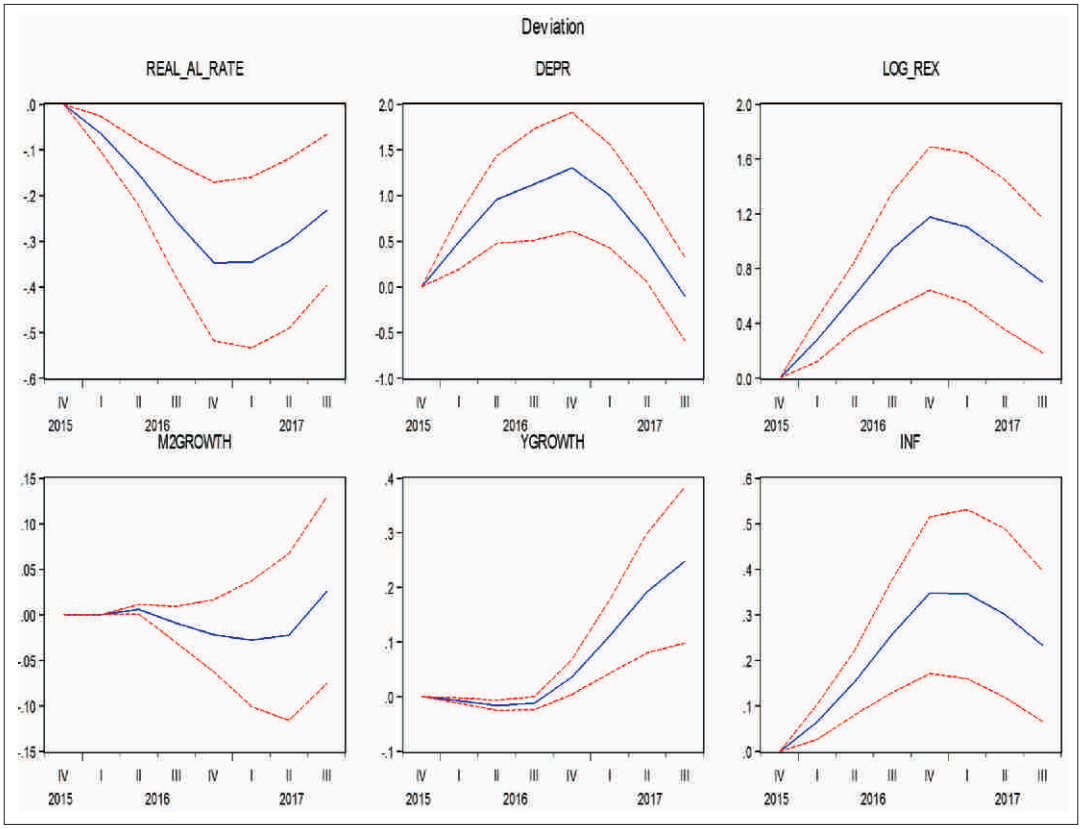


A positive shock to copper prices will lead to both indirect and direct effects on consumer prices. Specifically, an increase in copper prices will directly have a positive effect on consumer prices as a measure of economic activity. Rising copper prices are seen as an indicator for better economic performance going forward, leading to an increase in demand and prices. On the other hand, the indirect effect of a positive shock to copper prices will occur through aggregate demand and hence prices. In addition, an increase in economic activity will have a positive effect on money supply and hence prices. Another indirect effect of a positive shock to copper prices is through its effect on the exchange rate and consequently inflation. In this regard, higher copper prices will lead to an appreciation in the exchange rate, with a stronger exchange rate exerting downward pressure on prices. In this case, the overall effect of copper prices on the exchange rate tends to dominate in the medium-term, and hence the fall in inflation observed in the Figure 6.

Analysis of Shocks to Foreign Interest Rates (Federal Funds Rate)

The effects of a 100 basis point shock to the US Federal Funds rate (FFR) from the first quarter of 2016 to the third quarter of 2017are presented in Figure 7.

Figure 7: Response of Key Variables to a 1% increase in the Federal Funds Rate



A positive shock to the FFR has direct impact on the exchange rate of the Kwacha through the interest rate parity hypothesis. The rise in US FFR, via a positive shock, will lead to a depreciation of the Zambian Kwacha as economic agents move out the Zambia financial assets in search of higher yields in the US. The resultant depreciation in the exchange rate will lead to an increase in aggregate demand and consequently raise import prices. Further, depreciation of the domestic currency will lead to a decrease in broad money growth as the central bank responds to stabilise the exchange rate and dampen inflationary pressures through tight monetary policy. Finally, the rise in inflation will lead to a fall in the real lending rate.

5. Conclusion

The main objective of this paper is to document the ZQM, which is an aggregate macroeconomic model. The model has been developed with a view to provide short to medium-term forecasting and policy analysis to inform Bank of Zambia monetary policy formulation and implementation. The model is based on a simple econometric modelling strategy using relevant economic theories to support the various components of the model. The level of exogeneity is quite high with model users required to provide assumptions on seven exogenous variables to be able to use it successfully.

Equations in the model were estimated on a sample size covering the period from late 1990s to the fourth quarter of 2014. This period covers the era of numerous economic policy reforms by the government that moved the economy from a command or centralised one to

market-based. Overall, the performance of the model is reasonable and acceptable. The paper demonstrated in-sample and out-of-sample forecasting performance. Experience from the use of the model to produce out-of-sample forecasts indicates that the ZQM performs relatively well in forecasting important variables such as inflation and broad money growth. Furthermore, the use of the model to undertake policy analysis was demonstrated, with the results being consistent with the expected outcomes. The model also captures the important channels through which monetary policy is transmitted in the economy.

It should also be noted that economic models are a simple representation of the complex economic reality and as such the forecasts and policy analysis emanating from the models must be interpreted and used with caution. Judgment and the experience of the users of the models as well as policy makers is therefore, important in making the outputs from the models useful. As a simple representation of reality, the model must be updated and developed on a regular basis to take into account the evolutions in the economy and make the model more relevant. As Popper (1959) stated, all models are a simplification of reality that are eventually falsified by the data, leading to the development of better models. While the model documented here is deemed to be useful in the BoZ's formulation of monetary policy, its usefulness might wane, prompting the development of better models to inform policy formulation.

The model documented here is not without limitations. The limitations worth noting include the absence of the fiscal sector and the use of interpolated quarterly real GDP data. Although the fiscal sector is indirectly captured through reserve money and consequently money supply growth, an explicit inclusion of the fiscal block in the model is important given the impact of fiscal developments on key variables such as the exchange rate, output growth and inflation. In view of this, an attempt to include the fiscal sector has been made in a different version of the model that is under development. On the issue of interpolated quarterly real GDP data, this limitation is reflected in some of the results obtained from the model, particularly those relating to output growth. Nonetheless, this issue is likely to be resolved as soon as the Central Statistical Office starts producing quarter real GDP data.

References

Abdi, A.I., and Aragie, E.A., (2012). *"Economic Growth in the Horn of Africa: Identifying Principal Drivers and Determinants"*, The Horn Economic and Social Policy Institute (HESPI) Policy paper no. 12/3

Adam Smith (1776). *"An Inquiry into the Nature and Causes of the Wealth of Nations". Available online at http://www.gutenberg.org/files/3300/3300-h/3300-h.htm*

Ackay, O.C.; Alper C.E.; and Ozmucur, S. (2003). "*Budget deficit, Inflation and Debt Sustainability: Evidence from Turkey*", Bogazici University Paper No. SBE 1-15.

Adam, C.; Kwimbere, D.; Mbowe, W.; and O'Connell, S. (2012). "*Food Prices and Inflation in Tanzania",* Working Paper Series N° 163, African Development Bank, Tunis, Tunisia.

Adam, C. (1999). "Financial Liberalisation and Currency Demand in Zambia", *Journal of African Economies*, Vol. 8, No. 3, pp. 268–306.

Ahmed, Q.M.; Muhammad, S. D.; Noman, M.; and Lakhan, G.R. (2014). "Determinants of Recent Inflation in Pakistan: Revisit", *Pakistan Journal of Commerce and Social Sciences,* Vol. 8, No.1, pp. 170- 184.

Ahrend, R., P. Catte, and R. Price. (2006). "Factors Behind Long-Term Interest Rates," Financial Market Trends, OECD, No. 91, (November).

Akinboade, O.A.; Siebrits, F. K. and Niedermeier, E. W. (2004). "*The Determinants of Inflation in South Africa: An Econometric Analysis*", AERC Research Paper 143, African Economic Research Consortium.

Amadeo, E.J. (1986a): Notes on capacity utilisation, distribution and accumulation, Contributions to Political Economy, 5: 83-94.

Amadeo, E.J. (1986b): The role of capacity utilization in long period analysis, Political Economy, 2: 147-160.

Amadeo, E.J. (1987): Expectations in a steady-state model of capacity utilization, Political Economy, 3: 75-89.

Amarasekara, C. (2005). 'Interest rate pass-through in SriLanka', *Staff Studies*, 35 (1/2): 1-32.

Atesoglu, H.S., Smithin, J. (2006): Real wages, productivity and economic growth in the G7, 1960-2002, Review of Political Economy, 18: 223-233.

Arize, A.C.; Malindretosb, J.; and Shwiffa, S.S. (1999). "Structural breaks, Cointegration, and Speed of Adjustment: Evidence from 12 LDCs Money Demand", *International Review of Economics and Finance* Vol.8, pp. 399–420.

Arize, A, (1989), "An econometric investigation of money demand behaviour in four Asian developing countries", *International Economic Journal*, Vol.3, No.4, pp.79-93.

Bahmani-Oskooee, M. (1996). "The Black Market Exchange Rate and Demand for Money in Iran", *Journal of Macroeconomics*, Vol.18, No. 1, pp. 171-176.

Balazs, E. & Macdonald, R. (2009). 'Monetary transmission mechanism in transition economies: surveying the surveyable', Journal of Economic Surveys, 23(2): 277-327.

Bahmani-Oskooee, M. and Tanku, A. (2006). "Black Market Exchange Rate, Currency Substitution and the Demand for Money in LDCs" *Economic Systems,* Vol. 30, pp. 249-263.

Ball, L. (2012). "Short –run Money Demand", *Journal of Monetary Economics*, Vol .59, pp. 622-633.

Bandara, R. (2011). "The Determinants of Inflation in Sri Lanka: An Application of the Vector Autoregression Model", *South East Asia Economic Journal*, Vol. 12. No.2, pp. 271-286.

Bank of Zambia, 2010. Annual Report

Bank of Zambia, 2009. Annual Report

Basher, S. A. and Elsamadisy, E.M. (2012). "Country heterogeneity and long-run determinants of inflation in the Gulf Arab states", *OPEC Energy Review,* Vol. 36, No.2, pp. 170-203.

Barbosa-Filho, N.H., Taylor, L. (2006): Distributive and demand cycles in the US economy – a structuralist Goodwin model, Metroeconomica, 57: 389-411.

Barro, Robert J., and Xavier Sala-i-Martin. (1990). "World Real Interest Rates," in NBER Macroeconomics Annual, edited by Olivier J. Blanchard, and Stanley Fischer: 15-61. Cambridge: MIT Press.

Barry P. Bosworth (2008): Interest Rates and Economic Growth: Are They Related? Brookings Institution.

Bashir, F. and A. Luqman, (2012). Long run Determinants of Real Exchange Rate: An Econometric Analysis from Pakistan, Pakistan Journal of Social Science, 8(2): 471-484.

Baumol, William J., (1952). "The Transactions Demand for Cash: An Inventory Theoretic Approach," QJE, Vol. 66 (November). Pp 545-56

Bhaduri, A. (2006): Endogenous economic growth: a new approach, Cambridge Journal of Economics, 30: 69-83.

Bhaduri, A., Marglin, S. (1990): Unemployment and the real wage: the economic basis for contesting political ideologies, Cambridge Journal of Economics, 14: 375-393.

Blanchard, O. and L. S., (1984). "Perspectives on High World Real Interest Rates", *Brookings Papers on Economic Activity, 1984:2*: 273-334.

Blecker, R.A. (1989): International competition, income distribution and economic growth, Cambridge Journal of Economics, 13: 395-412.

Blecker, R.A. (2002): Distribution, demand and growth in neo-Kaleckian macro-models, in: Setterfield, M. (ed.), The Economics of Demand-led Growth, Cheltenham: Edward Elgar.

Bonga-Bonga, L. (2010). 'Monetary policy and long term interest rate in South Africa', International Business and Economics Research Journal, 9(10): 43-54.

Brzoza-Brzezina, Michael, and Jesus Crespo Cuaresma. (2008). "Mr. Wicksell and the Global Economy: What Drives Real Interest Rates?" Working Paper, Oesterreichische National bank. Macroeconomic Policy after the Conservative Era, Cambridge: Cambridge University Press.

Cassetti, M. (2003): Bargaining power, effective demand and technical progress: A Kaleckian model of growth, Cambridge Journal of Economics, 27: 449-464.

Cata˜o, L.A.V. and Terrones M.E. (2005). "Fiscal deficits and inflation", *Journal of Monetary Economics* Vol. 52. Pp.529–554.

Chileshe, Patrick; T. Rassmussen, L. Mwansa; F. Mbao; P. Zgambo and B. Mwanza. (2014). Monetary Policy Transmission Mechanism in Zambia, Bank of Zambia Working Paper 1/2014: Available at http://www.boz.zm/Publishing/41/41_Monetary%20Policy%20Transmission%20Mechanism%20in%20Zambia.pdf

Chowdhury, I., Hoffmann, M., Schabert, A. (2006). "Inflation dynamics and the cost channel of monetary Transmission", *European Economic Review*, Vol. 50, pp. 995–1016.

Cornwall, J., Cornwall, W. (2002): A demand and supply analysis of productivity growth, Structural Change and Economic Dynamics, 13: 203-229.

Desroches, Bridgitte, and Michael Francis. (2007). "Global Savings, Investment, and World Real Interest Rates," Bank of Canada Review, Winter 2006-07: 3-17.

Diouf, M.A. (2007). "*Modeling Inflation for Mali*", IMF Working Paper (WP/07/295), International Monetary Fund.

Dumenil, G., Levy, D. (1993): The Economics of the Profit Rate, Aldershot: Edward Elgar.

Dutt, A.K. (1984): Stagnation, income distribution and monopoly power, Cambridge Journal of Economics, 8: 25-40.

Dutt, A.K. (1987): Alternative closures again: a comment on 'growth, distribution and inflation', Cambridge Journal of Economics, 11: 75-82.

Dutt, A.K. (1990): Growth, Distribution and Uneven Development, Cambridge: Cambridge University Press.

Dutt, A.K. (2003): New growth theory, effective demand, and post-Keynesian dynamics, in: Salvadori, N. (eds.), Old and New Growth Theories: An Assessment, Cheltenham: Edward Elgar.

Dutt, A.K. (2006): Aggregate demand, aggregate supply and economic growth, International Review of Applied Economics, 20: 319-336.

Dornbusch, Rudiger, (1985), "The Purchasing Power Parity," NBER Working Paper 85/1591
Dornbusch, R. (1976): Expectations, 'Expectations and Exchange Rate Dynamics' *Journal of Political Economy* 84: 1161 - 76.

Ederer, S. (2008): Competition-oriented wage policies and its effects on effective demand in the Netherlands, WIFO Working Papers 312/2008, Vienna: WIFO.

Ederer, S., Stockhammer, E. (2007): Wages and aggregate demand: an empirical investigation for France, in: Hein, E., Truger, A. (eds.), Money, Distribution and Economic Policy -Alternatives to Orthodox Macroeconomics, Cheltenham: Edward Elgar.

Elliot, G., Rothenberg, T.J., Stock, J.H. (1992): Efficient tests for an autoregressive unit root, NBER Technical Working Paper Series No. 130, Cambridge: NBER.

European Commission (2007): Annual macro-economic database (AMECO), November, http://ec.europa.eu/economy_finance/indicators/annual_macro_economic_database/ameco_en.htm.

Ford, R; and Laxton, D. (1990). "World Public Debt and Real Interest Rates," Oxford Review of Economic Policy, vol. 15 (2): 77-94

George, E. A. J., (1999), "Foreword in Economic Models at the Bank of England", Bank of England.

Goldfeld, S. (1973). *The Demand for Money Revisited*. Brookings Papers on Economic Activity 3, 577-638.

Gordon, D. (1995): Growth, distribution, and the rules of the game: social structuralist macro foundations for a democratic economic policy, in: Epstein, G.A., Gintis, H.M. (Eds.), Macroeconomic Policy after the Conservative Era, Cambridge: Cambridge University Press.

Gottschalk, J.; Kalonji, K.; and Miyajima, K. (2008). "*Analyzing Determinants of Inflation When There Are Data Limitation: The Case of Sierra Leone*", IMF Working Paper (WP/08/271), International Monetary Fund.

Grossman, G.M., Helpman, E. (1994): Endogenous innovation in the theory of growth, Journal of Economic Perspectives, 8: 23-44.

Hamori, S. (2008). "Empirical Analysis of the Money Demand Function in Sub-Saharan Africa." *Economics Bulletin*, Vol. 15, No. 4, pp. 1-15.

Handa, Jagdish, (2009). Monetary Economics 2nd ed., Routledge, New York.
Havi, E.D.K., Enu, P., Osei-Gyimah, F., Attah-Obeng, P., and Opuku, C.D.K., (2013), *"Macroeconomic Determinants of Economic Growth in Ghana: Cointegration Approach,"* European Scientific Journal, July 2013 Edition, Vol. 9, No. 19.

Hein, E. (2008): Money, Distribution Conflict and Capital Accumulation. Contributions to 'Monetary Analysis', Basingstoke: Palgrave Macmillan.

Hein, E., Schulten, T., Truger, A. (2006): Deflation risks in Germany and the EMU: the role of wages and wage bargaining, in: Hein, E., Heise, A., Truger, A. (eds.), Wages, Employment, Distribution and Growth. International Perspectives, Basingstoke:
Palgrave Macmillan.

Hein, E., Vogel, L. (2008): Distribution and growth reconsidered – empirical results for six OECD countries, Cambridge Journal of Economics, 32: 479-511.

Hein, E., Vogel, L. (2009): Distribution and growth in France and Germany – single equation estimations and model simulations based on the Bhaduri/Marglin-model, Review of Political Economy, forthcoming.

Hicks, J. (1932): The Theory of Wages, London: Macmillan.

Jenkins, C. (1999). "Money Demand and Stabilization in Zimbabwe", *Journal of African Economies*, Vol. 8, No. 3, pp. 386–421.

John, M., G. Pokhariyal. (2013).Two Stage Interest Rate Pass Through in Kenya, JETEMS, 4(1).

Kabundi, A. (2012). "*Dynamics of Inflation in Uganda*", Working Paper Series No 152, African Development Bank, Tunis, Tunisia.

Kinda, T. (2011). "*Modeling Inflation in Chad*", IMF Working Paper (WP/11/57), International Monetary Fund.

Kaldor, N. (1955/56): Alternative theories of distribution, The Review of Economic Studies, 23: 83-100.
Kaldor, N. (1957): A model of economic growth, The Economic Journal, 67: 591-624.

Kaldor, N. (1961): Capital accumulation and economic growth, in: Lutz, F.A., Hague, D.C. (eds.), The Theory of Capital, London: Macmillan.

Kaldor, N. (1966): Causes of the Slow Rate of Economic Growth in the United Kingdom, Cambridge: Cambridge University Press.

Kalecki, M. (1954): Theory of Economic Dynamics, London: George Allen and Unwin.

Kalecki, M. (1971): Selected Essays on the Dynamics of the Capitalist Economy, 1933-70, Cambridge: Cambridge University Press.

Kallon, K.M. (1992). "An Econometric Analysis of Money Demand in Ghana", *The Journal of Developing Areas*, Vol. 26, No. 4, pp. 475-488.

Khalid, A.M. (1999). "Modelling Money Demand in Open Economies: The Case of Selected Asian Countries", *Applied Economics*, Vol.31, No.9, pp. 1129-1135.

Kandil, M. and Morsy, H. (2009). "*Determinants of Inflation in GCC*", IMF Working Paper (WP/09/82), International Monetary Fund.

Khan, R.E.A. and Gill, A.R. (2010). "Determinants of Inflation: A Case of Pakistan (1970-2007)", *Journal of Economics*, Vol. 1, No.1, pp. 45-51.

Kleimeier, S. & Sander, H. (2003). *Expected versus Unexpected Monetary Policy Impulses and Interest Rate Pass-through in Eurozone Retail Banking*. Limburg Institute of Financial Economics Working Paper 03-032.

Kurz, H.D., Salvadori, N. (2003): Theories of economic growth: old and new, in: Salvadori, N. (ed.), The Theory of Economic Growth: a 'Classical' Perspective, Cheltenham: Edward Elgar.

Lin, H.Y. and Chu, H.P. (2013). "Are Fiscal Deficits Inflationary?" *Journal of International Money and Finance,* Vol. 32, pp. 214–233.

Makaambi, S., N. Wawire, J. Omolo. (2013). Nature and Dynamics of Adjustment of Commercial Banks' Retail Rates to Monetary Policy Changes in Kenya, International Journal of Business and social science, 4(5).

Marquetti, A. (2004): Do rising real wages increase the rate of labor-saving technical change? Some econometric evidence, Metroeconomica, 55: 432-441.

McCombie, J. (2002): Increasing returns and the Verdoorn Law from a Kaldorian perspective, in: McCombie, J., Pugno, M., Soro, B. (eds.), Productivity Growth and Economic Performance. Essays on Verdoorn's Law, Basingstoke: Palgrave Macmillan.

McCombie, J., Pugno, M., Soro, B. (2002b): Introduction, in: McCombie, J., Pugno, M., Soro, B. (eds.), Productivity Growth and Economic Performance. Essays on Verdoorn's Law, Basingstoke: Palgrave Macmillan.

McCombie, J., Pugno, M., Soro, B. (eds.) (2002a): Productivity Growth and Economic Performance. Essays on Verdoorn's Law, Basingstoke: Palgrave Macmillan.

Misati, R.N., Nyamongo, E.M. & Kamau, A.W. (2011). 'Interest rate pass-through in Kenya', International Journal of Development Issues, 10(2): 170 – 182.

Mungule O.K., (2004).The determinants of real exchange rate in Zambia, AERC Research Paper no. 146.

Mutoti, N; Zgambo, P.; Mbao, F.Z.; Kapembwa, C.; Chokwe, E.; and Kachingwe, N. (2011). "Oil Prices and Consumer Inflation in Zambia", Bank of Zambia Reader, Vol.01, No. 06, pp.60-73

Mkenda, B. K. (2001). Long run and Short run determinants of the real exchange rate in Zambia. Working Papers in Economics no. 40, Department of Economics, Goteborg University, 1 – 67.

Naastepad, C.W.M. (2006): Technology, demand and distribution: a cumulative growth model with an application to the Dutch productivity growth slowdown, Cambridge Journal of Economics, 30: 403-434.

Naastepad, C.W.M., Storm, S. (2007): OECD demand regimes (1960-2000), Journal of Post Keynesian Economics, 29: 211-246.

Nacheja Jean-Claude, (2001). "A co-integration Analysis of Broad Money Demand in Cameroon," IMF working Paper 01/26

Nguyen, H.M.; Cavoli, T.; and Wilson, J.K. (2012). "The Determinants of Inflation in Vietnam, 2001–09", *ASEAN Economic Bulletin,* Vol. 29, No. 1, pp. 1–14.

Okello A. J., (2014). Interest Rate Pass-through in Uganda, Bank of Uganda Research Bulletin, 1(1).

Orr, Adrian, Malcolm Edey, and Michael Kennedy. 1995. "The Determinants of Real Long-Term Interest Rates: The Evidence from Pooled-Time-Series," OECD Economic Studies, No. 25: 75-107.

Pamu, E.M, and Simuchile, H. (2004). "*Dynamics of Inflation Determination in Zambia*", Bank of Zambia Reader, Vol. 3, No.2.

Pamu, E.M, Phiri, W. and Kapembwa, C. (2008). "Money Demand in Zambia", *The BOZ Reader*, Vol. 01, No. 4, pp. 13-21

Ricardo, D. (1817), "*On the Principles of Political Economy and Taxation".* London: John Murray.

Robinson, J. (1956): The Accumulation of Capital, London: Macmillan.

Robinson, J. (1962): Essays in the Theory of Economic Growth, London: Macmillan.

Romer, P.M. (1994): *"The Origins of Endogenous Growth"*, Journal of Economic Perspectives, 8:3-22.

Rowthorn, R. (1981): Demand, real wages and economic growth, Thames Papers in Political Economy, Autumn.

Saeed, A., Awan, R. U., Sial, M. H. and Sher, F. (2012). An econometric analysis of determinants of exchange rate in Pakistan. International Journal of Business and Social Sciences, 3(6), 184 – 196.

Shefeni-Shefeni, J. (2013). Interest rate pass-through in Namibia, Journal of Emerging Issues in Business, Finance and Economics, 2(2).

Simwaka, K. (2006). Modelling and Forecasting the Malawi Kwacha-US Dollar Nominal Exchange Rate, MPRA research paper no 3327.

Simatele M. C. H. (2004). "*Financial Sector Reforms and Monetary Policy in Zambia*", PhD Thesis, Department of Economics, School of Economics and Commercial Law, Göteborg University, Sweden.

Simwaka, K.; Ligoya, P.; Kabango, G.; and Chikonda, M. (2012). "Money Supply and

Inflation in Malawi: An Econometric Investigation", *Journal of Economics and International Finance*, Vol. 4, No.2, pp. 36–48, 22.

Setterfield, M., Cornwall, J. (2002): A neo-Kaldorian perspective on the rise and the decline of the Golden Age, in: Setterfield, M. (ed.), The Economics of Demand-led Growth. Challenging the Supply-side Vision of the Long Run, Cheltenham: Edward Elgar.

Solow, R.M. (2000): The neoclassical theory of growth and distribution, Banca Nazionale del
Lavoro Quarterly Review, 53: 349-381.

Steindl, J. (1952): Maturity and Stagnation in American Capitalism, 2nd. Edition, 1976, New
York, London: Monthly Review Press.

Stockhammer, E., Ederer, S. (2008): Demand effects of the falling wage share in Austria, Empirica: forthcoming.

Stockhammer, E., Hein, E., Grafl, L. (2007): Globalization and the effects of changes in functional income distribution on aggregate demand in Germany, Department of
Economics Working Paper No. 114, Vienna University of Economics and Business Administration.

Stockhammer, E., Onaran, Ö. Ederer, S. (2009): Functional income distribution and aggregate demand in the Euro area, Cambridge Journal of Economics: forthcoming.

Stockhammer, E., Stehrer, R. (2008): Goodwin or Kalecki? Functional income distribution and aggregate demand in the short run, manuscript. 38

Sowa, N.K. (1994). "Fiscal Deficits, Output Growth and Inflation Targets in Ghana", *World Development*, Vol. 22, No. 8, pp. 1105-l 117.

Taylor, L. (1991): Income Distribution, Inflation, and Growth. Lectures on Structuralist Macroeconomic Theory, Cambridge/Mass., London: MIT Press.

Tinbergen, J., (1936), An Economic Policy for 1936, in: L.H. Klaassen, L.M. Koyck and H.J. Witteveen (eds.), *Jan Tinbergen, Selected Papers*, Amsterdam, 1959 pp. 37- 84 (original in Dutch

Tillmann, P. (2008). "Do Interest Rates Drive Inflation Dynamics? An Analysis of the Cost Channel of Monetary Transmission", *Journal of Economic Dynamics & Control,* Vol.32, pp. 2723–2744.

Tobin, J., (1956), "The Interest Elasticity of the Transactions Demand for Cash," Review of Economics and Statistics, Vol. 38 (August), pp. 241-47.

Ubide, A., (1997), "Determinants of Inflation in Mozambique," IMF Working Paper 97/145 (Washington: International Monetary Fund).

Uni, H. (2007): Growth regimes in Japan and the United States in the 1990s, Revue de la Regulation, no. 1: 1-20

Valadkhani, A., (2008). "Long- And Short-Run Determinants of the Demand for Money in the Asian-Pacific Countries: An Empirical Panel Investigation", *Annals of Economics and Finance*, Vol. 9, No.1, pp. 47-60.

Verdoorn, P.J. (1949): Factors that determine the growth of labour productivity, in: Vergeer, R., Kleinknecht, A. (2007): Jobs versus productivity? The causal link from wages to labour productivity growth, TU Delft Innovation Systems Discussion Papers, IS 2007-

Walterskirchen, E. (1999): The relationship between growth, employment and unemployment in the EU, paper presented at a Workshop in Barcelona, 16 – 18 September 1999, European Economists for an Alternative Economic Policy (TSER Network). You, J.-I. (1994): macroeconomic structure, endogenous technical change and growth, Cambridge Journal of Economics, 18: 213-233.

Whitley, J. D., (1994), A Course in Macroeconomic Modelling and Forecasting, Harvester Wheatsheaf.

Zgambo, P., and Chileshe, P., (2014). "The effectiveness of Monetary Policy in Zambia". A Research Paper done for Comesa Monetary Institute (CMI)

CHAPTER FIVE

Bayesian Vector Auto-Regression Short-Term Inflation Forecasting Model for Zambia

Francis Ziwele Mbao

Abstract

Short-term inflation forecasting models are essential for forward looking monetary policy interventions, whose impulses influence the real economy with a lag. The purpose of this paper is to develop a Bayesian short-term inflation forecasting model as an addition to the already existing models used in forecasting inflation at the Bank of Zambia. Good forecasting requires a suite of models involving both short and medium term forecasting. The Bayesian modelling approach used in this paper estimates the benchmark model. Alternative models are estimated by making alterations to the hyper parameter responsible for controlling the overall tightness as well as changing the lag length. This is in addition to estimating a VAR model so as to increase the domain of models to choose from for forecasting purposes. Each model is assessed for its forecasting ability using the Root Mean Square Forecasting Error. The results indicate that the benchmark model offers the best forecasting ability and is recommended for the purpose of short term inflation forecasting at the Bank of Zambia.

1. Introduction

Short-term inflation forecasting models are important for pre-emptive monetary policy actions given that monetary policy impulses influence the real economy with a lag. Bank of Zambia (BoZ) monetary policy framework reorientation from targeting monetary quantities to targeting monetary prices (interest rates) requires pre-emptive monetary policy actions in order to minimise output volatility in the pursuit of price stability.The purpose of this paper is to provide a short–term inflation forecasting model based on Bayesian techniques as an addition to the already existing models used at BoZ.

In Zambia, the known Bayesian estimation for forecasting inflation is Mutoti (2009), in which commodity prices (petrol and maize) are allowed to interact with monetary variables (broad money supply-M2, USD/ZMK exchange rate, and 91-day Treasury bill yield rate) and real variables (gross domestic product and consumer price index).

This paper undertakes the estimation procedure in the spirit of Mutoti (2009) but differs in the following: whereas Mutoti (2009) uses petrol and maize exclusively as commodity prices in the estimation framework, this paper constructs and uses composite prices for petrol and diesel as well as for maize, breakfast meal, and roller meal in the estimation

Key Words: Inflation, Bayesian, Forecasting, and Root mean Square.

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framework. The motivation is that while it is true that price changes for petrol and diesel are virtually done at the same time (by virtue of them being administered prices) and may therefore trend together, the two, however, have different weights in the CPI and the percentage change is not always uniform. Therefore, each item has a unique influence in Zambia's inflationary process. The argument holds for maize and mealie meal as well. The idea is to capture each commodity's unique dynamics in Zambia's inflationary process by bringing them into an index. Secondly, while Mutoti (2009) uses a Bayesian VECM, this paper employs a Bayesian VAR as indicated by unit root tests.

The rest of the paper is structured as follows: Section two provides a brief discussion of the literature on Bayesian VARs while section three discusses the data used and the methodology.. In section four, various models are presented under different assumptions while section five presents the results.. Section six concludes the paper.

2. Bayesian VARs and Forecasting: A Brief Survey of Literature

Although Bayesian methods are used in other analytical and empirical works, they have in the last two decades become popular in macroeconomic forecasting especially using the VAR approach (Carriero *et al.*, 2013). Their popularity in forecasting in the last twenty years stems from the seminal papers of Doen *et al.* (1984) and Litterman (1986). Bayesian methods used in forecasting exercises include the works of Geoff *et al.* (1998), Robertson and Tallman (1999), Canova and Ciccarellic (2004), Kapetanios (2005), Biswas *et al.* (2010), Banbura (2010) and Anand et al. (2011), among others. Recently, Giannone et al. (2014), Carriero *et al.* (2013) and Giannone *et al.* (2012) account among those that have used Bayesian VAR for forecasting purposes.

The seminal contributions of Doen et al.. (1984) and Litterman (1986) to Bayesian estimation of the VAR, have made it computationally less challenging to incorporate prior beliefs regarding macroeconomic variables and accommodate a large set of variables..

Litterman (1986) work is based on the 'Minnesota' prior that incorporates three statistical properties of macroeconomic time series data: which are, trends ; the relative importance of recent values of a given series compared to past values; and the fact that past values of a given series contain more information about its current state than past values of other variables. These properties of the 'Minnesota' prior make many macroeconomic time series follow a random walk. The implication of this belief is that the prior mean of the coefficient on the own first lag of each variable in a Bayesian VAR set up is one (1); and the coefficients on cross lags (higher lags) are likely to be close to zero (0). Therefore, the Minnesota prior assumes a normal prior with mean zero and small standard deviations for long lags. The two main features of the Minnesota prior are: (1) the posterior independence between equations, and (2) the fixed and diagonal residual variance-covariance matrix.

Sims and Zha (1998) have proposed a technique that avoids the assumption in the Minnesota prior that the error covariance matrix is fixed and diagonal. This is achieved by the Normal-Wishart prior. Under the Normal-Wishart prior, the prior distribution for the VAR coefficients is normal, while the prior distribution of the error covariance matrix is inverted Wishart. This arrangement permits the random walk feature of the Minnesota prior on the coefficients to be used without having to take independence across the equations of the VAR as an exact restriction.

Doen *et al.* (1984) and Sims (1993) have incorporated into the Bayesian VAR the belief that macroeconomic data is usually associated with unit roots and cointegration and this is because models with Minnesota priors are not fully data–determined models. The unit root prior known as "sum of coefficients" prior credited to Doen *et al.* (1984) and "dummy initial observations" prior attributed to Sims (1993) features cointegration.. The priors are

incorporated into the estimation procedure by adding dummy observations to the system of equations. The sum of coefficients prior is imposed on the autoregressive coefficients and it is a modification of the Minnesota prior that essentially transforms a VAR into an error correction equation. The dummy initial observations prior incorporate the cointegration beliefs about the variables considered in the VAR.

Bayesian VAR estimations are either done in levels or growth rates but with implications on forecasting abilities. Carriero et al. (2013) recommends the estimation of a Bayesian VAR using the Minnesota prior when the data is differenced to get reliable forecasts. If the data is in levels they recommend the use of the Minnesota prior together with the sum of coefficients and dummy initial observations priors. This is consistent with Banbura et al. (2010) who states that estimating a Bayesian VAR in levels works well conditional on following the Sims and Zha (1998) Normal–inverted Wishart prior. They argue that specification in levels is beneficial with an imposition of the sum of coefficients and dummy initial observations priors of Doen et al. (1984) and Sims (1993) under an optimal level of tightness and lag length.

3. Methodology and Data

The Methodology

Generally, a VAR equation of dimensional row random vector is as indicated in equation (1). In a Bayesian approach the prior beliefs are incorporated in the VAR by setting the moments of the prior distribution of the coefficients as indicated in equation (2), with the sum of coefficients prior implemented using equation (3), and the dummy initial observations prior is incorporated by modifying equation (4).

$$y_t = \alpha + \sum_{i=1}^{L} \beta_i y_{t-L} + \theta_t \qquad 1$$

where, $t = 1, \ldots\ldots\ldots, T$;

$\alpha = 1 \times \rho$ unknown vector;

β_i = unknown $\rho \times \rho$ matrix, $i = 1, \ldots\ldots, L$; and

$\theta_t = \theta_1, \ldots\ldots\ldots, \theta_T$, the independent and identically distributed error terms.

The error terms are normal, i.e. N_p (0,Σ) with ρ *x* ρ unknown covariance matrix Σ. In the model above *L* is the lag, and the unknown matrix of the regression coefficients α' and β_i' is represented by Φ.

$$E\left[(\boldsymbol{\Phi}_k)_{i,j}\right] = \begin{cases} \delta \text{ if } j = i, k = 1 \\ 0 \quad \text{otherwise} \end{cases}, \qquad V\left[(\boldsymbol{\Phi}_k)_{i,j}\right] = \begin{cases} \dfrac{\lambda_1 \lambda_2}{k} \dfrac{\sigma_i}{\sigma_2}, \; k = 1, \ldots\ldots, p \\ \lambda_0 \sigma_i, \end{cases} \qquad 2$$

where, $(\Phi_k)_{i,j}$ are elements in position (*i,j*) in matrix Φ and δ is the prior mean that takes the values 0 or 1. When the VAR is specified in levels, δ = 1. However, when one specifies the VAR's in growth rates then δ = 0. The hyperparameter λ_1 controls the overall tightness in terms of how the prior impacts the posterior distribution. If $\lambda_1 \to 0$, or indeed $\lambda_1 = 0$ then posterior distribution equals the prior. In this case the data do not influence the estimates but when $\lambda_1 \to \infty$ the posterior expectations are consistent with the ordinary least square (OLS) estimates.

The sum of coefficients prior is implemented by the hyperparameter μ_1 in equation (3) and represents the dummy setting for the prior:

$$y_d(i,j) = \begin{cases} \bar{y}_{0i}/\mu_1 & \text{if } i = j, \\ 0 & otherwise \end{cases}; \; x_d(i,s) = \begin{cases} \bar{x}_{0i}/\mu_1 & \text{if } i = j, \quad s < M \\ 0 & otherwise \end{cases} \qquad 3$$

where i and j lie in the domain 1 to N and s =1,2, ..., M. The factor μ_1 is the hyperparameter and its role is to influence the level of tightness that aims at realising the belief of the presence of unit roots in the variables of interest, which is the aspect that requires differencing the data. This is achieved when $u_1 \rightarrow 0$ (Carriero *et al.*, 2013). The elements y_d and x_d are the dummy variables.

Further, the dummy initial observations prior is incorporated in the estimation through the hyperparameter μ_2 represented in equation (4).

$$y_d(j) = \begin{cases} \bar{y}_{0j}/\mu_2 & \text{if } i = j, \end{cases}; \; x_d(s) = \begin{cases} \bar{x}_{0i}/\mu_2 & \text{for } s < M \\ 1/\mu_2 & \text{for } s = M \end{cases} \qquad 4$$

where $j = 1,2, \ldots \ldots \ldots, N$ and $s = 1,2, \ldots \ldots \ldots, M$

The hyperparameter μ_2 controls the tightness that aims at achieving co-integration among the variables in the VAR. When $\mu_2 \rightarrow 0$ the model assumes cointegration because either all the variables become stationary with means equal to the sample averages of the initial conditions or there are unit roots with a drift (Carriero *et al.*, 2013).

With regard to the parameters for the priors - or hyperparameters used by researchers - a number of studies have largely used the following for their baseline specifications;, Banbura *et al.*, 2010; Giannone *et al.*, 2012; Carriero *et al.*, 2013; and Giannone *et al.* 2014):

$$\lambda_0 = 0; \; \lambda_1 = 0.2; \; \lambda_2 = 1; \; \mu_1 = 1; \; \mu_2 = 1$$

The Bayesian set up described above implies a tighter representation where the prior belief about the behaviour of macroeconomic data - and not the data used in the estimation - is taken to strongly influence the estimates. Further, no presence of unit root and no co-integration are assumed in this Bayesian set up.

The Data

The data used in the study are for the period January 1994 to August 2014. The sources are: BoZ for broad money (M2), exchange rate and Treasury bills rate; Central Statistical Office: real GDP, the CPI and the prices of maize and mealie meal; and Energy Regulation Board: Fuel prices.

The composite price of fuel (WPDP) is obtained by getting a sum of the weighted prices of petrol and diesel. The weight applied to the two commodities respective prices is obtained by dividing the weight of petrol and diesel in the CPI basket by the sum of the two items weights in the CPI basket[1]. The same logic is used in determining the composite price for the two brands of mealie meal and maize (WPBRM).

[1]That is, if x_1 and x_2 are the respective weights for diesel and petrol in the CPI basket then the weight attached to diesel price in the composite price, for instance, is $\left[\frac{x_1}{x_1+x_2}\right]$. Thus, the composite price for the two commodities (Diesel price: P_d and Petrol price: P_p) is determined as $\left[\frac{x_1}{x_1+x_2}\right]P_d + \left[\frac{x_2}{x_1+x_2}\right]P_p$.

Monthly real GDP is obtained by interpolating annual real GDP using Eviews 9.0 under the assumption of quadratic match average. The GDP series used in this study involves the one rebased in 2010. The CPI data is based on the 2009 rebased series.

Unit Roots

The table below shows results of the Augmented Dickey-Fuller (ADF) test performed on the variables of interest in the study. All the variables are stationary in levels except real GDP, which is nonetheless stationary after first difference.

Table 1: ADF Unit Root Test Results

Description	Levels t-Value	First Difference t-Value	Order of Integration
Log (CPI)	-5.2033	-	I(0)
Log (Real GDP)*	0.0606	-4.0042	I(1)
Log (Exr)	-4.8571	-	I(0)
Log (M2)	-4.9246	-	I(0)
TB*	-6.7407	-	I(0)
Log (WPBRM)*	-3.3037	-	I(0)
Log (WPDP)	-4.5004	-	I(0)
1% level: -3.4544435%	*level: -2.87204110%*		*level: -2.572439*

*Trend and Intercept

4. The Models

The modeling approach in this paper follows Banbura et al. (2010); Giannone et al. (2012 and 2014), and Carriero et al. (2013) for the benchmark model, which is the same as the baseline model indicated above. Thedata is in log-levels, except for the Treasury bills yield rate, with a lag length (L) of 13 as in Carriero et al. (2013) and Giannone et al. (2014). This lag length has been found to be more ideal and hence the choice in this paper. The data used (Sample adjusted) covers the period January 1995 to December 2013. The choice of this modelling approach assumes no unit root and presence of co-integration and is supported by the results in Table1.

Alternative models, which are generated in order to obtain as many models as possible where an appropriate model can be selected from for forecasting purposes, are estimated by making alterations to the hyper parameter and lag length (L) as follows:

Alternative model 1: This model is like the benchmark in all respects except $\lambda_1 = 0.25$ and implies a relatively less tightly hyper parameter influencing the prior belief. With this, it means that the posterior distribution is slightly different from the prior distribution.

$$i.e. \quad L = 13;\ \lambda_0 = 0;\ \lambda_1 = 0.25;\ \lambda_2 = 1;\ \mu_1 = 1;\ \mu_2 = 1$$

Alternative model 2: This model differs from the benchmark counterpart only in respect of lag length with the lag of 12 being adopted in this specification.

$$i.e. \quad L = 12;\ \lambda_0 = 0;\ \lambda_1 = 0.2;\ \lambda_2 = 1;\ \mu_1 = 1;\ \mu_2 = 1$$

Alternative model 3: This model is similar to alternative model 2. The difference, nonetheless, lies in the value assigned to the hyper parameter λ_1. In this regard, $\lambda_1 = 0.25$.

$$i.e. \quad L = 12;\ \lambda_0 = 0;\ \lambda_1 = 0.25;\ \lambda_2 = 1;\ \mu_1 = 1;\ \mu_2 = 1$$

Alternative model 4: This one is modelled along alternative model 3 but $\lambda_1 = 0.3$.

i.e. $L = 12;\ \lambda_0 = 0;\ \lambda_1 = 0.3;\ \lambda_2 = 1;\ \mu_1 = 1;\ \mu_2 = 1$

Alternative model 5: Like alternative model 4, this differs from alternative model 3 on the basis of the hyper parameter λ_1 in which case $\lambda_1 = 0.35$.

i.e. $L = 12;\ \lambda_0 = 0;\ \lambda_1 = 0.35;\ \lambda_2 = 1;\ \mu_1 = 1;\ \mu_2 = 1$

Alternative model 6: This is same as alternative model 5 but with a relatively less tightness of its hyper parameter λ_1. The hyper parameter therefore, assumed a value of 0.4, which is a relatively less tighter assumption.

i.e. $L = 12;\ \lambda_0 = 0;\ \lambda_1 = 0.4;\ \lambda_2 = 1;\ \mu_1 = 1;\ \mu_1 = 1$

In addition to the alternative models estimated using Bayesian methods, an unrestricted VAR with the same variables was estimated were all the variables were in levels except real GDP, which was in first difference. This is because all the variables except real GDP were stationary with the latter being stationary in first difference. The estimation was done with a lag of two as suggested by the Akaike, Schwarz Bayesian, and Hannan-Quinn information criteria.

For each model, the forecasts were performed and assessed against the actual values with a view of choosing one that had a better forecasting ability as the model of choice. This is the model that may be used in forecasting short-term inflation..

5. Forecasting Evaluation

The forecasts are done under the Dynamic-Stochastic Simulation option in EViews 9.0 for the data spanning the period January 2014 to August 2014. To evaluate the forecasting ability of each model, a Root Mean Square Forecasting Error (RMSFE) is used. The formula for RMSFE is:

$$RMSFE = \left[T^{-1} \sum_{t=1}^{T} (y_t - \hat{y}_t)^2 \right]^{1/2} \qquad 4.1$$

where $0 \leq RMSFE \leq 1$,and y_t represent the actual observation at time t and $\hat{y}_t$ are the forecasted values at a corresponding time t while T is the total number of observations for a given forecasting period.

Generally, the model with the lowest RMSFE relative to that from Benchmark Model provides more reliable forecasts and it is the one that is recommended. Table 2 shows the results of the RMSFE relative to that of the Benchmark Model. Overall, the results show that the benchmark model offers the best forecasting ability and is recommended for this purpose.

Table 2: Forecasting Evaluation Results

Description	3 Months	6 Months	9 Months
Bayesian Benchmark Model	**1.0000**	**1.0000**	**1.0000**
Bayesian Alternative Model_1	1.0606	1.0465	1.3934
Bayesian Alternative Model_2	1.5812	1.7728	1.5210
Bayesian Alternative Model_3	1.3465	1.0465	1.3728
Bayesian Alternative Model_ 4	1.2993	1.4960	1.4140
Bayesian Alternative Model_5	1.0307	1.1545	1.2983
Bayesian Alternative Model_6	1.2503	1.2908	1.5397
Unrestricted VAR Model	1.5414	1.4308	1.1210

Note: RMSFE relative to that from Benchmark Model

6. Conclusion

Short-term inflation forecasting models are important for forward looking monetary policy interventions. This is primarily due to the fact that monetary policy impulses influence the real economy with a lag. The purpose of this paper was to propose an additional short-term inflation forecasting model – based on Bayesian techniques to the already existing models used in forecasting short-term inflation at the BoZ.

The modelling approach used follows Banbura et al. (2010); Giannone et al. (2012 and 2014), and Carriero et al. (2013) for the benchmark model with alternative models also being estimated by making alterations to the hyper parameter responsible for controlling the overall tightness of the Bayesian model as well as changing the lag length. This is in addition to estimating an unrestricted VAR model. Each model was assessed for its forecasting ability using values of its RMSFE relative to that of the benchmark model and the results indicate that the benchmark model offers the best forecasting ability – as other models have their RMSFE relative to that of the benchmark of being above 1.0 – and is recommended for this purpose.

References

Anand, R.; D., Ding; and S.J., Peiris. 2011. "Towards Inflation Targeting in Sri Lanka", IMF Working Papers, WP/11/81

Ban´bura, M.; D., Giannone; and L., Reichlin. 2010. "Large Bayesian Vector Auto Regressions", Journal Of Applied Econometrics, 25: Pp.71–92

Biswas, D.; S., Singh; and A., Sinha. 2010. "Forecasting Inflation and IIP Growth: Bayesian Vector Autoregressive Model", Reserve Bank of India Occasional Papers, Vol. 31, No.2, Monsoon.

Canova, F. and M., Ciccarellic. 2004. "Forecasting and Turning Point Predictions in a Bayesian Panel VAR Model", Journal of Econometrics, Vol. 120, Pp. 327 – 359.

Carriero, A.; T. E., Clark; and M., Marcellino. 2013. "Bayesian VARs: Specification, Choices and Forecast Accuracy", Journal of Applied Econometrics, DOI:10.1002/jae.

Diouf, M.A.2007. "Modeling Inflation for Mali," IMF Working Paper, WP/07/295, https://www.imf.org/external/pubs/ft/wp/2007/wp07295.pdf

Doan, T; Litterman, R; and Sims, C. 1984. "Forecasting and conditional projection using realistic prior distributions," Econometric Reviews Vol. 3, Pp 1–100.

Geoff, K.; M., Aidan; and Q., Terry. 1998. "Bayesian VAR Models for Forecasting Irish Inflation", Central Bank of Ireland Technical Paper, 4/RT/98, MPRA Paper No. 11360, http://mpra.ub.uni-muenchen.de/11360/

Giannone, D; M., Lenza; D., Momferatou; and L., Onorante. 2014. "Short-term Inflation Projections: A Bayesian Vector-Autoregressive Approach", International Journal of Forecasting, Vol.30. Pp. 635 – 644.

Giannone, D; M., Lenza; and G., Primiceri. 2012. "Prior Selection for Vector Autoregressions. CEPR Discussion Paper No. 8755.

Kapetanios, G.; V., Labhard; and S., Price. 2005. "Forecasting Using Bayesian and Information Theoretic Model Averaging: An Application to UK Inflation", Bank of England Working Paper no. 268.

Kinda, T. 2011. "Modeling Inflation in Chad," IMF Working Paper, WP/11/57 http://www.imf.org/external/pubs/ft/wp/2011/wp1157.pdf

Litterman, R.B. 1986. "Forecasting With Bayesian Vector Autoregressions-Five Years of Experience,"Journal of Business & Economic Statistics, Vol. 4, Pp. 25-38.

Mutoti, N. 2009. "Forecasting Zambia's Inflation: Bayesian VEC Model", Bank of Zambia Working Paper, WP/07/2009, http://www.boz.zm/Publishing/41/41_BVECInflation%20modelJul09Final.pdf

Robertson, J.C. and E.W., Tallman. 1999. "Improving Forecasts of the Federal Funds Rate in a Policy Model", Federal Reserve Bank of Atlanta, Working Paper 99-3, http://www.frbatlanta.org/filelegacydocs/wp9903.pdf

Sims, C.A. and T. Zha. 1998. "Bayesian Methods for Dynamic Multivariate Models", International Economic Review, Vol. 39, No. 4, November, Pp 949-968

Sims C. 1993. A nine-variable probabilistic macroeconomic forecasting model. In Business Cycles, Indicators and Forecasting, Stock JH, Watson MW (eds). University of Chicago Press for NBER: Chicago, IL; Pp.179–212.

CHAPTER SIX

Interest rate formation in Zambia: Issues and Solutions

Gunnvald Grønvik[1]

Abstract

Real bank lending rates are rather high in Zambia while nominal bank deposit rates are close to zero and real deposit rates are negative. This contributes to low real investment and saving. Policy makers and business community therefore call for central bank policies that may improve the determination of bank lending and deposit rates. This paper presents a standard banking model that may be useful for discussing the determination of bank interest rates if bank and liquidity markets were well-functioning. The model for the individual bank is aggregated to a model for the banking sector, and this allows for discussion of central bank policy related to the functioning of relevant financial markets. Both impacts from monetary and supervisory policies are discussed. A key concept in the discussion will be the actual "real costs of banking". The paper argues that a liquid interbank market is crucial for competition among banks. It also argues that the Bank of Zambia (BoZ) can contribute to an adequate level of bank deposit rates. Regarding the "real cost of lending", institutional issues outside the remit of the central bank may be the key drivers of the real costs. Hence, lower real lending rates can only be achieved if required policies are implemented by other relevant authorities.

1. Introduction[2]

The supervisory reports received by the Bank of Zambia show that the average nominal bank lending rate in Zambia was 18.7 percent in 2014. Average bank deposit rates varied and were 1.3 percent for checking accounts and 6.1 percent for large deposits with 30-days maturity. The inflation rate in 2014 was 7.8 percent, according to the Central Statistical Office (CSO). Thus real bank lending rates were 10.9 percent and real bank deposit rates for checking accounts were -6.5 percent[3].

These real rates are clearly a problem for capital formation and growth. The low real deposit

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[2]This work draws on fruitful cooperation with colleagues in the BoZ and from technical experts on central bank modernization through my three inspiring years at the BoZ. Special thanks to Q. Farooq Akram and Peter Zgambo for suggestions and detailed comments on a previous draft, and to Marianne Ødegård and Francis Z. Mbao for ideas and research assistance. Remaining errors are my responsibility. Views expressed are mine and should not be attributed to BoZ or IMF.

[3]Source: Statistics Fortnightly, dated 2-March-2015 at www.boz.zm.

rates do not stimulate financial saving. Many projects are started before they can be fully financed. Thus, a large number of projects remain unfinished awaiting liquidity surplus with the investor. The high real lending rates may make (partial) external financing of investment projects prohibitively expensive, and a number of projects may never get off the ground.

Politicians and the general public regularly call upon the central bank to introduce policies to alleviate the problem. This paper seeks to explain bank behaviour in Zambia in order to outline what policy measures are needed to rectify the situation.

The structure of this paper is that in section 2 a standard banking model is developed and discussed. The model will give rules for optimal bank lending and deposit rates for a typical bank that maximizes profit. In section 3 the model for the individual bank is aggregated to a model for the banking sector. The aggregated model allows for a discussion of the relationship between central bank policies for monetary or supervisory purposes and banks' interest rates. This discussion highlights to what extent the central bank can solve the problem of low real deposit and high real lending rates. In section 4 the model serves as a framework for a discussion of the situation in Zambia; in particular, the formation of both interbank interest rates and interest rate facing customers and possible central bank policies to improve the determination of interest rates. Section 5 concludes.

2. The banking model

A model is a simplified description of reality which facilitates reasoning in a coherent and logical manner. The model needs to be rich enough to capture essential features of the problem at hand for practical discussions of policy. However, a model can never be detailed enough to give a precise description of the situation. My impression is that the basic regulatory environment in Zambia at present is fairly similar to the one in Norway replacing the post-World-War II credit rationing regime. Even though the regulatory regime is similar, bank behavior is not necessarily similar.

The similarities in regulatory regime lead me to use a model that is a slight variation of the model used in Grønvik (1994), which was mainly based on Klein (1971), Monti (1972) and Tobin (1982). Useful survey of the banking literature are Baltensperger (1980), Santemero (1984), Gorton and Winton (2003) and Thakor and Boot (2008).

Gorton and Winton (2003) emphasize the importance of understanding bank behaviour in the light of the regulation at the time and location under study and give references to works of importance in many fields. Amongst the topics discussed are bank panics, deposit insurance, and capital adequacy. They also discuss if and why bank loans are special, i.e. if they are producing other values to the lender than other means of financing, and how news related to renewals of bank loans may impact on the value of the lending firm. They also discuss deposits and hold up as additional benefits on how deposits can contribute to consumption smoothing and also create liquidity.

Grønvik (1994) sheds light on the change in banking behavior as Norwegian banking regulation moved from credit rationing in the 1970-ies to free market competition starting in the late 1980-ies[4]. This is a situation that is not irrelevant to throw light on challenges facing Zambia today.

The model chosen is deterministic and sufficiently rich to study the problem at hand, even though there are stochastic elements to bank-customer relationships and therefore also to

[4]Bank behaviour through this deregulation, which coincided with a similar deregulation in Sweden, contributed to the Nordic banking crises, cf. Moe, Solheim and Vale (2004).

interbank relationships. To do the modelling with stochastic loans and deposits, see Baltensperger (1980).

In the model, the banks are assumed to participate in four markets:

- Market for deposits from ordinary customers
- Market for loans to ordinary customers
- National and international market for bank liquidity
- Market for forward delivery of kwacha and foreign currency

This model assumes that no market power prevails in domestic and international interbank and money markets. However, banks are assumed to have some market power in markets for ordinary bank customers. The strategic type assumed is monopolistic competition. The banks face regulatory restrictions in terms of reserve and capital requirements, while the central bank sets the policy rate.

The specified regulatory restrictions will allow for a discussion of the effect on the interest rates banks offers to their customers from monetary as well as supervisory policies. There is no specific rule restricting bank activity in the international money market. However, a general supervisory rule requiring prudent behavior applies. In the model it will be assumed that the bank under study will behave cautiously avoiding unhedged foreign exchange risk[5].

The administrative (mainly staff) costs of running a bank are assumed to have a simple structure in the model, but not necessarily in the subsequent practical discussion of bank behavior.

a) Bank balance sheet

The bank activity can be explained starting from a specification of the bank balance sheets. The model specifies two balance sheets, a spot balance sheet and a forward balance sheet.

The spot balance shows that the bank uses funds for lending to customers, holding of reserves and a net placement in the domestic interbank market. The bank acquires its funds through customer deposits, central bank lending, and exchange of the bank's foreign net lending. The bank also puts its own equity capital to use. Note that government securities are not specified as a separate variable. Government securities are important in practice, but in this static model government securities can be seen as (negative) central bank lending. Specifying government securities as a separate variable would not increase the insights the model can offer, but in the discussion of the interbank market will also cover aspects of the government securities market.

The forward balance sheet specifies the bank's assets and liabilities at some future date. In principle it could have been a large number of forward balance sheets, one for each date when the bank has contractual obligations (to pay or receive). However, the important reason for specifying a forward market is to model the linkage between domestic and international money markets when banks hedge their foreign exchange exposure. This can be specified with one forward market. Thus, to avoid further complication only one forward market will be used.

[5]The bank behavior will be in line with what was required through the supervisory rule that prevailed in Norway through the 1980-ies and well into the 1990s.

The equations showing the balance sheets of bank i, spot (1) and forward (2) are:

$$L^i + R^i + IB^i = D^i + e_s F_s^i + C^i + W^i \quad 1$$

$$Kwf^i = ef^i \; Ff^i \quad 2$$

In these equations $\{L^i, R^i, W^i, D^i \geq 0\}$

The variables of the model are specified in Box 1 in the Appendix.

b) Bank behavior in customer markets

The core of banking is taking deposits and extending loans to the general public. Deposits are accepted from a broad spectrum of customers. Banks provide for safe-keeping, and make deposits liquid for the customer through the provision of cash withdrawal and payment system services. Customers can through this perform consumption smoothing at their own wish. Loans are extended to households and businesses with safe projects and sufficient collateral. The project may range from buying a car or consumer equipment to building dwelling houses, factories or machinery. Credit to smooth liquidity is not uncommon for firms and farmers where the activity has a business cycle.

In markets for loans and deposits banks will have market power even if the laws and rules that govern the business seek to promote competition. The reason is relationships that develop between customer and bank through the products that banks sell. When a customer opens a bank account and allows for incomes and expenditures to be channeled through the account, the bank will acquire information on the customer. This information will be useful for the bank in order to offer useful and affordable products for the customer. At the same time the information is such that another bank will be unable to perfectly access it in order to make a competing offer. The regulatory environment is one of competition, but the products delivered create a relationship between a bank and a customer that results in dependence between the two parties. Banks benefit from this relationship and can earn an informational rent.

This dependence on the customer side, when the regulatory environment is one of competition is captured through an assumption of monopolistic competition. The essence of this assumption when modelling is that banks face individual demand equations. Here this will be formulated through equations for loans and deposit directed towards the bank under study (bank-i).

The demand for loans from bank-i (L^i) is lower when the lending rate bank-i offers (rL^i) increases. The demand directed towards bank-i increases when other banks increase their lending rate so that the sector average rate (rL) increases. There are also a number of exogenous factors, captured through the vector Z that explains demand for loans.

The supply of deposited funds at bank-i increases with the deposit rate offered (rD^i), decreases with the rate offered by other banks (rD). The supply also depends on various exogenous factors (Z).

With the sign of the partial derivatives are indicated below the variable names, the equations are

$$L^i = L^{Di}(rL^i, rL, Z) \qquad 3'$$
$$\quad\; - \;\; +$$
$$D^i = M^{Si}(rD^i, rD, Z) \qquad 4'$$
$$\quad\; + \;\; -$$

These equations are invertible under some technical assumptions relating to their functional form. The details are found in Box 2 in the Appendix.

$$rL^i = rL^i(L^i, rL, Z) \qquad 3$$
$$(4)\; rD^i = rM^i(D^i, rD, Z) \qquad 4$$

The equations in this form will be used in the derivation of conditions for profit maximization.

c) Sources of bank liquidity

The description of the bank's sources of liquidity from domestic sources is fairly straight forward as the bank is assumed to be without market power in the liquidity markets.

In a competitive domestic money market, the bank can adjust its liquidity position freely, and thus net interbank position (IB^i) can take positive or negative values. Correspondingly, the interbank interest rate (rB_i) is exogenous to the individual bank and determined without bank market power.

The bank can supplement its liquidity position using the central bank liquidity facility. The interest rate (rC) of this facility is determined by the central bank. It is assumed that this liquidity facility opens for deposits and loans, and C^i can take negative values (i.e. bank borrowing in central bank). For simplicity it is here assumed the same interest rate (rC) for deposits and loans in the central bank[6].

IB^i and C^i are choice variables that are determined by the individual banks; they may take positive or negative values.

In addition, banks can obtain kwacha liquidity through an exchange of foreign funds to kwacha at a given spot exchange rate, eS. This can be done when customers sell foreign exchange to the bank, but the bank can also borrow foreign currency and exchange the borrowed funds for Zambian kwacha and use these funds to expand lending in Zambia.

It is necessary to explain bank activity in foreign exchange markets further. As most foreign exchange activity goes on in markets involving future commitments, forward contracts involving currency and kwacha will be studied here.

Let us assume that the bank agrees to deliver customer $KwCf^i$ at a future date in exchange for FCf^i units of dollars. We may think of the customer as a mining company that receives its incomes in foreign currency. The mining company wants to make sure it has sufficient kwacha available to pay the wage bill to the Zambian employees at the future date.

[6]This is a modelling assumption as BoZ does not pay interest on deposits from banks at present. To understand the assumption, remember that in this model government securities are seen as (negative) central bank lending, and placements in this form earns an interest. It can also be noted that Grønvik (1994) specifies an increasing central bank lending rate function, and with this assumption only the marginal central bank lending rate is important to interest rates offered to customers by the banks.

In order to protect shareholders against exchange rate risk, and to adhere to supervisory standards, the bank wants to manage exchange risk. Faced with the obligation to deliver kwacha when it receives dollars, it can hedge the obligation through taking up an international interbank spot loan of dollars of FBs^i. The bank has to pay the international interest rate rF so that the obligation when terminating the loan is FBf^i : $FBs^i(1+rF) = FBf^i$

The hedge may not be complete, and the open forward balance from the two transactions is $FCfi - FBsi\,(1+rF) = \mu^i$.

Here it will be assumed that the banks makes a perfect hedge, which implies $\mu^i = 0$.

We can then do today's book-keeping for the bank of all four transactions. The bank

- takes out loan at t = 0: $+ FB_s^i$ Dollars
- receives from customer at t = 1: $+ FC_f^i$ Dollars
- pays out principal and interest at t = 1: $- FB_s^i(1+rF)$ Dollars
- pays out to customer at t = 1: $- KwC_f^i$ Kwacha

When converting all these transactions to the same currency they can alternatively be written as:

$+ FB_s^i + FC_f^j - FB_s^i \cdot (1+r_F) - KwC_f^j / e_s$ Dollars 5'

$+ e_s \cdot FB_s^i + e_s \cdot FC_f^j - e_s \cdot FB_s^i \cdot (1+r_F) - KwC_f^j$ Kwacha 5"

Eliminating the two middle terms through the perfect hedge and assuming no other forward activity of the bank (i.e. remove the extra C and B in the variable names) yields:

$+ e_s \cdot F_s^i - Kw_f^j$

Inserting for $Kwf^i = e_f^i - F_f^i$ from forward balance (2) yields:

$+ e_s \cdot F_s^i - e_f^j \cdot F_f^j$

Replace Fs^i with the discounted forward equivalent

$F_s^i = F_f^j/(1+r_F) - e_f^j \cdot F_f^j + e_s \cdot F_f^j/(1+r_F)$ 5

This expression enters the profit equation.

The replacement of F_s^i with the discounted forward equivalent is also done in the balance sheet $F_s^i = F_f^i/(1+rF)$.

The actual decision rule for the bank in the foreign exchange liquidity market is determined through profit maximizing.

d) Regulations and policy tools

Banks in all countries are subject to considerable regulation. Some of the regulations aim to ensure that owners have necessary competence and are trustworthy. Most of the detailed regulations, for instance relating to proper book-keeping and adequate monitoring of risk related to bank customers, have supervisory purposes. Other regulations have monetary policy as their main purpose, i.e. they contribute to provide for management of demand in the national economy.

In the model here, only one regulation will be an active part of the bank decisions, while conditioning on the others. They could easily have been specified and might have been important in a dynamic model. The central bank lending arrangement is exogenous to the bank, but it plays an important part in other decisions of the bank. The important regulations and policy tools are reserve and capital requirements.

Reserve requirement:

$$R^i \geq \xi_R \cdot \dot{D} \qquad 6$$

Banks have to place a certain proportion of the deposits they take as reserves. These reserves will be remunerated with an interest rate of rR that is lower than the central bank deposit rate rC[7]. When banks maximize their profit, this regulation will be fulfilled exactly.

Capital requirement:

$$W^i \geq \xi_W \cdot f(L^i, \mu^i) \qquad 7$$

The capital requirement is a prudential requirement. It aims at making sure the holders of bank equity take some of the risk of their bank business. It has the effect of limiting the overall size of Bank i's activities. In this static model bank equity (W^i) will be considered predetermined and assumed large enough not to limit the bank behavior in customer markets in the period under study. In a dynamic context supervisory policies can be implemented through increases in ρW. The higher value this parameter takes, the more equity is needed by the bank to support lending activity. Equity is normally more expensive than other capital sources, so a higher value will reduce lending and increase lending rates.

Foreign exchange risk:

Supervisors may monitor the foreign exchange risk of banks directly, or the system for internal control with the foreign exchange exposure. Unexpected and large exchange rate movements may occur for reasons independent of a bank's own actions, and to protect shareholders, supervisors demand that banks have internal rules limiting exchange rate risk. A bank therefore aims at making receipts and outlays in foreign currency broadly in

[7]Currently, the interest rate on reserves in Zambia is zero, the assumed rate of r_R will lead to slightly more general formulation of possible policies.

line. Here banks are assumed to manage a perfect hedge as a voluntary understanding of a supervisory standard.

Central bank lending:

The central bank carries out its monetary policy with a number of instruments. The reserve requirement reduces the money multiplier, but is not very practical for short term policy changes. The central bank maintains a liquidity facility available for all banks. The terms of this facility is determined by the central bank. Here it is assumed that it opens for deposits and loans from banks, and the interest rate (rC) is the same for deposits and loans. The central bank can also change bank liquidity through open market transactions in government securities.

e) Bank cost structure

To show how running costs of the bank will affect bank behavior a simple cost structure will be assumed. The costs of having and managing a branch structure, necessary computing- and communication-platforms, security and top management will be assumed proportional with the activity directed towards customers. The equation is

$$Cost^i = \xi_L{}^i \cdot L^i + \xi_D{}^i \cdot D^i \qquad 8$$

An understanding of cost elements faced by banks in Zambia is important in the discussion of the high lending rates and the low deposit rates.

f) Optimal bank behaviour

Now all the elements of the environment for the bank are specified:

- Bank balance sheet
- Bank market power in customer markets
- Bank possibilities in liquidity markets
- Bank regulations
- Costs of service provision

These elements can now be brought together to determine optimal bank behaviour. The bank is assumed to have equity and consequently equity owners. The behaviour assumed is that the equity holder wants to maximize profit, and that the bank management abides by this wish from the owners. The task is thus to derive conditions for profit maximization under the prevailing conditions.

The way this model is specified gross income from lending is the amount of lending multiplied with the lending rate. The similar is true for all income components. The gross expenditures are similarly deposits multiplied by the deposit rate etc. The profit is found as the gross incomes minus the gross expenditures subject to the balance sheet, the reserve requirement, and the costs of service provision. The choice variables of the bank are the amount of deposits, loans, reserves, and net position in the interbank market domestically and abroad. As the model is designed, the costs of service provision follow automatically from the decided activity level. In practical banking, ways of organising the service provision efficiently will be an important issue. This will be discussed later.

$$\begin{aligned} \text{Max } \xi^i \quad & = L^i \cdot r_L^i(\cdot) + R^i \cdot r_R + IB^i \cdot r_{Bi} - \\ J\varepsilon \{D^i, L^i, R^i, IB^i, F_f^i,\} \quad & - D^i \cdot r_D^i(\cdot) + e_f^i \cdot F_f^i - e_s \cdot F_f^i/(1+r_F) \\ & - C^i \cdot r_C - (\xi_L^i \cdot L^i + \xi_D^i \cdot D^i) \end{aligned}$$

subject to

$$\begin{aligned} & L^i + R^i + IB^i = D^i + C^i + e_s F_f^i/(1+r_F) + W^i \\ & R^i \geq \xi_R \cdot D^i \\ & [\, W^i \geq \xi_W \cdot f(L^i, \mu^i)\,] \\ & \{\, L^i, R^i, W^i, D^i \geq 0\,\} \end{aligned} \qquad 9$$

when

$$\{r_R \geq r_C\}$$

The optimum prices rules for the bank in the liquidity markets are that it should trade domestically at the central bank rate. Even in the market for secured foreign interbank funding the solution is that the domestic central bank policy rate prevails.

$$r_{Bi} = r_C \qquad 10$$

$$e_f^i = e_s \cdot [(1+r_C)/(1+r_F)] \qquad 11$$

An important outcome here is that the central bank rate prevails, and at this price there is no quantity restriction. That is: unlimited funds are available domestically or through secured international lending and if a bank has surplus funds then it can place unlimited funds at this rate in the two markets.

The optimum price rules for customer markets have similar structures. Starting from the central bank (or interbank rate) the optimal rate to customers are first corrected according to whatever costs may be incurred through regulation. In addition the bank has to cover the relevant real costs. This corrected rate is then corrected through a mark-up (mark-down) reflecting the market power of the bank.

$$r_D^i = a_D \cdot [r_C - \xi_R \cdot (r_C - r_R) - \xi_D^i] \quad , a_D < 1 \qquad 12$$

$$r_L^i = a_L \cdot [\, r_C + \xi_L^i] \quad , a_L > 1 \qquad 13$$

In the optimum prices rule for deposits (12) the term - $\xi R(rC-rR)$ reflects the cost of the reserve requirement. In the optimum price rule for loans there is no similar direct cost of regulation, but an active requirement connecting lending to the amount of equity would have had a similar effect and increased the bank's optimal lending rate. The cost of reserve requirement is fully borne by depositors when banks maximize profits because the size of required reserves is determined by the deposit base.

At present banks get no interest income from required reserves in Zambia, i.e. $rR = 0$. The optimal interest rate equation then can be further simplified to

$$r_D^i = a_D \cdot [r_C \cdot (1-\xi_R) - \xi_D^i] \quad , a_D < 1 \qquad 12'$$

The results (10) - (13) are derived through some tedious calculations shown in Box 3 in the Appendix.

An important result is that the optimal customer deposit and lending rates are independent of each other. This is due to the fact that – for the individual bank – unlimited funds are available through the domestic money market and through secured international lending. A consequence of this is that the most important thing authorities can do to improve competition – i.e. to increase deposit rates and reduce lending rates – is to make sure that the interbank markets are well-functioning.

Summing up, it has been shown that:

- The central bank policy rate prevails in markets for domestic and interbank funding. At the going interest rate, there is unlimited access to interbank funds.
- The exchange of liquidity between banks through an efficient interbank market is the most important factor to secure competition in markets directed towards ordinary customers.
- Customer deposit and lending rates deviates from net funding costs plus the allowance for costs of service provision with a factor representing the market power of the bank. Deposit and lending rates are independent of each other because of the unlimited access to interbank funds.
- The reserve requirement is exactly fulfilled, and the cost is fully borne by depositors.
- At these prices the volume of loans and deposits are determined according to market demand.

3. The behaviour of the banking sector

In the previous section a model for an individual bank that maximizes profit was developed and to profit maximizing rules for the bank's behaviour was shown. I think the basic behavioural assumptions leading to these results are realistic for most Zambian banks. Starting from the model for the typical bank-i, we can now turn to the issue of modelling the banking sector.

The result will be a model for the entire banking sector that is analogous with the model for the individual bank. However, here the aggregation will be done step by step so that it is easier to see the weaknesses in the reasoning. Note should also be taken that it is necessary to study the assumptions on what variables are exogenous in a macro setting.

a) Balance sheets and aggregated liquidity markets

The first thing in the aggregation is to introduce the total quantities of the banking sector through summing up the quantity variables over all N banks.

$$X = \sum_{i \in \{1, \cdots, N\}} X^i \qquad X \in \{D, L, R, C, F_f, W\}$$

In doing this it should be noted that aggregated net interbank position by definition is zero.

$$IB = \sum_{i \in \{1, \cdots, N\}} IB^i = 0$$

This will lead to the balance sheet equations (a) and (b) in the banking sector model in Box 4 in the Appendix.

The starting point in the aggregation is the markets where banks interact, i.e. the domestic interbank markets. First it can be noticed that since all banks through their profit maximization fulfil the reserve requirement exactly, this will be true for the banking sector also, compare (c) in the model.

The assumption on no market power in the liquidity markets imply that the interbank rate is the same and equal to the central bank lending rate for all banks. Turning to the international section of the interbank market, the net position of the banking sector may deviate from zero. However, the price rule applies so that the hedged international interbank rate equals the central bank lending rate. A last point is that the banking sector as a whole will fulfil the statutory reserve requirement exactly[8]. These considerations will lead to the equations (d) and (e) in the sector model.

b) Aggregated customer markets

The aggregation from the demand and supply equations for bank loans and deposits to equations for demand and supply directed towards the entire banking sector is not trivial. The assumptions used here will contain three elements, and will lead to an atomistic symmetric equilibrium. The atomistic part of the assumption is that it is assumed that all banks behave as if their interest rate does not affect the market average interest rate. The symmetric part of the assumption assumes that all banks face the same demand elasticity. It is also assumed that the cost of providing the deposit and loan service is the same for all banks. The third assumption is that competition secures that the cost of the banking activity per unit of deposits and loans are the same for all banks.

Under these assumptions the solution is that the customer interest rates equations directed towards the sector as a whole retain the same form as those from each of the individual banks.

The solution is shown in equations (f) and (g) and in each of the two equations there is a deviation from net funding and service provision cost with a factor representing the market power the banks have over their customers.

It may be argued that the assumptions used in this aggregation are unrealistic. An alternative assumption could be that some banks are market leaders while others follow their price decisions. It can also be assumed that larger banks understand that their decisions influence the average interest rates offered by the banking sector. These assumptions would clearly lead to different and messier price equations for individual banks. In particular, the equations would be different for market leaders and market followers. However, this alternative assumption would give sector equations with similar properties. The key factor driving the sector equation is the fact that the competitive rate in the interbank market prevails and that these markets are unlimited in volume.

c) Status of variables in aggregated model

Before closing the discussion of the model for the sector, it is necessary to go through the status of its variables.

[8]The model here is deterministic, and thus there is no uncertainty related to the amount of deposits the banks will receive from their customers. In the real world it will be some uncertainty, and provided there is some penalty for having to small reserves, banks will fulfil the requirement with a small margin.

Variables and parameters that are instrumental for monetary or supervisory policy purposes and determined by the central bank are:

- Central bank policy rate
- Reserve requirement, rate of return on reserves
- Equity requirement
- Supervisory standards related to foreign exchange exposure

An exogenous variable is:

- Spot exchange rate (kwacha/dollars)

The variables determined through the banks' optimizing behaviour are:

- Bank lending rate to customers
- Bank deposit rate to customers
- Bank reserves
- Interbank interest rate
- Forward exchange rate

Variables that are independently determined by market demand or through rules the banks have to abide by are:

- Volume of customer loans
- Volume of customer deposits
- Bank net lending in dollars (spot and forward)
- Bank equity capital

Lastly, residuals from the banking sector balance sheets are:

- Banking sector's liquidity position with the central bank
- The banking systems net Kwacha-position forward

d) Model and reality

It is important to remember that even if variables in the model are independent or exogenous in the model, they need not have this status in real life. The model is a limited technical description of some important connections between variables. There may of course be important connections between variables that are not included in this model. The most important limitation of the model is that it is a static one-period-model that does not cover the real economy, in particular prices and exchange rate determination.

At present, the central bank lending rate is the main instrument for central bank monetary policy in Zambia. The target for central bank policy is to secure a moderate inflation through balancing domestic demand and supply in the real economy. Given that the model does not cover inflation and the real economy, it is not suited to discuss monetary policy. However, the central bank policy rate is the key driver of the model solution in both liquidity and customer markets. Thus, it will be possible to discuss effects of monetary policy as well as aspects of how the spread between the central bank rate and the commercial banks' deposit and lending rates to customers can be reduced.

It should also be repeated that an important financial asset, government securities, are not part of the model. The reason is that in this static model we would have no way of distinguishing between government securities and (negative) central bank lending, and thus specifying another variable would offer no additional insights. However, in the practical use of the model, it is important to remember that domestic interbank funds for the sector as a whole consists of government securities as well as funds (deposits or loans) in the central bank.

If we were to extend the model to cover more than one period it would be possible to distinguish between long and short interest rates. In practical discussions at least three perspectives are important

- Central bank (and interbank) overnight rate
- Three-month rate driving foreign exchange swaps
- Three-year government bonds

A multi-period model would not change the fundamental logic of the model and would also have limited impact on the discussion of what can be done to obtain better interest rates in the customer markets.

4. The optimal rate and the situation in Zambia

The purpose of this work is to discuss the formation of rates in customer markets, and to discuss factors that may contribute to explaining high lending rates and low deposit rates in Zambia. The model developed is fairly general, and it is not inconsistent with any rules and regulations in Zambia. The country seeks to have competitive markets and has no general prohibitions relating to activities in foreign countries and currencies. Further, the prudential regulation of the financial sector seeks to be in line with best international practice.

Thus, the model ought to give guidance to how interest rate formation in Zambia is and can be. If we look at the structure of the optimal solutions for the interest rates offered to customers they are very similar:

Table 1: Optimal interest rates in customer markets

	b)		c)		a)		d)	
Lending rate	=	Market power parameter	×(Funding rate	+	Cost of regulation	+	Cost of service provision	)
Deposit rate	=	Market power parameter	×(Funding rate	-	Cost of regulation	-	Cost of service provision	)

As it is especially important to look into what authorities can do to influence interest rate formation, the discussion will be started with a sub-section on the tasks of the BoZ and effects of regulation and policy. The other elements of the perceived optimal interest rates will be discussed in the subsections that follow as indicated by the column header in the table.

a) The effects of central bank policy

Before going into the effect of the various central bank policy instruments, it is useful to repeat the tasks of the central bank. The way these tasks are accomplished has an important bearing on the actual interest rates that banks will offer in the customer markets.

The Bank of Zambia act stipulates the Functions of the Bank in Section 4 (1):

> *"The Bank shall formulate and implement monetary and supervisory policies that will ensure the maintenance of price and financial systems stability so to promote balanced macro-economic development."*

The act stipulates monetary and supervisory policies as the main target of the central bank. As said the model developed here cannot discuss how these main targets can be pursued, but effects from the chosen policies can be discussed.

The main target of securing moderate inflation is achieved through balancing domestic demand and supply, with due consideration to effects from possible changes in the international value of kwacha. The international value of the kwacha will affect prices through prices on imports and the competitiveness of the real economy. In the discussion of monetary policy a term structure of interest rates need to be studied to observe market expectations, and to discuss how the central bank can perform the necessary 'expectation management'. At present, the central bank policy rate is the main instrument for central bank monetary policy in Zambia. The reserve requirement is a supplement as it affects the liquidity of the banks. However, as unlimited funds are available for the banks through the foreign exchange markets, the banking system as a whole can acquire and redistribute the liquidity it wishes through the domestic and international interbank markets. Thus, the reserve requirement will only be effective as a monetary policy tool if the interbank markets are not fully efficient[9].

The main target of securing sound financial institutions is achieved through supervision based on the principles drawn up by the Basel Committee on Banking Supervision. These principles are worked out and modified through international experiences from problems in individual banks and banking crises in the whole financial system in some countries. A lot of the supervisory work goes into how internal routines and accounting are practiced. Most of these features cannot be translated into the language of the model here. However, the Basel recommendations also deal with risk based capital requirement as modelled in (7). The equity requirement varies with the type of risk the bank takes on, and lately many countries adjust the capital requirement in order for banks to build a capital base when the business cycle is good that is sufficient through the full business cycle.

The Bank of Zambia act stipulates more on the Functions of the Bank in Section 4 (2):

> *"Without prejudice to the generality of subsection (1) and subject to the other provisions of this Act the Bank shall*
>
> *(a) licence, supervise and regulate the activities of banks and financial institutions so as to promote the safe, sound and efficient operations and development of the financial system;*
>
> *(b) promote efficient payment mechanisms;*
>
> *(c) issue notes and coins to be legal tender in the Republic and regulate all matters relating to the currency of the Republic;*
>
> *(d) … (e) …. (f) …"*

The model here is well suited to discuss how one can achieve the target of a "sound and efficient operations and development of the financial system". This will be summed up in

[9]The reserve ratio and rate of return on reserves have an effect on who pays for the soaking up of excess interbank liquidity created through the unfunded government spending in the years of dramatically high inflation in Zambia.

the next section of the paper. Elements of this discussion will be dealt with later in this section.

b) The market power parameter

The size of the market power parameter is an empirical question. In perfectly competitive markets the parameters would take the value of 1, and poor competition results in large deviations from 1. In some of the political debate it may at times seem to be this factor that determines interest rates, and that the lack of efficient competition is the main problem relating to interest rates in Zambia. However, the model points to three other factors in the formulation of optimal competitive interest rates, and not much can be said about the market power parameters' deviation from 1 without knowing the size of these three other factors (inside the parenthesis in table 1). We have already mentioned some effects central bank policy may have, and in the two next subsections the other factors will be studied.

c) The funding rate

A major result from the model is that the key to a market for loans and deposits with efficient competition between the service providers is the bank funding rate. The same marginal funding (or placement) rate needs to apply to all service providers, and for the sector as a whole it is the central bank rate that will be the marginal funding rate.

In the discussion of the marginal funding (or placement) rate it is important to keep in mind that the model does not distinguish between central bank loans (or deposits) and Government securities. In the practical discussion of how well the markets function we therefore need to study these markets in addition to the interbank market.

Thus, there are four markets to comment on. They are

- The deposit and lending facility in the Bank of Zambia (BoZ)
- The Zambian leg of the international interbank market
- The Zambian interbank market
- The Zambian government bond market

The facilities in the Bank of Zambia

The banks can place any deposit in BoZ both on a reserve account and on an unrestricted deposit account. These deposit accounts carry no interest income, but as BoZ is the issuer of the Zambian currency they do not carry any risk either. The banking sector as a whole holds considerable funds without any remuneration in their deposit accounts with BoZ. This can only be explained through malfunctioning of other markets for liquid bank funds. With fully functioning interbank markets free bank deposits in the BoZ would have been small, covering unexpected payment surprises. In addition the sector would have deposited the required reserves in the BoZ.

Banks have access to a lending facility in the BoZ. The interest on loans in BoZ is linked to the BoZ policy rate, and banks will normally seek to avoid central bank lending as that, with well-functioning interbank markets, is more costly than interbank lending. In an emergency or when large unexpected payment shocks occur, banks may use the central bank lending facility as a measure of last resort.

The international interbank markets

Banks have accounts with foreign banks in order to service their own customers. Exporters will receive payments in foreign currencies and need to bring money to Zambia to pay Zambian taxes, wages and other expenses in Zambia. Importers need to pay for imports. Some banks will only have foreign exchange activity related to servicing their customers' needs for payment services.

As explained in the model, banks may also access foreign interbank markets to obtain (or invest) additional funds. These markets are highly competitive, but participants need to be internationally trustworthy to participate in them. This may be an issue for some of the national Zambian banks, but there are a large number of foreign owned banks in Zambia. These banks may access the foreign markets either directly or through their mothers. If the domestic interbank markets are well-functioning, the Zambian banking sector as a whole should through hedged lending be able to attract unlimited funds at the Zambian interbank rate.

Thus, once again the issue is how well the Zambian interbank markets function.

The Zambian interbank markets

Interbank market activity is to a large extent loans with very short maturity, i.e. overnight or a couple of days. Interbank loans are typically used to bridge between shocks received through termination of other (domestic or international) financial contracts or from large payments between customers. Examples can be paying back some other interbank loan or that a bank may have large outlays for wages for a large customer one day. With well-functioning developed markets, any Zambian bank would be able to receive or deposit the necessary overnight funding through the interbank market. In general it can be said that the interbank market reduces the risk in the banks' maturity transformation when they invest short-term deposits in long-term assets (mainly loans and government securities). Thus, for the banking system as a whole, a well-functioning interbank market offers greater possibilities to extend loans (or to put it another way: To keep the money trusted by depositors to banks to work).

However, interbank market activity has been fairly limited in Zambia. There are several explanations to this. Lack of trust between banks leads to low limits on exposure between banks. This may be related to assessment of default risk by the bank asked to give a loan. However, it may also reflect fear from delayed settlement of the repayment, i.e. fear of a liquidity risk. Regardless of the reason, a market for loans without collateral has not developed. A way to overcome this obstacle would be to extend collateralized loans. For short-term interbank loans to be collateralized a delivery-versus-payment real-time-settlement solution using government securities as collateral, needs to be available.

From September 2014 the BoZ provides such a settlement solution for government bonds. This is a major development and hopefully, it will foster the creation of a liquid interbank swap market. With a liquid interbank market the price fixing of that market will be sharper, and inefficiencies in the customer markets will subsequently be reduced.

The Zambian government securities market

The government securities market is important for the smooth day-to-day financing of the Zambian government. Government securities may be government bonds and Treasury bills. The bills have shorter maturity than the bonds. Here these markets will be discussed as one, called the government bond market.

In addition to banks, the main investors in the government bond markets are pension and insurance companies. In developed economies, secondary government bond markets are very liquid, i.e. professional investors and others can buy or sell fairly large blocks of a single issue without large effects on the price. This is not the case in Zambia, and there are several explanations to this and they are related both to the primary and secondary market for government bonds.

In the primary market bonds are sold in auctions that mainly attract professional investors. Traditionally in Zambia, each bond auction has been for a new bond issue. With weekly or monthly auctions to deal with the government financing needs on a running basis, this has given a very large number of small government bond issues, and they have not been suitable for secondary trade. The practice of all auctions in new issues has now stopped. Now benchmark issues are reopened at later auctions. This opens for larger bond issues and is a prerequisite for increased liquidity in secondary markets.

However, larger issues do not automatically increase liquidity in the secondary bond market. The tax system creates additional obstacles that need to be overcome. The two main problem of the tax code are that there is different tax treatment of different investor groups as some investors may get the withholding tax on the coupon refunded. Secondly, there is a capital gains tax on the gain from issue until redemption to be paid at redemption. Securities are sold at different prices both in each auction and in the reopening of bond issue. The capital gains tax therefore implies that the taxation of different bonds within the same issue differs. The implication of all this is that buyer and seller find it difficult to agree on a transaction price and it will also be difficult for a potential market maker to quote bid and ask prices.

The conclusion of this is that a common funding price for interbank transactions will not be established directly through the markets for government securities as long as the tax obstacles remain in place. However, as pointed out above, the newly established real time settlement facility that allows for pledging government securities as collateral in real time can be used by banks to pledge government securities as collateral for interbank loans. Since Zambian banks have considerable funds invested in government securities, this may open for a much better liquidity in the interbank market.

d) The real cost of banking

It is said that banking is about transforming liquid savings in the form of customer deposits to the financing of real investments. This transformation takes place indirectly through the institution, and the real costs of banking can probably best be discussed separately for deposit taking and lending.

Real benefits and real costs of deposits

Bank need to receive deposits from customers in order to be able to give loans. For this to happen, the banks must be trustworthy, and customers will make deposits in banks if the return and convenience services the bank offers to depositors are considered sufficiently attractive. The return takes the form of interest income, and the main conveniences are related to security and payments.

Banks show that they are trustworthy through complying with rules set up by the regulator, having sufficient equity capital and responsible behaviour[10]. Through this depositors will

[10]The schemes are created by law, but not necessarily guaranteed or funded by authorities. The current international recommendation is to establish deposit guarantee schemes that are funded, and the fund should be established through fees paid by participating banks. A government guarantee may be needed in the first years until the fund has been paid up by the fees from the participating banks.

feel that their savings are safe when deposited in the bank. In developed economies the security of normal deposits from households and non-professional customers are bolstered through deposit guarantee schemes created by law . Through deposits customers will reduce the risk of being robbed for their cash savings. The customers also need to be able to access their deposits through withdrawals in branches or ATMs, or through initiating payments that go directly to the final receiver. Account to account payments reduces security concerns with payee, payment receiver and the involved banks.

Banks deliver different services related to payments. Payments done through bank transfers or cheques can be verified by the bank as an involved third party if disputed. Bank transfers do not require physical handling of cash and cash can be withdrawn at ATMs close to where they will be used and thereby reducing security risks related to cash transport and storage. Payments done through point-of-sale terminals can be verified and eliminate security concerns.

Banks need infrastructure to deliver payment services, and the payment service infrastructure need participation from all banks to be efficient from the view of payees and payment receivers as well as from the banks. Zambian banks have high cost in cash handling, both directly in branches or when cash is distributed through ATMs. They can improve their service to customers and save currency handling costs through introducing systems for more account to account payments. For this to be possible a national switch covering all streams of payments[11] with the participation of all banks need to be operational.

In the model it is assumed that the direct cost of managing a system of deposit accounts is proportional with the deposit received. In addition the expense through interest payments to depositors is part of the model. The linear cost structure is not unrealistic in the current heavily cash based system in Zambia. A national switch will entail some system costs, but if a fair system for participation fees is established, the linearity assumption will be reasonable even when the national switch comes into operation.

With the high cost related to currency in branches and ATMs, the cost factor for deposit taking (κ_D in the model) is likely to be relatively high in Zambia (compared to in developed economies), and it can be substantially reduced when the national payment switch becomes operational.

Real costs of loan provision

Banks extend loans to customers as external financing of projects or businesses of the customers. The loans may be given as overdraft facilities to smooth out a seasonal liquidity pattern of an enterprise, to finance the building of a house, or to equip the enterprise with cars or machinery. The customer needs the loan to improve the chance of success for his project, and he is willing to pay the lending rate interest to get the loan.

A project involves uncertainty and by giving a loan the bank takes a risk on the project and the customer. To avoid giving out loan where customers are likely to get problems in meeting their obligations or may end up in an outright default, the banks will study the business plan of the project and the customers possible other sources of income that may meet the obligations. In addition the bank will to take some collateral security before extending a loan.

The costs of project evaluation before extending loans are real, but will probably not differ much between countries. The difference in cost for the banks from different countries of

[11]All streams of payments include point-of-sale payments and ATM-withdrawals based on payment cards, settlement of cheque transactions, credit transfer payments and direct debit payments entered by paper forms or electronically through business solutions or private internet banking.

giving loans are mainly connected to the national systems for securing collateral, and for claiming it if necessary.

The most important form of pledged collateral for ordinary customers in developed economies is real estate. It is used by households when buying their homes, by farmers both for building farm houses, for buying tractors or other mechanical tools, and for having credit lines until the harvest season, and by factories and merchant businesses for acquiring business locality, machinery and inventory. In Zambia the system for acquiring title deeds for real estate properties and using the title deeds as collateral is difficult[12]. There may also be legal issues related to sale of claimed collateral, i.e. whether the collateral can be freely sold in the market and the sale proceeds can be used to cover the default.

Banks may also use cars, machinery or shop inventory as collateral. A system for this – a collateral register – is presently being developed in Zambia. Stringent rules so that claims entered in the register have the best priority and that makes sure that the claim does not disappear through the sale of the asset are necessary. If used by all finance institutions a collateral register will be useful. Banks may also use equity or other financial claims as collateral. For widespread and cheap availability of credit to ordinary customers these forms of collateral are not sufficient. Therefore, the cost factor for extending loans ((κL in the model), is very high in Zambia compared to what they are in countries with developed registers of land.

Interesting observations regarding both "Registering property" and "Resolving insolvency" are found in special studies in the last issue of "Doing Business" cf. World Bank (2014). The status for each country related to the quality of systems for property registration is not yet part of the overall index. However, work on collecting data has started and a clear pattern seems to emerge: Many poor countries have poor (if any) systems for registration of property and most rich countries have open and transparent systems. Bribery associated with property registration is frequent in countries with poor property registration systems, and the good property registration systems open for use of land as collateral and consequently better and cheaper access to credit. It is expected that the indicator system for the ease of doing business will be expanded with a measure on the quality of the land registration system next year. Zambia has neither an electronic database for encumbrances nor an electronic geographic information system, and is likely to end up with a poor score in the new index.

The index for the quality of the systems for resolving insolvency has been revised. Zambia is now ranked as number 95 out of the 189 countries in this index. The index now it includes a measure for the strength of the insolvency framework and here Zambia is graded 7 (with 16 a maximum). This comes as an addition to the measure of time, cost and likely outcome of an insolvency process. The values for Zambia are 2.4 years, with a cost of 9 percent and a recovery rate of 39.3 percent. To put these numbers in perspective I quote the values for my country. Norway is ranked #8 and use on average 0.9 years on the procedures, the cost amounts to 1 percent and the recovery rate is 92.3 percent. From this it should be clear that the cost related to non-performing loans for Zambian banks are dramatically higher than the same costs for Norwegian banks. These costs have to be recovered, and the real cost element for Zambian banks are much higher than in countries with an efficient system for resolving insolvency. The costs have to be paid by the many good Zambian lenders in the first instance, and by all Zambians in the later instances as expensive credit reduce overall growth of the economy.

[12]My understanding of these issues is based on newspaper reports, supplemented by my own and my wife's discussions with owners and investors in tourism, community schools and other lines of business. In addition, I discussed the issues informally with colleagues at the BoZ. The reading of the selected studies from World Bank (2014) has increased my confidence in my understanding.

5. Central bank policy to improve interest rate formation

a) About a central bank model

Before summing up findings and pointing to issues that need further attention for the BoZ, it is useful to reflect on the purpose for a central bank to model bank behaviour. A model may serve at least two purposes, internal and external. The internal purposes are to have clarifying internal discussions on the policy choice faced by the central bank at any given time. The channels by which a proposed policy measure will affect interest rates can then be discussed. The external purposes of a model are very similar as the central bank needs to explain to the general public why (or why not) a certain policy measure has been implemented, i.e. why and how does it work and why are other policy options not so suitable. It should also be added that having a reference model facilitates easier discussion in situations when the model does not apply. This will be illustrated through a discussion of possible effects of an interest rate cap in a subsection below.

As pointed out previously the model here is not designed to be suitable for discussions of monetary policy. However, the model is well suited to discuss policies to promote "sound and efficient operations and development of the financial system". It is sufficiently comprehensive for discussion of bank response to possible policy measures such as change in the policy rate, in prudential measures and in limits to foreign exchange exposure of banks and thus the model can bring out policy dilemmas. The model can also assist the central bank in explaining the policy chosen to important stakeholders such as government, banking industry and the general public through the media. This can be achieved as the model is also sufficiently simple.

b) Deductions from the model

The main findings of the model as regards the interest rate formation are summed up in Table 1. The key to efficient markets and a situation where banks compete based on their effectiveness in delivering bank services to customers is to have efficient and liquid interbank markets. Note that the effectiveness of the monetary policy increases if the interbank markets functions well. A common interbank rate is the marginal funding or placement rate for banks and the rate will be decided through monetary policy. The model shows that this rate will impact on the interest rates both depositors and lenders meet. Thus, both to meet the primary goal of "maintenance of price and financial systems stability" and the secondary goal cited above, the key to effective policy is liquid interbank and government securities markets.

The further effect from use of other instruments for monetary or supervisory policies has been discussed earlier. An increase in the reserve requirement based on deposits will reduce the deposit rate and an increase in the equity requirement based on loans will increase lending rates as explained. This should be taken into account in policy discussions.

c) Policies for an efficient interbank market

In the discussion of the different parts of the interbank market some issues were mentioned as major impediments to obtaining liquid markets. There is no easily available tool for the BoZ to increase the trust between banks so as to increase the interbank credit lines. The best thing the BoZ can do in this respect is probably to maintain a good quality in the financial supervision so that banks are assured that possible bad-banks will be corrected well before they actually default. Good quality supervision in line with international best practice is probably the most important thing BoZ can do to improve trust among banks domestically and internationally.

Turning to government securities, it must be kept in mind that BoZ does not decide the taxation of the returns from investment in government securities. Thus, BoZ cannot change the tax code to meet a requirement for a liquid secondary market in government securities to develop. However, the BoZ can discuss the taxation issue with the Ministry of Finance. It should then be kept in mind that the properties of the secondary market will have a significant impact on the primary market and therefore on the borrowing costs for the government. A liquid investment is more attractive and should result in lower rates in the primary market. This will reduce the cost of government borrowing. It can be argued that the reduction in debt servicing will out-weigh the loss in tax income through abolishment of the capital gains tax. The taxation of securities should therefore be considered carefully.

A measure that is fully in the hands of the BoZ is the modern real time settlement facility for government securities, which was operationalized in September 2014. Thus, government securities can now be pledged in real time as collateral for interbank loans. The facility is part of the BoZ real-time-settlement and provides for a delivery-versus-payment option for collateralised interbank lending. This should create a much more liquid interbank market and improve competition between Zambian banks.

d) Policies for improved deposit markets

A large section of the Zambian population is un-banked, i.e. they have no connection with the banking sector or the financial industry. This increases the costs of consumption smoothing, as well as security cost related to payments and storage of wealth for the un-banked population relative to what would be the case with a bank connection that offered standard payment services. There have been bank failures in Zambia, and a trustworthy system for deposit protection under the rules set up by the government should eliminate or reduce sharply the fear for future bank failures. This would, as shown by Diamond and Dybvig (1983), improve general welfare as it would increase the banks' ability to finance productive investments. The current international standards for effective deposit protection systems are found in IADI (2014). A proposal for a law setting up a Zambian deposit protection scheme adhering to the international standards is currently under consideration by the Ministry of Finance.

The point highlighted in the motivation of this paper is to pursue policies that will lead to increased interest rates on deposits from customers. These rates may in fact increase without any other policies implemented than the creation of a liquid interbank market. This can happen if a bank specializing in deposit taking is established. In Zambia the interest rates on government securities are high and a bank may be set up that invests all deposited funds in government bonds. To illustrate the high return it can be noted that the yield on 3-year Zambian government bonds was 15.8 percent as an average in 2014. A deposit-only-bank will need to provide deposit services such as offering opportunities for withdrawal and payment services[13]. The current level of service in this respect in Zambia can be served by participation in the ZECHL check-clearing and having some ATMs in addition to a main office. Such a bank could avoid all project evaluation and collateral management associated with loans, and could thus offer a deposit customer a considerably higher interest rate than being offered in Zambia at present. For this business model to work out, the deposit-only-bank would depend on a liquid interbank market to meet the daily swing in customer deposits[14].

[13]Deposit rates in Norway increased dramatically through the establishment of a bank as described here when credit markets were liberalized in Norway in the early 1980s.

[14]This function of the interbank market is also pointed out by Diamond and Dybvig (1983) in their analyses showing the benefits of deposit protection.

If additional policies to reduce the cost of managing deposit accounts were implemented the interest rate offered could be higher, and a positive real deposit rate should be possible. This would give incentives to financial saving until projects can be fully financed and completed. This will sharply reduce the starting up projects based on surplus in the day-to-day liquidity. Such projects represent a capital waste until they are completed and productive.

The cost of deposit management will also be reduced through the ongoing establishment of a more modern payment system. With an increasing share of payments done directly from account to account the large security and teller cost associated with the use of cash currency can be reduced. Zambian banks are currently working on the establishment of a national payment switch that will facilitate interoperability in payments whether they are initiated by payment cards or other ways. BoZ is ensuring that the progress in this project is maintained and that relevant security standards are observed.[15] It will also be important that the rulebook of the national switch open for entry of new banks without an excessive up-front-payment for new banks to make use of the payment infrastructure created through the national switch.

BoZ is, through its stake in ZECHL, a main investor in the national switch project, and can also use moral suasion to commit the commercial banks to the completion of the national switch project. Thus, the tools to lay the foundation for better deposit rates to customers are mainly in the hands of the BoZ, they are actively being used, and an improved payments-system infrastructure should evolve within a year or two.

e) Policies for reduced lending rates

The creation of a liquid interbank market is probably not enough to reduce interest rates on loans to customers without any other changes taking place. However, a marginal effect may occur. Liquid market may make banks feel more confident with a reduced liquid margin in the BoZ, and therefore banks may want to extend more loans. For this to take place they need to move a bit further out on the demand schedule for bank loans and consequently they may have to reduce the rates. This is not likely to lead to any substantial reduction in lending rates.

The factors pointed create substantial real costs in bank lending, are related to collateral management. The system for establishing and claiming collateral based on real estate property, is outside the reach of the BoZ. As a supervisory measure, BoZ should continue to insist that the banks make provisions in the lending rates they demand from all lending customers to enable them cover costs they incur when loans become non-performing. This may result in high interest rates both for the good and the bad customers. BoZ should also continue to try to adhere to international standard for capital adequacy in Zambian banking[15].

The important thing the BoZ can do in relation to improving the system for collateral is to point out the problem both to relevant authorities and to the general public. It should be born in mind that there are two important elements to this. With an electronic system of land titles that cover the entire country, property can be used as collateral for loan or transfer of land parcels. This will increase security for title holders and facilitate easier and wider access to credit. A more efficient system for insolvency handling will reduce the real costs of banking and through competition also the lending rates.

[15]The present situation also put purely Zambian businesses at a competitive disadvantage relative to companies that also have activity in countries with systems for property registration. The international companies can use assets outside Zambia to raise necessary capital for activity in Zambia and thereby get much lower cost of borrowed capital.

The relevant authorities include the Ministry of Lands and the Ministry of Justice. The Ministry of Lands needs to develop a system where the legitimate owner is registered and can easily obtain proof of ownership. The system should also register if the property is used as collateral and the priority between creditors. The Ministry of Justice needs to develop stringent laws on how to use title deeds as collateral and the rules applicable when the collateral is called upon. Persons with a legitimate interest should be able to find out whether the property is used as collateral. The rules must ensure that full value is obtained when a forced sale takes place, and a bank can only take what is pledged and that the remainder is returned to the original owner.

Creating a good system for registration of title deeds and for registry of title deeds pledged as collateral is a huge task. The administration of the system needs to be sufficient to avoid queues in order to have full effect on the real costs of the bank lending. The systems in use in Europe have been developed over several hundred years. For a system to work there is need to create a common legal understanding of how it should operate – and the lay-man's general understanding of the system is as important as the specialists understanding of the details. This is no easy task, and many highly developed economies have a long way to go to establish truly well-functioning systems in this area[17].

f) The use of the model in policy analyses

The model can and should be used in policy analyses. The model can assist in the discussion of policy measures that are partly or not at all captured directly by the model. This is because the model shows the optimal market behaviour of a rational banker maximizing profit. Some moderate additions of "practical complications" will not render the basic results from the model impractical.

Increasing deposit interest rates in order to bank the unbanked population

If authorities want to increase the success of banking the unbanked population a policy to increase deposit rates may be considered. This can according to the model be achieved through a reduction of the reserve ratio (ξR), or through an increase in the interest paid on required reserves (rR). Assuming we are in a situation where Zambian banks do not have full access to funding through the international interbank market both these measures may be unwanted. Reducing the reserve ratio will free up banking liquidity, increase bank lending and threaten price stability. Increasing the interest paid on required reserves will be costly for the BoZ (or the MoF).

Moving outside the model, it can be considered if an option with increased interest rates on some reserves is possible. For the purpose of banking the unbanked, rates on relatively small deposits from individuals should be increased. Thus, it could be considered to increase the return only on reserves associated with these deposits, i.e. deposits to be covered by a deposit protection system. Then reserves covering large deposits and deposits from professional investors will not earn interest. This will probably cost a lot less for authorities, and can therefore be a viable solution. How large share of the deposits that will be covered by a deposit guarantee I an empirical question the BoZ can find the answer to once the details of a deposit guarantee system have been decided.

[17]World Bank (2014) informs that Thailand between 1984 and 2004 implemented one of the world's largest land titling program, and issued more than 8.5 million titles. Rwanda completed its process of regularising of land tenure in 2014 and aim at registering all land in the country and issuing land titles.

Effects of a statutory cap on lending rates

A statutory cap on bank lending rates has been discussed and pursued as a policy at times. The model may assist in the understanding of the consequences of a lending rate cap. In this discussion it is useful to start with breaking the one-period-assumption of the model. It is necessary to distinguish between loans already given and loans that only are applied for, and between good and not so good creditors. For loans already given the cap may be effective or not. It is not likely that banks will increase lending rates on their good creditors with rates below the cap. The not so good creditors with loans already given where the banks would like to charge higher rates than the statutory cap, will experience a lower lending rate than what they otherwise would have. For loans applied for, and not yet given by the bank, it is useful to recall the equation for the optimum interest rate decision of bank-i:

$$r_L^i = a_L \cdot [\, r_C + \xi_L^i]$$

The optimum lending rate covers the banks costs (financial and non-financial) of giving the loan with a mark-up reflecting the market power of the bank. If we assume that bank-i has no market-power the power-factor is identically one ($\alpha L = 1$). If the statutory cap is lower than cost coverage for bank-i, new loans will not be given. If the statutory cap interest rate covers the costs of the bank new loans will be given. If the power-factor is above one, new loans will contribute positively to profit as long as the real costs (financial and non-financial) are covered. Thus a profit maximizing bank may lend some new loans at a lower interest rate than otherwise would have been the case. If bank-i interprets the cap as a signal of what lending rates ought to be, some new loans may also be extended with a higher interest rate than without a cap in place. Taking into consideration uncertainty, it is also likely that bank-i will avoid some marginal loans that otherwise would have been given.

Summing up, it is likely that some lenders will benefit from a statutory lending rate cap, but it is also likely that fewer new loans will be given and thus that some economic activity will be curbed reducing growth and employment slightly.

6. Concluding remarks

This work started by pointing out that real bank deposit and lending rates are out of line with what would be useful for developing the Zambian economy. It was also pointed out that many assume that the BoZ is in a position to correct this using the tools available through the BoZ act and other laws regulating banking and payment services. To discuss the issues involved a standard banking model has been developed.

It has been found that the key to effective competition is the interbank market, and BoZ can through policy measures within its remit improve the functioning of the interbank markets. An important step in this respect was taken in September 2014 with the opening of the CSD for government bonds. Fully effective financial markets covering securities in addition to interbank markets need change of the tax code, policy measures at the hand of the government and parliament.

Effective interbank market and a comprehensive national payment switch – measures within the remit of the BoZ – can probably lead to decent bank deposit rates. If this is accompanied by legislation to introduce deposit guarantee, it would probably be much easier to bank the unbanked and reduce the resources spent on security and on counting and transporting notes and coins. This should also contribute to reduced costs in handling deposits by banks.

To reduce the real costs of bank lending substantially, an efficient system for the use of real estate as collateral need to be developed. This is a major task of national interest and the establishment of the system must be initiated and funded by government and parliament. Once operational service charges for changing ownership and for recording new collateral should cover the expenses related to operation and maintenance of the system. The establishment of such a system would probably over time lead to substantial reduction in lending rates, but is clearly outside the remit of the central bank. However, the BoZ can contribute to the creation of an understanding of the importance of such a project.

References

Baltensperger, E. (1980): «Alternative Approaches he Theory of the Banking Firm». *Journal of Monetary Economics 6*, 1-37.

BIS (2014): *International regulatory framework for banks (Basel III)*. Web-page of Bank for International Settlements (https://www.bis.org/bcbs/basel3.htm?ql=1)

CPSS and IOSCO (2012): *Principles for financial market infrastructures. Basel and Madrid: Bank for International Settlements and International Organization of Securities Commissions.*

Diamond, D. and P. Dybvig (1983): «Bank runs, deposit insurance, and liquidity. *Journal of Political Economy 91*, 401-419.

Gorton, G. and A. Winton (2003): «Financial intermediation». Chapter 8, p 431-552 in *Handbook of the Economics of Finance*. Elsevier, North-Holland.

Grønvik, G. (1994): «Bankregulering og bankatferd 1975-1991». (Banking Regulation and Banking Behaviour 1975-1991, PhD dissertations in Economics). *Norges Bank Occasional Papers 22*.

IADI (2014): *Core principles for Effective Deposit Insurance Systems*. Web page of International Association of Deposit Insurers: http://www.iadi.org/docs/cprevised2014nov.pdf

Klein, M.A. (1971): «A Theory of the Banking Firm». *Journal of Money, Credit, and Banking 3*, 203-218.

Moe, T. G., J.A. Solheim and B. Vale (eds) (2004): «The Norwegian banking crises». *Norges Bank Occasional Papers 33*.

Monti, M. (1972): «Deposit, Credit, and Interes Ratet Determination under Alternative Bank Objective Functions». Page 430-454 in G.P. Szegö and K. Shell (eds), *Mathematical Methods in Investment and Finance*. Amsterdam: North-Holland.

Santemero (1984): «Modelling the Banking Firm: A Survey». *Journal of Money, Credit, and Banking 16*, 576-602.

Thakor, A.V. and A.W.A. Boot (eds.) (2008): *Handbook of Financial Intermediation and Banking*. Amsterdam: North-Holland.

Tobin, J. (1982): «The Commercial Banking Firm: A Simple Model». *Scandinavian Journal of Economics 84*, 495-530.

World Bank (2014): *Doing business 2015. Going Beyond Efficiency. Comparing Business Regulations for domestic firms in 189 Economies.* Washington D.C.: The World Bank.

Appendix: Boxes on the model

Box 1: The variables of the model

L^i	–	Loans to customers given by bank i
R^i	–	Required reserves held by bank i
IB^i	–	Domestic interbank deposits given by bank i
D^i	–	Deposits from customers in bank i
e_j	–	Exchange rate (kwacha/dollars), j Є spot, forward
F_j^i	–	Net international lending by bank i,
Kw_f^i	–	Net Kwacha-position forward of bank i
C^i	–	Bank i's liquidity position with central bank
W^i	–	Equity capital of bank i
$Cost^i$	–	Cost of running bank i
K_j^i	–	unit cost from activity J at bank i, J Є Deposits, Loans
r_J^i	–	interest rate on J at bank i, J Є Deposits, Loans
r_J	–	Market interest rates,
		J Є Deposits, Loans, Foreign, InterBank, Central Bank, Reserves
	–	Variable for banking sector constructed through deletion of the hyphen i

Box 2: Developing the inverted demand equations

As the development of equations from (3') to (3) and from (4') to (4) is identical, only L^i-developed here.

(3') $L^i = L^{Di}(r_L^i, r_L, Z)$ (- , +)

Sector average interest rate found as average:

$$L\cdot(1+r_L) = \sum_i L^i\cdot(1+r_L^i) \quad => \quad r_L = \sum_i r_L^i L^i / \sum_i L^i$$

Assuming that banks behave as if own interest does not influence sector average rates:

$$\varepsilon_L^i = (\delta L^{Di}(r_L^i, r_L, Z)/\delta r_L^i)\cdot r_L^i/L^i \quad < 0$$

Technical assumption (needed in the aggregation) $\varepsilon_L^i = \varepsilon_L^i$ for all i

As (by assumption) banks loan demand decreases with the banks own offered interest rate, the loan demand equation is invertible, i.e.

(3) $r_L^i = r_L^i(L^i, r_L, Z)$ with $\varepsilon_L^i < 0$ and similarly

(4) $r_D^i = r_D^i(D^i, r_D, Z)$ with $\varepsilon_D^i > 0$

Box 3: Maximize profit for bank i:

Replacing for Ri and Ci through restrictions yields:

$$\text{Max } \Pi^i = L^i \cdot r_L^i(\cdot) + \xi_R \cdot D^i \cdot r_R + IB^i \cdot r_{Bi} -$$

$$J \in \{D^i, L^i, R^i, IB^i, F_f^i,\}$$

$$- D^i \cdot r_D^i(\cdot) + e_f^i \cdot F_f^i - e_s \cdot F_f^i/(1+r_F)$$

$$- r_C \cdot (L^i + \xi_R \cdot D^i + IB^i - D^i$$

$$- e_s F_f^i/(1+r_F) - W^i - (\kappa_L^i \cdot L^i + \kappa_D^i \cdot D^i))$$

$$\{ L^i, R^i, W^i, D^i \geq 0 \}$$

Optimum conditions found by setting partial derivatives equal to zero:

$$\partial\Pi^i/\partial B^i = r_{Bi} - r_C = 0 \qquad => \qquad r_{Bi} = r_C$$

$$\partial\Pi^i/\partial F_f^i = e_f^i - e_s/(1+r_F) - r_C \cdot (-e_s/(1+r_F)) = 0 \qquad => \qquad e_f^i = e_s \cdot (1+r_C)/(1+r_F)$$

$$\partial\Pi^i/\partial L^i = r_L^i(\cdot) + L^i \cdot \partial r_L^i/\partial L^i - r_C - \kappa_L^i = 0 \qquad => \qquad r_L^i = \alpha_L \cdot [r_C + \kappa_L^i]$$

$$\partial\Pi^i/\partial D^i = \xi_R \cdot r_R - r_D^i(\cdot) - D^i \cdot \partial r_D^i/\partial D^i - r_C \cdot (\xi_R - 1) - \kappa_D^i = 0 \qquad => \qquad r_D^i = \alpha_D \cdot [r_C - \xi_R \cdot (r_C - r_R) - \kappa_D^i]$$

Here these simplifying parameters are introduced:

$\alpha_L = 1 / [1 + (L^i/r_L^i(\cdot)) \cdot (\partial r_L^i/\partial L^i)]$ or $\alpha_L = 1 / [1 + \varepsilon_L^i]$ and it follows that $\alpha_L > 1$

$\alpha_D = 1 / [1 + (D^i/r_D^i(\cdot)) \cdot (\partial r_D^i/\partial D^i)]$ or $\alpha_D = 1 / [1 + \varepsilon_D^i]$ and it follows that $\alpha_D < 1$

Box 4: The model for the banking sector

The equations for the balance sheets of bank of the banking sector are:

(a) $L + R = D + e_s F_s + C + W$

(b) $Kw_f = e_f \cdot F_f$

The reserve equation and the price equations of the liquidity markets are

(c) $R = \xi_R \cdot D$

(d) $r_B = r_C$

(e) $e_f = e_s \cdot (1+r_C)/(1+r_F)$

The price equations of the customer markets are

(f) $r_L = \alpha_L \cdot [r_C + \kappa_L]$

(g) $r_D = \alpha_D \cdot [r_C - \xi_R \cdot (r_C - r_R) - \kappa_D]$

CHAPTER SEVEN

Employment Creation Potential in the Bee-keeping Sector of Zambian Economy

*Syed Ali**

Abstract

The study was conducted in Kapiri-Mposhi district of Central Province in February and March 2015 using multi-stage random sampling technique to select the beneficiaries. Cost and Revenue method was used to determine the net income or profit and employment was measured as the number of days worked in the beekeeping activity. The study revealed that the beekeeping sector of the Zambian economy has potential to create employment, generate income and reduce poverty. The net profit per litre was K17.86. The income to investment ratio was higher, i.e., 3.64:1; the cost-output ratio was lower, i.e., 0.20:1 and the employment to investment ratio was higher, i.e., 0.84:1. The study suggests that the banks and micro finance institutions should provide credit to the beekeepers to improve productivity. Since the beekeeping sector had the potential to absorb the unemployed, the government, at all levels, should provide necessary infrastructure, like transport facilities and enabling environment like market information. The study also recommends establishing an Accredited Certifying Institute to certify the national honey standards for getting premium price in the international and national markets.

1. Introduction

Total global unemployment in 2014 was 199.4 million and the total unemployment rate was 5.9 percent (ILO, 2015). The current structure of the Zambian economy and sources of growth are such that formal wage jobs are being created slowly. This pace is nowhere close to being able to absorb the new cohorts of youth that are entering the labor market. Unemployment in Zambia is an issue, but afflicting mainly the urban youth (World Bank, 2013a). The unemployment rate is highest for youth who have completed senior secondary education, perhaps explained by the fact that better educated youth, especially in urban areas, have more resources and can afford to be unemployed while waiting for opportunities in wage employment (Guarcello et.al, 2012). Jobs are also important for the psychological well-being of people and social cohesion (World Bank, 2013b). Zambia is committed to planned socio-economic development of the country. The aim of Revised Sixth National Development Plan (2013-16) is to achieve the objectives of Vision 2030, that is, prosperous middle-income. Zambia's bee products sector has potential to contribute to income generation and employment creation and also to supplement other economic activities in the rural and urban settings. The Zambian honey sector has a highly developed institutional framework with many actors, government bodies, private sector companies and non-

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governmental organizations while key actors include the Zambia Honey Council whose key mandate is to co-ordinate the sector with the private sector is the key driver for developments in the sector (SNV, 2010).

A study by Zambia Honey Council (2010) revealed that Northwestern province is the leading honey producer in the country; other significant producers of honey are the Copperbelt and Eastern provinces. Most beekeepers appeared not to be deriving the maximum benefits from the honey industry due to lack of knowledge about the honey markets. Beekeepers lack the regulatory framework cost guide and often beekeepers are paid less for their products. Beekeepers often lack means of transporting their honey to the urban markets and lack knowledge about modern honey production techniques. Beekeeping has potential to improve economic, social and health status of rural people if theoretical and practical training can be conducted (Kumar, et.al., 2010). Beekeeping is one of the best practices that has been recognized to improve livelihood of poor farming communities without much investment cost (Baptist and Punduhewa, 1983). Zambia has thousands of hectares of Brachystegia wood lands, which provide an excellent source of nectar for bees, so that in most seasons bees can be depended upon to give a surplus of honey (Mickels-Kokwe, 2006).

Zambia is a traditional beekeeping country. It has immense potential to increase production. Presently, the national domestic demand alone is between 100-150 tons per annum, which has never been met. It is therefore imperative that the beekeeping industry be developed to levels where the domestic demand is met and surplus produced for export. The domestic demand for bee wax is large though most wax is exported, thus serving as an important source of foreign exchange for the nation (ZFAP, 1997).

The main markets for bee products continue to be United Kingdom (55%), Germany (35%), and South Africa (5%). Other markets (5%) have been Botswana, Libya, Tanzania and Zimbabwe. Honey and bee wax products have great market potential in Canada, Middle East, Japan and U.S (SNV, 2010).

Despite the conducive environment for beekeeping in Zambia to provide employment opportunities, reduce poverty levels and earn foreign exchange, the sector faces a number of constraints. These include: poor statistics on the size and structure of the sector; lack of policies and a regulatory frame work to guide stakeholders on forest resource use. The other challenges are: management of bees and handling of bee products; lack of national honey standards, lack of competition amongst input providers and traders. Poor infrastructure and transport facilities; lack of collaboration between stakeholders and lack of market information and entrepreneur skills are the main concerns of Zambian beekeeping sector. Beekeepers are, therefore, not able to locate input and credit providers, find buyers and negotiate fair prices (Husselman, 2008).

The rest of the paper is organised as follows: section 2 address the importance of the study while section 3 presents the methodology used for the study; section 4 deals with data analysis and discusses the results while the conclusion and recommendations are presented in section 5.

2. Importance of the Study

Employment creation and income generation are essential for poverty eradication. Zambia is a capital poor country. There is, therefore, need to develop those activities which require less capital but create more employment and income. Beekeeping activity needs less capital, but has the capacity to create more employment and generate more income for poverty reduction in rural areas. But the beekeeping sector in Zambia faces many challenges relating to infrastructure, investment, technology, marketing, finance, etc. (CIFOR, 2008). This

study is important in finding out the potential of beekeeping activity in creating employment and generating income in the Kapiri-Mposhi district of Central Province in Zambia and suggests policy measures. This study fills the gap in the existing literature on the potential of beekeeping activity in employment creation and income generation in the rural areas. The specific objectives of this study are to:

1. Understand the socio-economic conditions of the beekeepers.
2. Find out the type of plants/cultivated crops which can offer fodder to honey bees.
3. Investigate the type of technology used in bee production.
4. Assess the sources of cost of honey production.
5. Find out the sources of revenue, net income, and investment to income ratio.
6. Research the employment creation potential, employment to investment ratio and income to employment ratio in beekeeping activity.
7. Examine the sources of credit for beekeeping activity.

3. Methodology

This study used multi-stage stratified random sampling technique for selecting the sample. There are six agricultural blocks in Kapiri-Mposhi district. They are: Mulungushi, Changondo, Chipepo, Lounchu, Lukanga and Nkole. In the first stage, out of these six blocks, Mulungushi Block was selected for this study due to higher number of bee keepers (about 40%). The Mulungushi Block consists of six agricultural camps. These include Imansa, Kakulu, Luanshimba, Lukanda, Kaunga and Kambosha. In the second stage, out of these six camps, two camps, namely, Lukanda and Luanshimba, were selected due to higher number of bee keepers. In the third stage, a total of 128 bee keeping households were selected, 82 from Lukanda and 46 from Luanshimba. The required data were collected through questionnaire and interview with the respondents. The information was collected in February/March 2015 for the recent bee keeping season, i.e., September to December, 2014. Data were analysed by using simple percentages and averages. Costs and revenue analysis was used to measure profitability or net income. Employment was measured as the number of days worked in the bee keeping activity.

The traditional technology includes fixed comb-hives and the modern technology used was movable frame hives, top bar hives, smokers and protective cloth in honey production. The sources of cost of production of honey were technology cost, imputed value of family labour, cost of hired labour, cost of empty containers and transport. The imputed value of family labour was measured on par with the hired labour. The sources of revenue include the value of quantity of honey and bee wax sold. To measure income to investment ratio, the net income was divided by the total cost. To calculate employment to investment ratio, number of man-days of employment created was divided by the cost of production. Income to employment ratio was measured by dividing the net income with the number of man-days of employment created. The sources of credit for beekeeping activity were taken as banks, micro finance institutions, co-operatives, relatives and friends.

4. Data Analysis and Discussion

4.1 Socio-economic conditions of beekeepers

Table 1 shows the socio-economic conditions of beekeepers.

Table 1: Socio-economic conditions of beekeepers

Distribution	Value	Percentage
Mean age of beekeepers (years)	43.4	-
Gender:		
(a) Male	106	82.81
(b) Female	22	17.19
(c) Total	128	100.00
Marital Status:		
(a) Married	119	92.96
(b) Un-married	04	3.12
(c) Divorced	02	1.56
(d) Widow	03	2.36
(e) Total	128	100.00
Main Occupation:		
(a) Agriculture	125	97.65
(b) Beekeeping	03	2.35
(c) Total	128	100.00
Subsidiary Occupation:		
(a) Agriculture	03	2.35
(b) Beekeeping	125	97.65
(c) Total	128	100.00
Average Land ownership (hectares)	13	-
Level of Education		
(a) Illiterate	20	15.62
(b) Primary	46	35.93
(c) Secondary	52	40.62
(d) Tertiary	10	7.83
(e) Total	128	100.00
Training in Beekeeping (days)	1.52	-
Experience in Beekeeping (years)	5.58	-

Source: Primary data

The total number of beekeepers was 128 and their mean age was 43.4 years. The age distribution of the beekeepers shows that 3.12 percent were between 15-24 years, 21.87 percent between 25-35 years; 58.6 percent between 36-60 years and 16.41 percent above 60 years. 82.81 percent were men and only 17.19 percent were female. This implies that majority of beekeepers were above middle age and beekeeping is a male dominated sector. These findings were similar to Ajao and Oladimeji (2013); Babatude et. al (2007); Ebojet et.al., (2008) Chale et.al., (2013); and SNV (2010). 92.96 percent were married, 3.12 percent were not married, 1.56 percent were divorced and 2.36 percent were widows. The main occupation of the beekeepers was agriculture (97.65%). They were taking beekeeping activity as subsidiary occupation. The average land ownership of the beekeepers was 13 hectares. It is interesting to know that majority of beekeepers studied up to secondary level (40.62%). The mean days of training in beekeeping were 1.52 and experience in beekeeping activity was 5.58 years.

4.2 Type of Plants or Cultivated crops which can offer fodder to Honey Bees

Table 2 shows the type of plants or cultivated crops of beekeepers, which can offer fodder to honey bees.

Table 2: Types of plants/cultivated crops of Beekeepers, which can offer fodder to honey bees

Details of Plants/Cultivated Crops	Number of Beekeepers	Percentage
Maize	121	94.53
Sunflower	92	71.87
Tomato	120	93.75
Banana	114	89.10
Coffee	0	0
Mango	127	99.25

Table 2 shows that 94.53 percent beekeepers were having access to maize, 71.87 percent to sunflower, 93.75 percent to tomatoes and 99.25 percent to mango trees for offering fodder to honey bees. Thus, there was an excellent source of nectar for bees so that in most seasons bees can be depended upon to give a surplus of honey. These results support the study by Mickels–Kokwe (2006).

4.3 Technology used in Honey Production

Table 3 shows the technology used in Bee production.

Table 3: Technology used in Bee Production

Details of Technology	No. of Bee keepers	Percentage
Traditional (Fixed Comb-hives)	89	69.53
Modern (Movable Frame hives, Top bar hives, Smokers and Protective Cloth)	03	2.35
Both	36	28.12
Total	**128**	**100**

The traditional technology (fixed comb-hives) was used by 69.53 percent beekeepers and the modern technology was used by only 2.35 percent beekeepers. Both traditional and modern technology was used by 28.12 percent beekeepers for producing honey. The capacity to produce honey can be increased by using modern technology like movable frame hives, top bar hives, smokers and protective cloth.

4.4 Cost of Production of Honey

Table 4 shows the cost of production of honey.

Table 4: Cost of Production of Honey

Details of cost of production	Amount (Kwacha)	Percentage
Technology Cost	12.81	7.27
Family Labour (Imputed)	87.50	49.65
Hired Labour	31.32	17.78
Other Cost (empty containers and transportation)	44.57	25.30
Total Cost	176.20	100.00
Cost per litre	4.90	-

The total cost of producing 35.94 litres of honey was K176.20. The cost per litre production of honey was K4.90 only. Half of the total cost (49.65%) was due to family labour. The family labour was imputed on par with the hired labour. The hired labour cost was only 17.78 percent, as most of the work was done by the family labour. The technology cost was the lowest because in Lukanda Camp area all the farmers were using traditional technology, i.e., fixed comb-hives and in Luanshimba Camp area the beekeepers were supplied freely, both types of techniques, by a Non-government Organisation. Hence, the technology cost was zero in this camp area. The other cost includes purchase of empty containers and transportation of honey to the road side in Lukanda, as the road is far from the village. The beekeeping activity was providing more employment to family members than hired labour and their share in total cost of production of honey was about 50 percent.

4.5 Sources of Revenue, Net income and Net Income to investment Ratio

Table 5 shows the sources of revenue, net income and income to investment ratio of the beekeepers.

Table 5: Sources of Revenue, Net income and Income to Investment ratio of the Beekeepers

Source	Quantity Sold in Litres	Price per litre (Kwacha)	Revenue in Kwacha	Net Income in Kwacha	Net Income per Litre	Net income to Investment Ratio	Cost-Output Ratio
Honey	35.94	22.76	817.99	641.79	17.86	3.64	0.20
Beeswax	-	-	-	-	-	-	-
Total	**35.94**	**22.76**	**817.99**	**641.79**	**17.86**	**3.64**	**0.20**

Source: Primary data

The total revenue from the sales of honey was K817.99. The beekeepers are not benefited from bee wax. Bee wax also offers opportunities as an export by-product whose potential remains unexploited. The development of bee wax and other by-products' markets would significantly increase the economic benefits. This result was consistent with SNV (2010) which pointed out that bee wax offers opportunities as an export by-product whose potential remains unexploited and the development of bee wax and other by-products' markets would significantly increase the economic benefits from the sector. All the beekeepers sold honey in the village and road side only. They were unable to sell in the towns due to transportation problems. This finding is synonymous with the study by CIFOR (2008). The average net income of the beekeepers was K641.79 and the net income per litre sale of honey was K17.86 (cost per litre being K4.90). The net income to investment ratio was K3.64. It means increase in cost of production by one kwacha leads to increase in net income by K3.64. The cost –output ratio was K0.20, which means increase in cost of production by one kwacha leads to increase in output by K0.20. The cost-output ratio was computed by dividing the quantity of honey produced and sold (i.e., 34.94 litres) by total cost of production of honey (i.e., K176.20).

4.6 Employment Creation

Table 6 shows employment creation in beekeeping activity.

Table 6: Employment Creation in Beekeeping Activity

Details	Employment (Man-days)	Percentage	Employment to Investment Ratio	Income to Employment Ratio
Beekeepers	78.74	52.98		
Family labour	61.07	41.10		
Hired labour	8.80	5.92		
Total	**148.61**	**100.00**	**0.84**	**4.32**

Source: Primary data

The total employment created in beekeeping activity was 148.61 man-days. The percentage of employment creation for beekeepers was 78.74 man-days (52.98%), for family labour 61.07 man-days (41.10%) and for hired labour 8.80 man-days (5.92%) only. The employment to investment ratio was 0.84, which means one kwacha investment in beekeeping creates 0.84 man-days of employment. The employment to investment ratio was generated by dividing the man-days of employment generated (i.e., 148.61) with the total cost of production/investment (i.e., K176.20). Income to employment ratio was 4.32, which means increase in employment by one man-day leads to increase in net income by K4.32. The income to employment ratio was generated by dividing the net income (i.e., K641.79) with man-days of employment generated (i.e., 148.61).

4.7 Sources of Credit to Beekeepers

Table 7 shows the sources of credit to beekeepers.

Table 7: Sources of Credit to Beekeepers

Source	Amount	Percentage
Banks	-	-
Micro Finance	-	-
Co-operatives	22.26	11.26
Relatives/Friends	175.35	88.74
Total	**197.61**	**100**

Source: Primary data

The sources of credit to the beekeepers ware co-operatives and relatives or friends. The total credit from these sources was K197.61. The credit from relatives or friends was K175.35 (88.74%) and from co-operatives it was K22.36 (11.26%). There was no role for banks and micro finance institutions in providing credit to the beekeepers. A similar result was observed by Ajao and Oladimeji (2013); Ebojei et.al., (2008); SNV (2010); ZHC (2010) and CIFOR (2008). The implications of these findings were that the beekeeping sector was ignored by the financial institutions and there was need for providing loan to the beekeepers to use modern techniques of production to increase honey production which could increase their income to eradicate poverty in the rural areas.

4.8 Challenges of Beekeeping Activity

Table 8 shows the challenges of beekeeping activity.

Table 8: Challenges of Beekeeping Activity

Details of Challenge	No. of Respondents	Percentage
Lack of beekeeping knowledge	53	41.40
Financial Constraints	127	99.21
Transportation problem	112	87.50
Total	**128**	**100**

Source: Primary data

Out of 128 respondents, 41.40 percent were lacking beekeeping knowledge, 99.21 percent were having financial constraints and 87.50 percent were having transportation problems to take honey to town or roadside for selling. These results were consistent with the study by CIFOR (2008); ZHC (2010) and SNV (2010). The implications of these findings are that the beekeepers could not use modern techniques of honey production due to lack of knowledge and financial constraints and could not have access to markets due to transportation problems which resulted in getting lower price. Training could be given to beekeepers through the government and non-government organizations to enhance honey production. Interventions aimed at addressing the financial constraints through the provision of credit and enhancing transportation infrastructure can also help in improving productivity and incomes in the beekeeping sector.

5. Conclusion and Recommendations

The impact of beekeeping activity on employment and income was positive. The income to investment ratio was higher and the cost-output ratio was lower. The employment to investment and income to employment ratios were higher. But the bee keepers were facing the problems of transportation, finance and access to market.

To address these challenges, it is recommended that the banks and micro finance institutions should consider providing credit to the bee keepers. The government, at all levels, should also endeavour to stimulate bee keepers to boost honey production by providing infrastructure like transport facilities and enabling environment like access to market. In addition, the government should establish an Accredited Certifying Institute to certify the national honey standards for getting premium price in the international and national markets.

References

Ajao, A.M & Oladimeji, Y.U (2013): Assessment of Contribution of Apiculture practices to Household income and poverty alleviation in Kwara State, Nigeria; International Journal of Science and Nature, Vol. 4 (4) 2013, pp.687-698.

Babatude, R.O; Olorunsanya; Omotesho, O.A and Alao, IB.I (2007): Economics of Honey Production in Nigeria. Implications for Poverty Reduction and Rural Development, GAEP, 3 (2), PP. 23-29.

Baptist, B.A; and Punchihewa, R.K.W (1983): A Preliminary Analysis of the Principal Factors which will affect apiary Honey Production in Sri Lanka, in K.N. Mahrotra; M.G. Jotwani, T.P. Sriharan; B. Subramanyam, P.J. Rao, D.S. Bisht and M. Naim (eds): Second International Conference on Apiculture in Tropical climate, Indian Agricultural Research Institute, New Delhi, India, pp. 87-99.

Chala, K., Taiye, T and Kebede, D (2013): Assessment of Honey Production and Marketing System in Gomma District, South Western Ethiopia, Green Journal of Business and Management Studies, 3 (3), pp. 99-100.

CIFOR (Center For International Forestry Research) (2008): "Bee Keeping in Zambia", February, 2008, No. 7, Lusaka, Zambia

Ebojei, G.O; Alamu, J.F and Adeniji, O.B (2008) Assessment of the contributions of Beekeeping
Extension Society to the Income of Bee farmers in Kudama State.

Guarcello et.al (2012) Youth Disadvantage in the Labour Market: Empirical Evidence from Nine Developing Countries. Background Paper for the Education for All Global Monitoring Report 2012. UNESCO, Paris.

Holmes, W.D (1964): Bark-hive Beekeeping in Zambia, Forest Development Bulletin ZA; Revised by G.M. Zulu, 1970, Government printer, Lusaka, p.23.

Husselman, M (2008):" Beekeeping in Zambia", Center for International Forestry Research, February 2008; No. 7, CIFOR, Lusaka, Zambia.

International Labor Organization (ILO) (2015): Global Employment Trends for Youth 2015, Scaling up investment in decent jobs for youth, ILO, Geneva, p. 79.

Kumar, J; Sharma, S; Lal, R (2010): "Beekeeping: A lucrative rural enterprise", Science Tech Entrepreneur, March 2010, p.5

Mickels-Kokwe, G (2006): Small scale woodland-based Enterprises with outstanding economic Potential- The case of honey in Zambia, Bogor, Indonesia, Center for International Forestry Research.

Sichinga, Robert (2014):"Honey big Revenue Earner", Daily Mail, Nov. 28, 2014, Online edition
SNV (2010): Enhancing the competitiveness of the Zambian Agriculture Industry: Honey Value Chain Development; SNV Netherlands Development Organisation, Capacity Development Services for Apiculture in Zambia.

World Bank (2013): World Development Report 2013, Jobs, Washington D.C.

World Bank (2013a): Zambia's Jobs Challenge, Realities on the ground, the World Bank, Washington D.C, USA, October, 2013, Issue 2.

World Bank (2013b): World Development Report 2013, Jobs, Washington D.C.

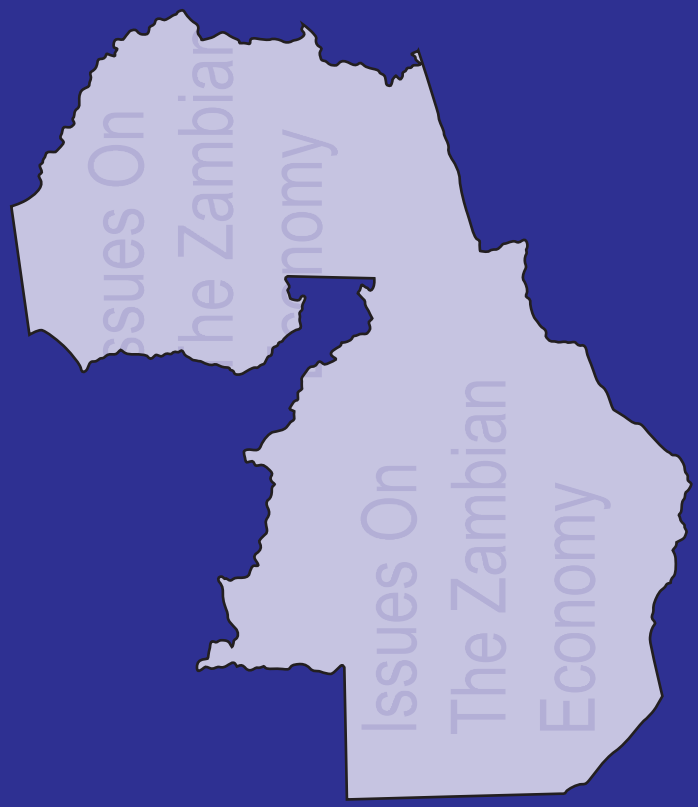
Zambia Forestry Action Plan (ZFAP) (1997): Challenges and opportunities for Development: Ministry of Environment and Natural Resources, ZFAP, GRZ, 1998.

Zambia Honey Council (ZHC) (2010): Report on the Zambia Honey Sector, 2010, Lusaka.

Issues On The Zambian Economy

Bank of Zambia

Vol.02, No. 01, 2015



ISBN 968-9983-870-32-0