

# Sectoral effects of Monetary Policy in Uganda: A DSGE Analysis

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## **Abstract**

The paper investigates the sectoral effects of monetary policy in Uganda. While focusing on the agricultural and industrial sectors, we examine the effect of a positive interest rate shock, while taking care of the effect of exogenous exchange rate shocks on real output. The analysis is based on a Dynamic Stochastic General Equilibrium (DSGE) model. The empirical findings suggest that the agricultural and industrial sectors are negatively affected by positive interest rate shocks. A similar effect is realized with a positive exogenous exchange rate shock. Since the Bank of Uganda (BoU) is pursuing an Inflation Targeting policy framework, raising interest rates to fight inflation would invariably hurt sectoral growth, as demonstrated by the findings of the analysis. To minimize the negative impact on growth, monetary policy requires a broader view of policy objectives, with greater priority accorded to output growth, alongside the control of inflation. This can be done by ensuring that authorities put in place alternative financing options, targeted at priority sectors. Further, authorities should ensure policies geared towards increasing the supply of foreign exchange, so as to reduce the negative impact associated with exchange rate risks on domestic production, and create long-term capacity to boost production.

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**Keywords:** Monetary Policy; sectoral growth; DSGE; Uganda

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## 1. Introduction

Over the past two decades, Uganda's economy recorded impressive growth rates averaging 7 percent per annum. This sustained growth trajectory however changed during the post global financial crisis period. Specifically, average growth has decelerated to about 4.7 percent during the past five years, hitting lows of 3.4 percent in 2011/12. The impressive pre-crisis growth was achieved in a large part due to a robust macroeconomic management strategy that focused on price stability as the anchor for real sector performance. However, recent developments, including inflation spikes in 2011, have led to pursuance of a more restrictive monetary policy which could have implications on private investment and growth through high interest rates.

Evidence suggests that a restrictive monetary policy mitigates aggregate demand which has negative implications for private investment and growth (Prasand and Zhang, 2015). Indeed, there is emerging evidence linking Uganda's recent weak domestic growth to the restrictive monetary policy regime (MFPED, 2015 and BOU, 2015). Consequently, the extent of the impact of monetary policy on growth is of concern among policy makers. Particularly, the channels through which the monetary policy impulse is transmitted to the productive sectors of the economy has been a subject of intense debate (Prasand and Zhang, 2015).

The literature shows that, monetary policy may have adverse effects on sectoral growth and consequently on the entire economy and that; different sectors of the economy react differently to monetary policy shocks (Serju, 2003 and Nampewo, 2013). For the case of Uganda, as is clearly stated in the National Development Plan, emphasis is put on developing agriculture and industry as the primary growth sectors that will steer the economic transformation of Uganda's economy (NDP-2 2015).

The agricultural sector provides the most employment opportunities and takes-up the largest share of the consumption basket in Uganda. About 67 percent of Uganda's population is employed in the agricultural sector. In terms of the consumption basket, about 45 percent of the entire consumption expenditure is related to agricultural products. Besides, about 50 percent of Uganda's exports are agricultural in nature (BOU, 2015). The industrial sector although it remains relatively underdeveloped, it is critical for value addition of Uganda's agricultural exports and hence is important for boosting Uganda's tradable sector. The

services sector on the otherhand, is majorly non-tradable with minimal potential to boost Uganda's exports. Also, the services sector employs a small number of skilled workers and thus, is not necessarily employment intensive.

The primary objective of monetary policy is ensuring price stability. However, it is also concerned about growth, especially for the primary growth sectors of the economy. Thus, empirical evidence on how these sectors react to monetary policy shocks is relevant for policy direction. Against this background, this study examines the sectoral effects of monetary policy in Uganda. In particular, the study focuses on the two productive sectors; namely: agriculture and industry. The analysis uses the Dynamic Stochastic General Equilibrium (DSGE) modelling framework to test the differentiated impacts of monetary policy on sectoral growth. The study also accounts for the effect of a positive exogenous exchange rate shock on the sectors. Results suggest that a positive interest rate shock results into a decline in output for agriculture and industry sectors. A similar effect is realized with a positive exogenous exchange rate shock.

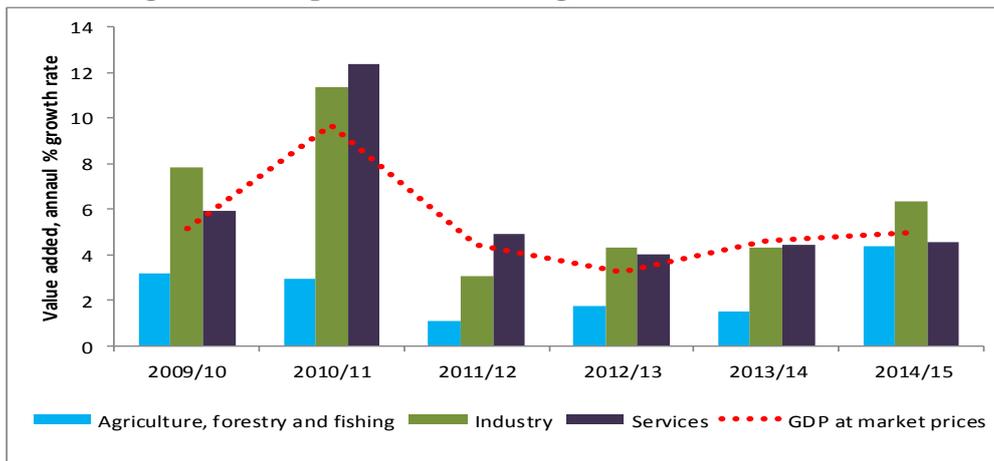
The rest of the paper is organised as follows: section 2 examines the structure of Uganda's economy and monetary policy; section 3 reviews the related literature, section 4 explores the model, section 5 reveals the results, while conclusions and policy considerations are presented in sections 6.

## **2. Structure of Uganda's Economy and Monetary Policy**

### **2.1. Structure of Uganda's Economy**

Uganda's economic growth has mainly been driven by the services sector over the past decades. The sector contributes about 50 percent of Uganda's GDP. The expansion of the services sector has been majorly driven by innovation and technology, mainly due to developments in the banking, telecommunication, and transport sub sectors (UBOS 2015). The downside is that most of the activities within the sector and, in particular, telecommunications, finance and real estate are not employment intensive and instead rely on a relatively small number of skilled workers. Besides, the sector is majorly non-tradable with minimal potential to boost Uganda's exports. Figure 1 summaries the structure of Uganda's economy.

**Figure 1: The performance of Uganda's economic sectors**



Source: Uganda Bureau of Statistics, statistical abstract, 2015

The agricultural sector includes the production of both cash and food crops, livestock, forestry agriculture-related services, and fishing. The sector contributes about 24 percent of Uganda's GDP. Whereas its contribution to GDP has been declining over time, the sector remains the main employer of Uganda's population. About 67 percent of Uganda's population is employed in the agricultural sector. Besides, the sector remains critical in driving Uganda's export base. About 50 percent of Uganda's export originate from the agricultural sector. In terms of the consumption basket, about 45 percent of the entire consumption expenditure is related to agricultural products. This keeps the sector at the forefront of accelerating Uganda's economy to attain the middle income status. This notwithstanding, the sector is still constrained with several factors of which high cost of credit emerges as the most binding constraint (NDP-2,2015).

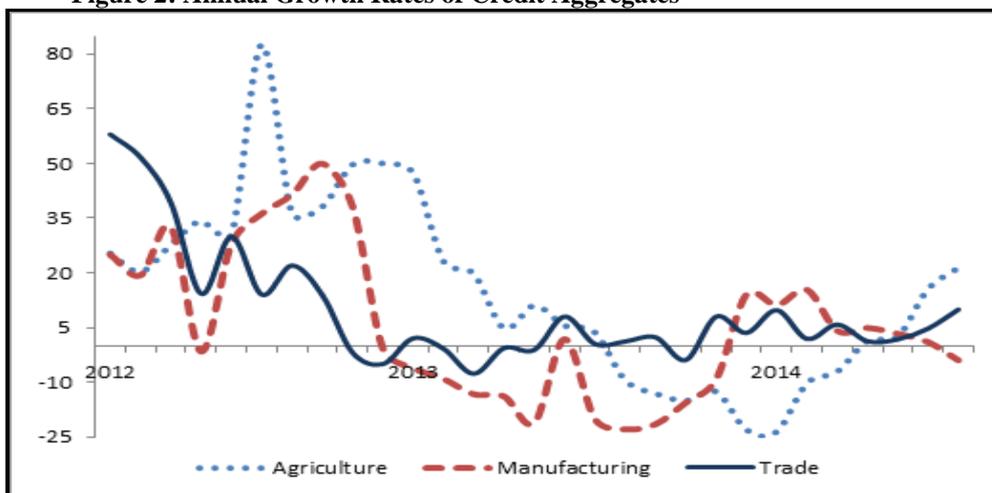
The industry sector includes, mining, manufacturing, electricity, water and construction. The sector remains relatively small and is dominated by subsidiaries of multi-national corporations, and heavy investment by foreign companies in sectors such as textiles, steel mills, tannery, bottling and brewing and cement factories. Small- and medium-scale enterprises in the sector account for over 90 per cent of enterprises (NDP-2,2015). The most important sectors are the processing of agricultural products (such as coffee), the manufacture of light consumer goods, and the production of beverages, electricity, and cement which largely depend on domestic sources of financing of which credit from the financial sector is important. The sector contributes about 19 percent to Uganda's GDP (UBOS 2015). Although the sector employs only 9 percent of Uganda's population, it remains at the centre

of transforming Uganda's agricultural primary exports by ensuring value addition and hence boosting Uganda's tradable sector.

### Monetary policy and growth

Uganda is currently implementing an inflation targeting framework, while maintaining a floating exchange rate regime, where BOU's involvement in the foreign exchange market is limited to occasional interventions to dampen excessive exchange rate volatility. This monetary policy framework has been successful in ensuring price stability as evidenced in the declining trend of inflation from highs of 30 percent in 2011 to the 5 percent BOU's medium term target (BOU, 2015 and MFPED, 2015). However, this has been achieved at a cost of high interest rates which have constrained credit growth across most sectors, including agriculture and manufacturing (figure 2).

Figure 2: Annual Growth Rates of Credit Aggregates



Source: Bank of Uganda, monetary survey, 2015

In addition, the floating exchange rate system has, nonetheless, presented certain difficulties for the country including, the heightened risk of exchange rate volatility which is disruptive to investment and economic activity (Aghion et al., 2009). For instance, in the 2013/14 and 2014/15 fiscal years, Uganda experienced a positive shock in the exchange rate which saw the Ugandan Shilling depreciating by 22 and 27 percent, respectively, against the US dollar. This was the biggest shock on Uganda's economy since the global financial crisis. This shock could be associated with the decelerated growth rates during this period.

### **3. Review of related literature**

#### **3.1. Empirical literature**

A large body of empirical work has employed fundamentals-based models in modeling the transmission mechanism of monetary policy on real growth (Kashyap and Stein, 2000; Angeloni et al, 2003; Monacelli, 2003; Ireland, 2005; Mugume, 2011). Most of these studies document that indeed monetary policy affects real growth. Notwithstanding this evidence, most studies tend to focus only on the effects of monetary policy at the aggregate level without necessarily analysing the sectoral effects of monetary policy, particularly in developing countries. A few studies that focused on the sectoral effects of monetary policy confirm that monetary policy has effects on sectoral growth.

Sahinoz and Cosar (2009) investigated the response of output in the Turkish manufacturing sector to a contractionary monetary policy shock. Their findings showed that the manufacturing sector responds to a restrictive monetary policy with a decrease in overall output of the sector. Similarly, Mehdi and Reza (2011) used the auto regressive distributed lag (ARDL) model to establish the effect of monetary policy on Iran's industrial sector. Their results also indicated that monetary policy affects Iran's industrial sector. Nampewo et al, (2013) analysed the sectoral effects of monetary policy in Uganda using a structural vector autoregressive model. Their findings indicate that a restrictive monetary policy affects growth of the agriculture, manufacturing and services sectors. Ifeakachukwu and Olufemi (2012) arrived at a similar conclusion.

A large body of empirical literature has assessed the impact of external shocks on the monetary policy transmission mechanism. The literature focusing on the impact of exchange rate shocks on the transmission mechanism and on growth indicates that the exchange rate risk is detrimental to growth (Mirdala, 2012; Arratibel, et al., 2011; Chipili, 2010). For instance, Bergin, (2004) and Obstfeld and Rogoff, (1998) argue that risks associated with exchange rate fluctuations introduce uncertainty which in turn generates negative economic welfare effects. Further, fluctuations in the exchange rate affect consumer goods prices which in turn affect demand and consequently consumption. They add that monetary policy is affected by currency fluctuations especially where domestic growth is underpinned by exports as authorities attempt to support the external sector through exchange rate stabilization at the expense of inflation stabilization (Crosby, 2000).

In the recent decades, analysis of monetary policy transmission mechanism has shifted from the econometric models to dynamic stochastic general equilibrium models (DSGE). Boivin, (2010), notes that DSGE models tend to incorporate relatively few sources of uncertainty compared to econometric models such as the vector autoregressive models and the autoregressive distributed lag models. This implies that DSGE models are structural in nature and that all the model's predictions can be traced back to assumptions about the structure of the economy, agent's preferences, production technology and the stochastic processes driving the shocks in the model. He further, notes that DSGE models are useful in capturing the effects of external shocks in small open economies. Empirical analysis of monetary policy effects at the sector-level using DSGE frameworks remains scarce.

The only study by Cardia and Murcia (2004) that used a DSGE model to analyze the transmission of monetary policy in a multi-sector economy, focused on the US which is a developed country and thus, not comparable to a developing countries like Uganda. Nonetheless, their results reveal a strong sensitivity to monetary policy shocks on sectoral output growth, particularly, construction and manufacturing sectors. The current study assesses the sectoral effects of monetary policy in Uganda based on a DSGE framework

### **3.2. Theoretical literature**

The theory of the monetary policy transmission mechanism stipulates the channels through which monetary policy shocks are transmitted to the decisions of firms, households, financial intermediaries, prices and economic growth (Mishkin 2004). The literature highlights four transmission channels of monetary policy. These include the exchange rate channel, the credit channel, the asset prices or wealth channels and the interest rate channel.

For the asset price channel, a tight monetary policy results into a rise in asset prices leading to an increase in the market value of firms and in the investment expenditure. A similar effect is realised with the wealth channel as an increase in asset prices leads to a rise in the financial wealth of consumers. This results into an increase in the life time resources of consumers which in turn increase the consumption expenditures of households (Mishkin, 1996). The asset price and wealth channels are irrelevant in most developing countries including Uganda due to small or underdeveloped stock markets (Mishra, Montiel, and Spilimbergo, 2014).

The credit channel comprises two channels: the bank-lending channel and the balance-sheet channel. The bank-lending channel is based on the assumption that a contractionary monetary policy reduces bank reserves and bank deposits and thus constrains the quantity of bank loans available to borrowers. This ultimately reduces private investment and output (Taylor, 1999). The balance-sheet channel is related to the effects monetary policy can exert on the net worth of businesses and households. A monetary contraction decreases the net worth of a firm through its cash flows and the value of its collateral, thus leading to a higher external finance premium associated with more severe moral hazard problems. This in turn would reduce the level of lending, investment, and output (Bernanke and Gertler, 1995).

In small, open economies like Uganda, the effects of monetary policy on the exchange rate are pronounced through the exchange rate channel. The theory of uncovered interest rate parity suggests that the expected shifts in the nominal exchange rate are related to the interest rate differential between the domestic and foreign interest rate. During a monetary policy tightening, domestic interest rates increase relative to the foreign interest rates. This results into a currency appreciation which causes a rise in net imports and a fall in output. The reverse is true for an expansionary monetary policy. However, as highlighted by Kasekende and Brownbridge, (2011), economies which are predominantly driven by imports may be negatively affected by unanticipated positive shocks in the exchange rate. This argument is supported by Obstfeld and Rogoff, (1998) who note that exchange rate risks affect consumer goods prices which in turn affect demand and consequently consumption.

Regarding the interest rate channel, the monetary authorities directly influence the official interest rates, which in turn alters; the money market rates, aggregate spending by increasing or decreasing investment and consumption expenditures, and thus affect output growth. Given some degree of price stickiness, a policy induced increase in the short-term nominal interest rates initially increases the longer-term nominal interest rates, in line with the expectations hypothesis of the term structure. This, in turn, translates into an increase in the real interest rate as prices are slow to adjust. Because firms face increased real cost of borrowing, they cut back on their investment expenditures. Similarly, households scale-back on their expenditures and consequently aggregate demand and inflation falls. For countries like Uganda which are implementing monetary policy in the context of an inflation-targeting framework, the interest rate channel is relevant since they use short-term money market

interest rates to influence the level of retail deposit and lending interest rates and eventually growth.

#### **4. Set-up of the DSGE model**

Our model setup comprises of the following sectors; 1) the household, 2) the firm 3) the central bank which is in charge of monetary policy and 4) the external sector. We assume that the economy is populated by households and by firms. The households supply labour to the firms and earn a wage, a portion of which is either consumed or saved for future consumption. The household aims to maximise its utility subject to a budget constraint which depends on the household's income and expenditure patterns. The firms, on the other hand, specialise in either agriculture or industry sectors and are assumed to use the labour supplied by the household. The firms face adjustment costs related to output loss associated with changes in the prices.

We include a monetary policy Taylor rule which reflects the actions of the monetary authority to adjust policy rates in relation to inflation and output movements of the sectors and thus influencing the firms and the household's consumption and expenditure patterns. A positive shock to the short-term interest rate (the central bank rate) is expected to lead to a rise in the domestic real interest rates. This, in turn, may increase the cost of borrowing hence forcing households to cut back on their consumption and other expenditures including investment. The result is a constrained aggregate supply leading to positive inflationary pressures and negative output growth.

Uganda is a small open economy and so is vulnerable to external shocks. Although the exchange rate channel of monetary policy transmission shows a positive response of output to an exchange rate depreciation through increased export competitiveness, this rather may happen in the long-run given that most developing countries including Uganda depend on imported inputs for production. Thus, risks associated with exchange rate shocks may be detrimental to growth in the short-run. Unlike in the econometric models that consider the exchange rate as an endogenous variable, in our DSGE model, we introduce an exchange rate shock as a purely exogenous variable that hits the economy from the external sector as opposed to a policy induced exchange rate reaction to a monetary policy shock. The layout of our DSGE model is as follows.

#### 4.1. Household

The economy is populated by infinitely lived households who supply labour to firms in two sectors: the agricultural sector and the industry sector. We assume that the household's labour supply is immobile across the sectors. The representative household, denoted by the superscript  $i$ , is indexed by  $A$  (agricultural sector) and  $I$  (the industry sector). The household maximises the discounted stream of utility as follows:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t [U(C_t^i, L_t^i)] \quad (1)$$

Where  $\beta^t$  is a constant discount factor;  $C_t^i$  is the composite consumption index and  $L_t^i$  is the leisure time by household. The household's utility function is defined as follows:

$$U(C_t^i, L_t^i) = \frac{C_t^{i1-\sigma}}{1-\sigma} - \eta_t \frac{L_t^{i1+\gamma}}{1+\gamma}; \quad (2)$$

Where;  $i \in \{A, I\}$

$\sigma$  is the inverse of elasticity of intertemporal substitution;  $\eta_t$  is the preference shock and  $\gamma$  is the inverse of Frisch elasticity of labour supply. The consumption index is defined as follows:

$$C_t^i = \prod_{j=1}^J (\xi^j)^{\frac{1}{\xi}} (C_t^j)^{\xi} \quad (3)$$

Where  $C_t^j$  represents the households consumption of goods produced in sector  $j$  where  $j = (A \text{ and } I)$  and  $\xi \in (0, 1)$  is the sectoral weights in the consumption index and  $\sum_{j=1}^J \xi^j = 1$

We assume that firms in both sectors produce differentiated products, which implies that

$$C_t^j = \left( \int_0^1 (C_t^{lj})^{\frac{\phi-1}{\phi}} dl \right)^{\frac{\phi}{\phi-1}} \quad (4)$$

Where  $C_t^{lj}$  is the household's consumption of the good produced by firm  $l$  in sector  $j$  and  $\phi > 1$  is the elasticity of substitution between differentiated goods within a sector.

The household's labour supply  $L_t^i$ ; is aggregate hours supplied to each firm in each sector and is defined in equation 5.  $\phi > 0$  is the elasticity of substitution between sectoral hours.  $L_t^j$ , is the number of hours worked in sector  $j$ .

$$L_t^i = \left( \sum_{j=1}^J (L_t^j)^{\frac{\phi-1}{\phi}} \right)^{\frac{\phi}{\phi-1}} \quad (5)$$

It then follows from equation 5 that the total number of hours worked in firm  $l$  in sector  $j$  is,  $L_t^{lj}$ , defined follows:

$$L_t^{lj} = \int_0^1 l_t^{lj} dl \quad (6)$$

#### 4.1.1 The household budget constraint

We assume that the household has accumulated savings ( $b_{t-1}$ ) from the previous period and that the household also earns a wage  $W_t$  from labour supplied to the firm. The household uses this income to finance its consumption and saving for the future in the form of bonds. The household aims to maximise its utility subject to a budget constraint which depends on the household's income and expenditure patterns as shown below:

$$\sum_{j=1}^J \int_0^1 \left( \frac{p_t^{lj} c_t^{lj}}{p_t^i} \right) dl + b_t = \sum_{j=1}^J \int_0^1 \left( \frac{L_t^{lj} W_t^{lj}}{p_t^i} \right) dl + \frac{r_{t-1} b_t}{\pi_t} \quad (7)$$

Where

$p_t^i = \prod_{j=1}^J (\zeta^j)^{\frac{1}{\zeta}} (p_t^j)^{\frac{\zeta-1}{\zeta}}$ ; is the aggregate price of all firms; and  $p_t^j = \left( \int_0^1 (p_t^{lj})^{\frac{\phi-1}{\phi}} dl \right)^{\frac{\phi}{\phi-1}}$  is the aggregate price of the sectors,  $j$  in firm  $l$

#### 4.2. Firm

Firms in the  $j$  sectors face a linear technology function in labour as follows:

$$Y_t^{lj} = A_t^{lj} \omega^j L_t^{lj} \alpha^j \quad (8)$$

Where  $Y_t^{lj}$  is the sectoral output for firm  $l$  in sector  $j$ ;  $A_t^{lj}$  is sector specific productivity shock; and  $L_t^{lj}$  is the sector specific labour supply;  $\omega^j, \alpha^j \in (0,1)$  and  $\omega^j + \alpha^j = 1$ .

We assume a firm that produces a homogenous intermediate good using labour supplied by the household. The intermediate-goods firm faces adjustment costs related to output loss associated with changes in the price of the intermediate good. Thus, introducing nominal price rigidities, we assume that the firm faces a cost when changing prices. The cost is represented by a quadratic form following the Calvo (1983) pricing theory as follows:

$$\theta_p \left( \frac{P_t^{lj}}{P_{t-1}^{lj}} \right)^\varepsilon D_{p,t-1} + (1 - \theta_p) \left( \frac{P_t^{lj*}}{P_{t-1}^{lj}} \right)^{-\varepsilon} \quad (9)$$

Where  $\theta_p \in (0,1)$  is the proportion of firms that do not adjust prices in each period. The other proportion of firms chooses the optimal price that maximizes their discounted future profits:

$$\max E_0 \sum_{t=r}^{\infty} \beta \theta^r \left( \frac{C_t^i}{P_{t+r}} \right)^{-\sigma} [P_t^{lj} - MC_{t+r}^{lj}] Y_{t+r}^{lj} \quad (10)$$

Where MC denotes the marginal cost of production in nominal terms

### 4.3. Monetary policy rule

We introduce a monetary policy Taylor rule based on a simple inflation targeting rule as follows:

$$r_t = \vartheta r_{t-1}^\gamma (\pi_t^\tau Y_t^\psi)^{1-\gamma} \epsilon^{\vartheta t} \quad (11)$$

Where  $\pi$  and  $Y$  are the steady state values of inflation and the output gap, respectively.  $\vartheta$  represents the central banker's preference for interest rate smoothing.  $\tau$  and  $\psi$  are the weights assigned by the central banker to react to the deviations of inflation and output from their steady state levels and to shocks. To capture the effect of the recent positive shock in the exchange rate on Uganda's economy, we include an exchange rate equation based on the uncovered interest rate parity from which we generate the shock as follows:

$$s_t = \Gamma(r_t - r_t^*) + \Theta s_{t+1} + \epsilon_s \quad (12)$$

where  $s$  is the real exchange rate;  $r$  is the domestic real interest rate;  $r_t^*$  is the foreign interest rate.

### 4.4. Exogenous shock process

We assume that the monetary policy shock ( $z$ ) and the exchange rate shock ( $s$ ) are exogenous shocks that follows an AR (1) process with its innovations drawn from normal distributions as defined in the equation. The monetary policy shock is defined as an interest rate shock arising from changes in the policy rate, the central bank rate, which is managed by the central bank. The exchange rate shock is defined as changes in the real exchange rate. A positive shock in the exchange rate is a depreciation while a negative shock is an appreciation.

$$\text{Monetary policy shock} \quad z_t = \rho_z(z_{t-1}) + \epsilon_{zt} \quad \epsilon_z = N(0, \delta_z^2) \quad (13)$$

$$\text{Exchange rate shock} \quad s_t = \rho_s(s_{t-1}) + \epsilon_{st} \quad \epsilon_s = N(0, \delta_s^2) \quad (14)$$

### 4.6. Calibration

Selection of calibration parameters for DSGE models is a challenging task (Clarida, Gali, and Gertler, 1998) as there appears to be no clear consensus on the values of some parameters and those used in the literature are mostly based on micro data from advanced countries. Thus the

selection of our calibration parameters has closely followed the parameters used by Adam and Walker (2015) and Prasad and Zhang (2015) who have developed DSGE models for East Africa and developing countries. We have also referred to Ugandan data to generate other parameters especially on sectoral shares to overall output and on labour. The parameters used in our model are presented in appendix 1.

We choose  $\beta^t = 0.99$  which amounts to a real interest rate of 4 percent per annum. We set the inverse of elasticity of intertemporal substitution to 2 i.e.,  $\sigma = 2$ , following Prasad and Zhang, (2015). We assume that 45 percent of total expenditure by households is accounted for by the agricultural related consumption and about 24 percent is for industry, based on estimates on Ugandan data (UBOS, 2015). Thus, for the agricultural sector,  $\xi_A = 0.45$  and  $\xi_I = 0.24$  for industry. We set  $\varphi = 10$  the elasticity of substitution for the differentiated good within a sector. The inverse of the Frisch elasticity of labour supply ( $\gamma$ ) is set to 10, implying an inelastic labour supply consistent with the estimates of Adam and Walker (2015) for East African countries. We set the number of households working in the agricultural sector,  $\omega$ , to 0.67 so as better to reflect the structure of Uganda's economy which is majorly agricultural based. We follow the Calvo pricing theory which assumes,  $\theta_p^{ij} = 0.66$  as a probability of not changing prices in each sector (Adam and Walker, 2015; Prasad and Zhang, 2015).

For monetary policy and exchange rate parameters, we follow (Adam and Walker, 2015; Clarida, Gali, and Gertler, 1998), and set  $\vartheta = 0.75$  and  $\tau = 1.5$ ; .These parameters are consistent with estimates on Uganda based on the Taylor rule. We set the persistence of the monetary policy shock to 0.8 implying a fairly persistent shock. We recalibrate the model for different parameters of consumption time preference, intertemporal substitutability, and labour supply elasticity to the respective values of 0.97, 2.5 and 20. This was done as robustness check for the calibrated parameters.

#### **4.7. Simulations**

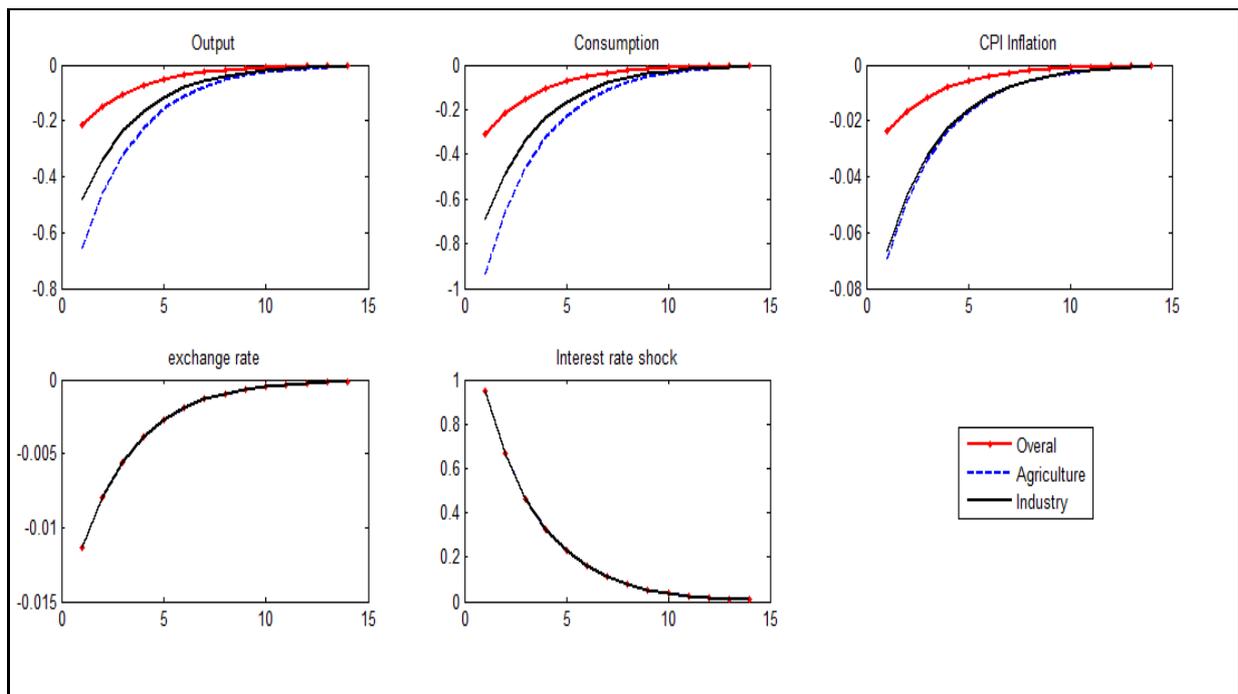
Using parameters calibrated to reflect the key features of Uganda's economy, we simulate the calibrated model over 15 quarters to assess the impact of a tight monetary policy on sectoral and overall growth. We conduct positive interest rate (tight monetary policy) and exogenous exchange rate shocks and compare the impact of the shock on agriculture, industry and on overall growth.

## 5. Impulse Response Functions

### Effect of a tight monetary policy (positive interest rate shock)

In this section we consider the effect of a monetary policy tightening where the Bank of Uganda raises its short-term policy rate. The solid red line gives the response of overall output growth. The solid black line shows the response of the agricultural sector, while, the blue dotted line shows the response of the industry sector. The results seem to indicate that all sectors react as expected to a positive monetary policy shock. The increase in the policy rate leads to an appreciation of the exchange rate and a fall in inflation. At the same time, the nominal interest rates increase which results into a decrease in the consumption expenditure and aggregate demand for both the agriculture and industry sectors. Consequently, an overall decline in sectoral and output is realised (Figure 3). The results are consistent with the findings based on the econometric models including the structural VAR model that was used by Nampewo et al 2013 and the autogressive model that was used by Mehdi and Reza (2011).

**Figure 3: Effect of a positive interest rate shock**

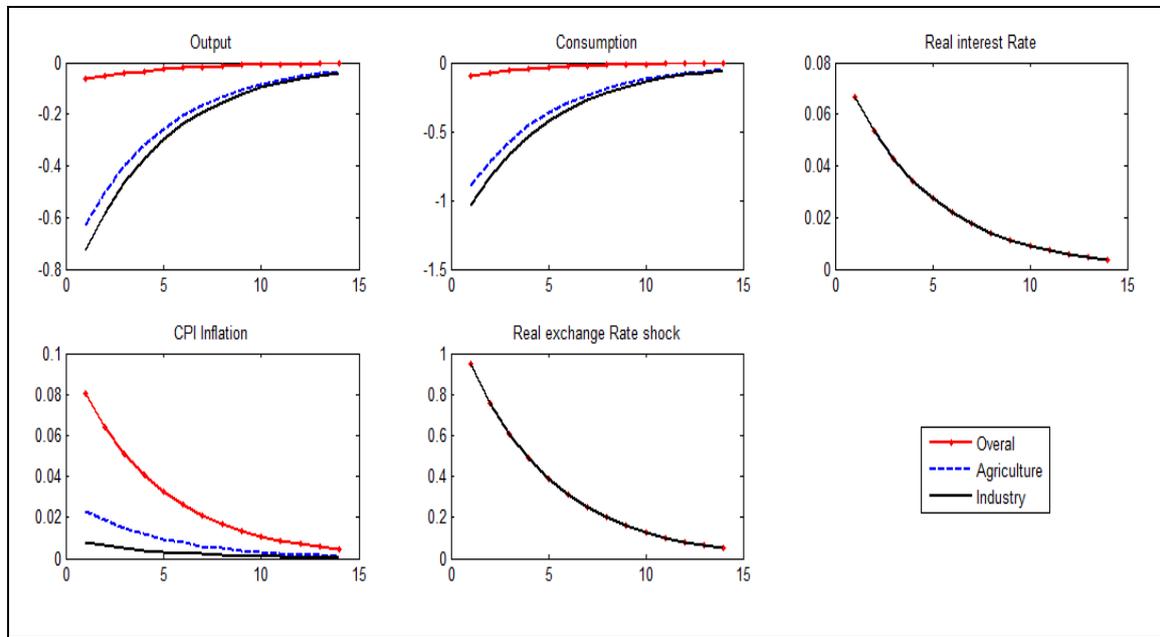


### Effect of a positive exogenous exchange rate shock

The effect of an exogenous positive exchange rate shock presented in figure 4 differs from the conventional exchange rate channel. In this case, an exogenous positive exchange rate shock results in increases in inflation which pushes monetary authorities to react by

increasing interest rates. The rise in interest rates reduces aggregate demand, leading to a fall in sectoral and overall output.

**Figure 4: Effect of a positive exchange rate shock**



The results in figure 5 seem to indicate that positive shocks in the exchange rate hurt the economy in the short-run. The agricultural sector which contributes over 50 percent of Uganda’s exports still faces structural issues that have negatively contributed to the growth of its exports which would have benefited from an immediate shock in the exchange rate leading to a depreciation. Besides, the sector also relies on imported inputs for production which is adversely affected by an exchange rate depreciation due the implied increased cost of doing business. Regarding the effects on the industrial sector, the Bank of Uganda indicates that manufacturing firms are among the largest users of foreign exchange in Uganda thus, a depreciation will make inputs into manufacturing more expensive (Tumusiime-Mutebile, 2015) hence affecting sectoral output which eventually feeds into overall output.

## 6. Conclusion and policy implications

### Conclusion

The paper investigates the sectoral effects of monetary policy in Uganda. While focusing on the agricultural and industrial sectors, we investigate the effect of a tight monetary policy, while taking care of exchange rate shocks on real output. The analysis based on a dynamic stochastic general equilibrium (DSGE) framework reveals that a tight monetary policy

(positive interest rate shock) negatively affects sectoral output growth for agriculture and industry sectors. A similar effect is realized with a positive exogenous exchange rate shock.

### **Policy implications**

The empirical findings suggest that the agricultural and industrial sectors are negatively affected by high-interest rates and positive exchange rate shocks. Since the Bank of Uganda (BoU) is pursuing an Inflation Targeting policy framework, raising interest rates to fight inflation would invariably hurt sectoral growth, as demonstrated by the findings of the analysis. To minimize the negative impact on growth, monetary policy requires a broader view of policy objectives, with greater priority accorded to output growth and development objectives such as employment, alongside the control of inflation. This can be done by ensuring that authorities put in place alternative financing options, targeted at priority sectors. However, the authorities should be mindful of the unintended consequences of these financing options on inflation and other economic variables in the short term.

In addition, authorities should ensure policies geared towards increasing the supply of foreign exchange, so as to reduce the negative impact associated with exchange rate risks on domestic production. This includes increasing production for export, increase in foreign market access, and promoting increased local demand for substitutes of imported consumer and investment goods and services.

### **Suggestions for Further Research**

Most developing countries, including Uganda are in the process of changing their monetary policy frameworks from monetary targeting to inflation targeting frameworks. This warrants a comprehensive re-examination of the monetary transmission mechanism for all the relevant channels.

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## Appendix1: Calibration parameter values

|                      |  |           |
|----------------------|--|-----------|
| $\beta$              | Discount factor  | 0.99      |
| $\sigma$             | Inverse of elasticity of intertemporal substitution                | 2         |
| $\xi_A$              | Weight of agriculture in consumption index                         | 0.45      |
| $\xi_I$              | Weight of Industry in consumption index                            | 0.24      |
| $\varphi$            | Elasticity of substitution for differentiated good within a sector | 10        |
| $\gamma$             | Inverse of the Frisch elasticity of labour supply                  | 10        |
| $\omega$             | Share of households working in the Agricultural sector             | 0.67      |
| $\alpha$             | Share of households working in the Industry sector                 | 0.12      |
| $\theta$             | Calvo sticky-price parameter                                       | 0.66      |
| $\varepsilon$        | Elasticity of substitution between different varieties             | 11        |
| $\vartheta$          | Degree of interest rate smoothing                                  | 0.75      |
| $\tau$               | Degree of response to inflation                                    | 1.5       |
| $\psi$               | Degree of response to the output gap                               | 0.125     |
| $\Theta$             | Degree of response to the expected exchange rates                  | 0.65      |
| $\Gamma$             | Degree of response to the interest rate differential               | 0.35      |
| $\rho_z, \delta_z^2$ | Monetary policy shocks: persistence, std. dev.                     | 0.8, 0.95 |
| $\rho_s, \delta_s^2$ | Exchange rate shocks: persistence, std. dev.                       | 0.8, 0.95 |

## Appendix 2: Equilibrium Conditions of the DSGE Model

### The household

The household budget constraint

$$\sum_{j=1}^j \int_0^1 \left( \frac{p_t^{lj} C_t^{lj}}{p_t^l} \right) dl + b_t = \sum_{j=1}^j \int_0^1 \left( \frac{L_t^{lj} W_t^{lj}}{p_t^l} \right) dl + \frac{r_{t-1} b_t}{\pi_t} \quad (14)$$

Households' intertemporal Euler equation

$$C_t^{lj-\sigma} = \beta E_t \left( \frac{r_t}{\pi_{t+1}} C_{t+1}^{lj-\sigma} \right) \quad (15)$$

Household's optimal labour supply decision

$$\omega_{j,t} = \phi_j C_t^{lj\sigma} L_t^{lj\psi} \quad (16)$$

### The firm

Cost minimisation for the firms in both sectors

$$\omega_{j,t} = x_{H,t} A_{H,t} \quad (17)$$

Output in the sectors

$$Y_{H,t} = \varrho A_{H,j} L_t^j \quad (18)$$

Optimal price-setting in the sticky price sector

$$\left( \frac{1-\theta_j^{\varepsilon-1}}{1-\theta} \right)^{\frac{1}{1-\varepsilon}} = \frac{\Gamma}{E} \quad (19)$$

Recursive formulation of  $\Gamma$

$$\Gamma_t = \frac{\varepsilon}{\varepsilon-1} C_t^{j-\sigma} Y_{j,t} \frac{\omega_{j,t}}{A_{j,t}} + \beta \theta E_t \pi_{j,t+1}^{\varepsilon} \Gamma_{t+1} \quad (20)$$

Recursive formulation of  $E$

$$E_t = x_{j,t} C_t^{j-\sigma} Y_{j,t} + \beta \theta E_t \pi_{j,t+1}^{\varepsilon-1} E_{t+1} \quad (21)$$

### Aggregation for the economy

Aggregate consumption

$$C_t = \lambda C_t^A + (1-\lambda) C_t^I \quad (22)$$

Aggregate output

$$Y_t = x_{A,t} Y_t^A + x_{I,t} Y_t^I \quad (23)$$

Aggregate price index for each sector

$$p_t^j = \left( \int_0^1 (p_t^{lj})^{\frac{\varphi-1}{\varphi}} dl \right)^{\frac{\varphi}{\varphi-1}} \quad (24)$$

Aggregate price for all firms

$$p_t^i = \prod_{j=1}^j (\zeta^j)^{\frac{1}{\zeta}} (p_t^j)^{\frac{\zeta-1}{\zeta}} \quad (25)$$

The definition of the real exchange rate:

$$rexrt = \frac{s_t}{s_{t-1}\pi_t} \quad (26)$$

**Monetary policy rule**

$$\log\left(\frac{r_t}{R^*}\right) = \log\left(\frac{r_{t-1}}{R^*}\right) + (1-\gamma)\left[\phi_\pi \log\frac{\pi_t}{\pi^*} + \phi_y \log\frac{y_t}{y^*}\right] \quad (27)$$

**The uncovered parity condition**

$$s_t = \Gamma(r_t - r_t^*) + \Theta s_{t+1} + \varepsilon_s \quad (28)$$

### Appendix 3: Effect of a monetary policy tightening

