FISCAL SUSTAINABILITY AND MONETARY POLICY IN UGANDA AND NEIGHBOURING COUNTRIES

A Dissertation

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Dedication

This Thesis is dedicated to my lovely mother Ms. Nancy Elsa Kateregga who has kept me strong and focused. She encouraged me throughout my studies.

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Abstract

The Fiscal sustainability of East African countries is examined by testing the governments' intertemporal budget constraint. We also examine the fiscal policy adjustments in the East African countries by use of both linear and non linear adjustments of the fiscal variables. The non-linear model adjustments are conditioned on both the budgetary deficit and the phase of the economic cycle. Results show that Tanzania has the best fiscal sustainability plan while the rest of the East African countries do not reflect a sustainable fiscal policy path. Uganda does not show any evidence of long run relationships in its fiscal variables. It also has no statistical significance of error correction or response of taxes to economic changes. We then analyze the Ugandan economy by determining the effect of monetary policy on inflation and output growth. We use the Cash-in-Advance model as well as vector auto regression models for comparison purposes. The impulse response functions show that the CIA, Bayesian and Structural VAR follow same path and give similar conclusion of behavior of the macroeconomic variables. Overall the models imply that the expected inflation effect dominates the output response to an expansionary monetary shock.

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List of Acronyms

ADF	Augmented Dickey-Fuller
CIA	Cash in advance
CBR	Central Bank Rate
CPI	Consumer Price Index
DSGE	Dynamic Stochastic General Equilibrium
EAC	East African Community
ECF	External Credit Facility
GDP	Gross Domestic Product
GIPS	Greece, Ireland, Portugal, Spain
GVC	Global Value Chain
IBC	Intertemporal Budget Constraint
IMF	International monetary Fund
KPSS	Kwiatkowski–Phillips–Schmidt–Shin
MTEF	Medium Term Expenditure Framework
NPV	Net Present Value
PAC	Portfolio Adjustment Costs
PVBC	Present Value Budget Constraint
RBC	Real Business Cycle
VAR	Vector autoregression

Chapter I: Introduction

1.1 Background Information

Developed and developing countries have both experienced financial crises. The respective financial crises were different in origin and solution but most importantly indicate a lax in the Economic policy regulation in both cases. Most Economies focused more on globalization, liberalization, privatization and the free market to stabilize and sustain their economies. The economies relied less on government intervention and regulations and more on the market economy for allocation of goods and services. As a result debt was piling up for both developed and developing economies. For the developed economies the debt was predominantly domestic while to developing and mostly African countries it was external debt and this debt was also partially used to finance the budget. The excessive and unregulated contraction of debt led to financial disasters in both cases. There were several debt relief initiatives due to failure to service debt for some East African countries. This also triggered an unsustainable fiscal policy path and a reduction in external sustainability in these economies.

Fiscal policy broadly involves the government spending and taxation to influence the domestic demand of an economy. Some of the targets of economic stability, economic growth and poverty reduction in the various economies can be met through a well-designed fiscal policy initiative. Depending on the status

of the economies, fiscal policy basically is about a fiscal expansion and/or a fiscal contraction. When the economy is in a boom then fiscal policy usually aims to contract to maintain the economy and in a recession the fiscal policy is more likely to go for expansion through increasing government expenditure and cutting of taxes.

We will focus on Uganda and its neighboring countries in the fiscal policy sustainability analysis. Fiscal policy authorities in the EAC partner states namely Uganda, Kenya, Tanzania, Burundi and Rwanda should be alert about the importance of fiscal policies especially with plans to establish an EAC Common market and monetary union. Moreover the key foundations for a functioning common market should be free movement of capital, goods and services Gastorn (2016). It is important to verify that fiscal policies of individual countries are sustainable in order to protect them and others from external shocks. The European case is a good example of what can go wrong with a monetary union if not well prepared. The East African Economies need to be sustainable individually in order not to affect the stability of their counterparts as well as be able to self-sustain. All the countries mentioned other than Kenya, have been bailed out before from high debt burden which shows a possibility of weakness or a justification to check their fiscal policy strength. In addition because of the financial distress in developed economies, there is a

probability of unforeseen cuts in donors pledges and disbursements which would require increased social spending by Government and an increase in taxes. This necessitates that we check the sustainability of the public finances of the East African countries to avoid a crisis in the region at a later stage.

Fiscal policies of individual countries should be sustainable in order to protect them and others from external and domestic financial shocks. In addition a fiscal policy that is not sustainable in the long run will undermine the ability of the Central bank to maintain monetary stability. Moreover Fiscal policy alone will not ensure the macroeconomic stability needed in an economy. Also due to the ongoing financial sector development, there is more risk taking in financial product developments as was noted in the developed countries. So there is need for the governments to intervene in the operations of the economies. Also one of major concerns of countries categorized as still developing is high inflation and low growth; this is because high inflation and inflation expectations are known to impede the growth of economies. Such issues should be solved through macroeconomic stable policies. This therefore has shifted the focus of the global economies back to the fiscal and monetary policy operations in the economies.

Monetary policy is conducted by central banks in both developed and developing countries. Central banks in most countries have been mandated to include

financial stability in their roles especially after the financial crises and the central bank of Uganda has not been an exception. Overall the role of central banks has now widened to include financial and market stability. Basically the central bank carries out its main role of monetary policy through utilizing monetary targeting or Inflation targeting. The underlying assumption of monetary targeting is that there is a predictable relationship between money and prices. However, hoped-for relationships between the monetary aggregates and monetary policy goals have weakened over time Bowdler and Radia (2012). This is one of the reasons why central banks including Bank of Uganda have adopted the alternative inflation targeting. Inflation targeting can simply be defined as a monetary policy operating strategy with a commitment to price stability as the goal of monetary policy. It is important to note that inflation targeting too has its limitations in effectiveness and is generally successful in well-developed financial environments with a credible monitory authority. In retrospect a significant difference between monetary targeting and inflation targeting might dwindle with economies with high inflation expectations and low credibility of monetary authorities or even have no effect. Though the role of central banks has fundamentally widened and central banks have varied their monetary policy tools over time, the traditional role of maintaining output and prices still remains a core objective and is what we focus on in the monetary policy section of this paper.

Neither fiscal nor monetary policy can work in isolation to develop and stabilize an economy. As an example Bank of Japan also stated that monetary policy alone cannot get Japan out of deflation and proposed three arrows that would be of help namely monetary policy including a 2% inflation targeting, fiscal policy with a 10 trillion yen package and a structural policy of fiscal austerity and deregulation. Hausman (2014)

1.2 Fiscal Policy plan for EAC

With plans to establish the EAC common market and monetary union, It is important to verify that fiscal policies of EAC partner states namely Uganda, Kenya, Tanzania, Burundi and Rwanda are sustainable in order to protect them from external shocks as well as boost economic development and growth.

The Fiscal policy measures for these countries broadly involve reduction of tax exemptions and increase in taxes base with better efficiency in tax collection and regulation. The IMF also plays a very important role in boosting the fiscal policy stance like managing their fiscal deficits through several programs like ECF in Burundi that ensures debt sustainability and the MTEF in Kenya where budgeting has also been decentralized to the county governments who

share their individual budgets with the National Treasury. Specifically Tanzania has embarked on managing expenditure growth as well through improved expenditure and debt management. Rwanda's mainly includes tax restructuring and reformation of priority government expenditure focus. While Uganda is keen on debt sustainability measures and pursues expansionary fiscal policy measures focusing on infrastructure, Outlook (2014).

Table 1.1: Budget deficit and Tax Revenue as a percentage of GDP

Year	Uganda	Kenya	Tanzania	Rwanda	Burundi
Budget Deficit					
2011	4.3	4.5	6.4	2.4	8.7
2012	3.0	4.7	4.6	1.2	9.1
2013	2.6	4.8	5.8	5.1	2.0
Tax Revenue					
2011	16.1	20.1	13.9	13.1	14.9
2012	13.1	20.1	14.4	13.6	14.1
2013	13.4	20.5	14.6	14.2	13.7

In table 1.1 above on average Burundi has the highest budget deficit as a percentage of GDP while Rwanda has the lowest. Kenya has tax revenue of 20% on average as a percentage of GDP considering years 2011-2013, which is the highest in the region for that period.

The East African countries have got similar constraints with the landlocked countries being more disadvantaged. Some of the impediments hindering

consistent growth are high production costs especially due to poor transport and energy costs, weak policy frameworks, as well as low investments and low skilled labor. The financial system is also still developing with the financial sector largely dominated by the banking sectors.

Table 1.2: Sector contribution as a percentage of GDP

Sector	Uganda	Kenya	Tanzania	Rwanda	Burundi
Agriculture, hunting, forestry, fishing	24	30	29	36	39
Manufacturing	9	10	9	5	11
Construction	15	5	9	8	4
Finance, real estate and business services	8	12	10	16	16
Wholesale and retail trade, hotels and restaurants	24	13	16	16	8

Table 1.2[1] shows numbers as of 2012 and 2013 for Uganda, Kenya, Tanzania and Rwanda, Burundi respectively. Generally the East African countries are known and shown to have Agriculture as their main economic activity with over a fifth of their GDP coming from Agriculture related activities and over 80% of workforce employed in this sector. In table 1.2 we see approximate share of Agriculture being highest in Burundi followed by Tanzania. In comparison Uganda has the lowest share of Agriculture and finance related activities and highest share of construction and trade related activities. Growth in Construction was due to roads, bridges and non-residential building sub-sector.

[1] The figures in table 1.1 and 1.2 were got from the African Economic Review 2014.

1.3 Summary findings of Fiscal sustainability Analysis

In the fiscal sustainability analysis we examine the sustainability of the government's intertemporal budget constraint for East African countries and their fiscal reaction with a nonlinear model. We consider both linear and non-linear adjustments of the fiscal variables. The non-linear model adjustments are conditioned on both the budgetary disequilibria and the phase of the economic cycle. Our analysis provides insight into the fiscal policies of the individual East African countries. Budgetary error correction by means of tax adjustments seem to be the main fiscal policy instrument for Burundi and Rwanda. Tanzania utilizes both taxes and government expenditure depending on whether they are reacting to a fiscal deficit or economic cycle. Burundi takes on a countercyclical fiscal policy in the economic booms while the fiscal authorities of Rwanda are more sensitive to the size of the deficits as opposed to the economic cycles. Overall results show that Tanzania has the best fiscal sustainability plan and the rest of the East African countries do not reflect a sustainable fiscal policy path.

1.4 Monetary Policy in Uganda

Uganda is one of such countries where high inflation is one of the major economic concerns. The Central Bank of Uganda is the main institution tasked with making sure that inflation is contained, through monetary policy activities. Moreover with a weal fiscal policy stance and poor results from our fiscal sustainability analysis, it is important to verify the effect of monetary policy on the Ugandan economy. In 2011 Uganda took on inflation targeting as the monetary policy stance. Previously the monetary policy framework in Uganda was not strongly defined. It was in general used to finance government activities and regulating or directing the exchange rate with hope that theses will eventually stabilize the prices in the economy. This was not very effective in containing high inflation and maintaining overall growth in the economy. Hence since July 2011, the Central bank of Uganda took on setting monthly targets of the Central Bank Rate in a bid to introduce an inflation targeting monetary policy framework. The CBR and is used to guide the 7 day interbank interest rates. The Central Bank target inflation rate is 5% over the medium term. We note that the central bank rate was introduced following the commence of inflation targeting in Uganda.

We note however that undertaking the inflation targeting framework has not restricted other monetary tools operations by the Central Bank. In addition to

setting a CBR, the Central bank of Uganda will continue to regulate the supply of bank reserves among other things. Moreover in general Inflation targeting lite regimes are usually flexible hence include mixed operating targets and instruments like exchange rate, aggregate money, exchange rate intervention and emphasis on financial stability. The inflation targeting framework will serve as an introductory step towards inflation and growth projections in the economy and ensure they are consistent with money's neutrality in the long run. The central objective of monetary policy is therefore to establish a credible anchor for domestic prices which in general leads to stabilization of output and prices.

Figure 1.1: The Inflation rate and CBR

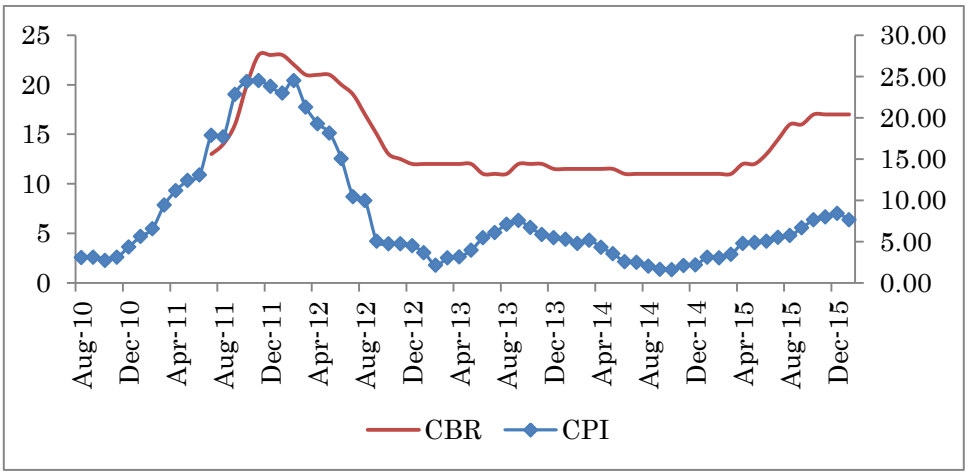
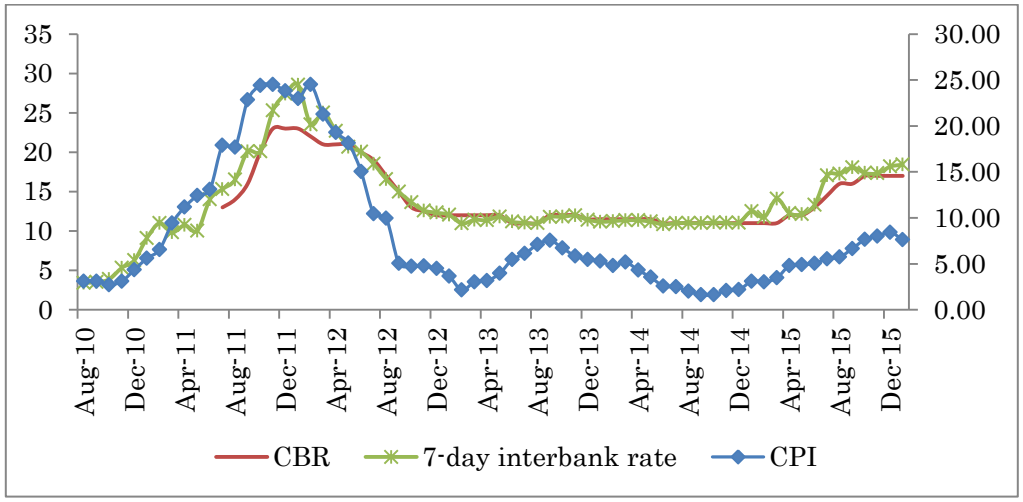
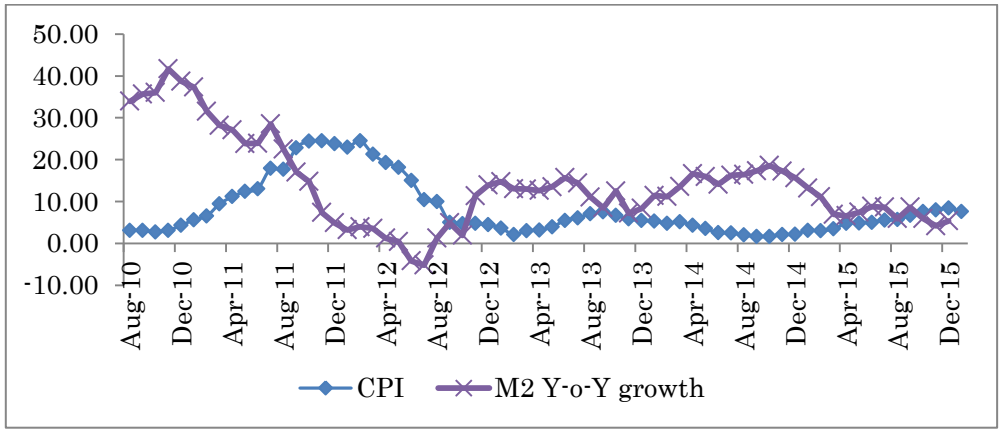


Figure 1.2: The Inflation rate and CBR and 7-day interbank rate



Figures 1.1 and 1.2 show the progression of the inflation rate with the Central Bank Rate and 7-day interbank rates. The graphs shows that since the CBR was introduced, the inflation rate seems to follow a similar path. The CBR also seems to be guiding the 7-day interbank rate as intended by the Monetary authority.

Figure 1.3: Annual Inflation rate and Money growth



From November 2010 to July 2012 we see a decline in money growth, while inflation increases from August 2010 till around March 2012 and begins to decline as money growth declines. The increase in inflation especially in 2011 even after introduction of inflation targeting framework was due to the excess liquidity due to additional budget spending by government as well as a deteriorating exchange rate. In addition inflationary expectations might have contributed further the rate escalation. After November 2012 we see a fairly stable inflation rate with a gradual increase from November 2014. The money growth rate has also decreased not exceeding 20% as in the previous regime before introduction of inflation targeting monetary policy framework.

1.5 Summary findings of Monetary Policy in Uganda

In this section we set out to determine the effect of a monetary shock on output growth and inflation of Uganda. We use a monetary Dynamic Stochastic General Equilibrium model specifically the Cash-in-advance model as well as vector auto regression models for comparison purposes. The Cash-in-advance (CIA) model allows us to determine the outcome given households have prior information on shocks, these results can also incorporate role of inflation expectations. The CIA model results showed that output growth turns out to be negative after a monetary shock. This implies the anticipated high inflation

effect dominates the response of output to the monetary shock. The Bayesian VAR estimated results were compared with the CIA model using the log data density where the Bayesian VAR had better results. The structural VAR imposes a long run restriction based on economic theory that money has no effect on output growth in long run. The impulse response functions show that the CIA, Bayesian and Structural VAR follow same path and give similar conclusion of behavior of the macro economic variables.

1.6 Organization of thesis

The next section will review various authors who attempted to analyze the fiscal sustainability and monetary policy in various countries as well as highlight the contribution of this paper. We shall also look at the theoretical framework for fiscal sustainability. Chapter III will show the Fiscal Policy Sustainability analysis of EAC countries, the linearity and non-linearity methodology and results. Chapter IV will deal with monetary policy in Uganda and its effect on growth and inflation. The CIA, Bayesian VAR and Structural VAR methodology will be used in this chapter and results discussed. We shall then conclude our analysis with some policy implications in chapter V.

Chapter II: Literature Review and Conceptual Framework

2.1 Literature review on fiscal policy

Although all the East African countries mentioned have Fiscal deficits most of the analysis on fiscal deficits that we are aware of is in form of individual country reports on fiscal deficits as well as on the determinants of the increase or improvement of the deficit. There is also a general convergence criterion in form of maintaining a fiscal deficit less than 2% including grants and less than 5% excluding grants. The East African countries strive to meet these conditions as a fiscal policy rule. There is no analysis on a fiscal sustainability plan for the fiscal policies in these countries. However, for some of the African countries like in West Africa, Oyeleke and Ajilore (2014) used the error correction approach to examine Nigeria's fiscal sustainability. They basically assumed a linear relationship between the macro economic variables of government taxes and expenditure. Oshikoya and Tarawalie (2010) applied the PVBC approach to analyze the concept of fiscal sustainability for the West African Monetary Zone countries. The analysis involved tests of stationarity and cointegration analysis whish are also based on a linear relationship of the annual data series they used on government expenditure, revenue and deficits. The results from this analysis gave similar results for Nigeria as that of Oyeleke and Ajilore (2014).

While in developed countries sustainability of the budget deficit has been tested using the intertemporal budget constraint of the government by different authors. Most of these authors use the condition that fiscal sustainability requires that the current market value of debt and the sum of expected future primary surpluses are equal. This analytical method is referred to as the Present Value Budget Constraint (PVBC) approach.

The pioneers of the PVBC approach Hamilton and Flavin (1986) analysed USA annual data from 1960 to 1984, they tested for stationarity of fiscal deficit and debt, where the US fiscal policy was found to be sustainable. To address the issue of whether fiscal policy in Spain was sustainable, Castro and Hernandez (2002) used the linear cointegration tests including structural breaks and annual data on revenue and expenditure from 1964 to 1998. They concluded that if Spain were to follow the pattern of past variables during that period in the future then its fiscal policy would remain sustainable.

Doi (2004) suggests that although cointegration among the variables is a necessary condition for the fiscal sustainability, fiscal sustainability is also maintained when the growth rate in nominal GDP is higher than the rate of increase in outstanding of nominal government bonds. This analysis was used for sustainability on government debt for the Japanese government debt data.

He also argued that testing of government debt gives more options for policy action. The result showed that the Japanese government bonds are not sustainable without changing the policy stance in the period under analysis which was annual data series from 1955-2000. The results showed that the Japanese government would face the severe fiscal situation in the near future.

In further analysis of the US economy Wilcox (1989) analysed the same data as in Hamilton and Flavin (1986), and his results were contrary to theirs. Although they used same procedure, the tests used in paper by Wilcox (1989) allowed for stochastic real interest rates and the real value of the discounted government debt.

As noted above, the majority of authors like in paper by Burret et al. (2013) who have researched on the issue of fiscal sustainability have employed linear cointegration tests to determine the sustainability paths of the economies in question. Relatively recent literature introduces the possibility of nonlinear adjustments in fiscal variables. In a paper written by Milas and Legrenzi (2013) on fiscal sustainability in GIPS, they use nonlinear models to determine fiscal policy adjustments. They focus on the state and cycle of the economy with state varying threshholds endogenously determined. In our research we shall use a similar approach with fixed threshholds.

2.2 Literature review on Monetary Policy analysis

Monetary business cycle models have been used to analyse the aggregate fluctuations of the US economy. Several authors like Nason and Cogley (1994) and Schorfheide (2000) have used these models to replicate fluctuations in the US economy. In both cases these models are combined with the structural VAR methods that imposes a nominal long run money neutrality assumption. While Schofield concentrated on the CIA and PAC monetary business cycle models, Nason and Cogley (1994) used four monetary business Cycle Models.

The results in paper by Nason and Cogley (1994) entitled 'Long-Run neutrality for Monetary Business Cycle Models' showed some evidence that nominal side dynamics could have been generated by the monetary business cycle models as opposed to the real side dynamics. There was evidence that response of inflation to real and nominal side shocks approximately matched the impulse responses. Schorfheide (2000) in the paper 'Loss Function-Based Evaluation of DSGE Models' found that the CIA model produces a better in-sample time series fit. Also in a paper with title 'Forecasting the Romanian GDP in the Long run using a Monetary DSGE' written by Caraiani (2009), a monetary DSGE model using Bayesian techniques was estimated. The DSGE model used was the one with

the Cash-in-advance constraint.

Christiano and Eichenbaum (1992) in the paper 'Liquidity Effects and the Monetary Transmission Mechanism' used general business cycle models and imply money shocks do affect interest rates exclusively through an anticipated inflation effect. In other wards higher inflation usually leads to lower output per person and lower output growth in the long run. This implies that the effect of a money supply shock will have conflicting conclusions to the conventional view on the permanent effect of monetary expansion on growth.

Most of the write ups on Monetary Policy in Uganda have been about the monetary policy transmission mechanisms and monetary policy tools. The authors have concentrated on issues like the effects of monetary policy on interest rates and exchange rates as in Atingi-Ego and Egesa (2008), in their paper addressing implications of Uganda's monetary policy instrument mix. Another paper was submitted to the Bank of England by same author Other papers by same author include 'Setting monetary policy instruments in Uganda' that concentrates on which tool is best for the monetary policy and the pass through effect to inflation and growth. He sets out to find whether the interest rate or money aggregates are best for monetary policy effects on the economy using Vector Auto regression analysis. Similarly in a paper by Adam (2009)

about 'The conduct of Monetary Policy in Uganda', he addressed the issues concerning the monetary policy tools and mechanisms and was in favor of the modification of monetary policy framework to inflation targeting. This view has since been adopted by the Central bank of Uganda.

This paper uses the Bayesian techniques and compares results with Svar that assumes long run neutrality of money. It does not deal with the monetary policy tools or transmission mechanism but seeks to determine the impact of a monetary shock to the economy. It basically uses a Bayesian econometric procedure to evaluate and compare the CIA model results. It is the only paper to the best of my knowledge to analyse the effect of monetary shocks on the Ugandan economy using the monetary business cycle models and Bayesian techniques. It also takes into account that these models can be misspecified and so a reference VAR model is introduced. This is the contribution that this paper brings to the analysis of monetary policy effect on Uganda's economy.

2.3 Conceptual Framework for fiscal sustainability Analysis

A basic description of fiscal sustainability that can be found in a paper by Milas and Legrenzi (2013) of the concept underlying fiscal sustainability analysis in this paper is written as follows.

One period nominal consolidated budget identity for the government sector is given by

$$G_t + i_{t-1}B_{t-1} = T_t + (B_t - B_{t-1})$$

$G_t$is the general government expenditure in nominal terms net of interest payments

$B_t$is the nominal stock of government bonds to the private sector

$T_t$is the nominal tax revenue

$i_{t-1}$is the nominal interest rate in the previous period

$i_{t-1}B_{t-1}$ is the interest payments on the outstanding debt. The implicit assumption is that debt matures in one period. The variables are converted to real terms by dividing through by nominal output Y_t

$$(G_t/Y_t) + (i_{t-1}B_{t-1}/Y_t)(Y_{t-1}/\ Y_{t-1}) = (T_t/\ Y_t) + (B_t/Y_t) - (B_{t-1}/Y_t)(Y_{t-1}/\ Y_{t-1})$$

After minor algebra and recalling that the term $Y_{t-1}/\ Y_t \equiv \frac{1}{[(1+\mu_t)(1+\pi_t)]}$ where $\pi_t$is the inflation rate and $\mu_t$is the GDP growth rate we obtain the following debt dynamics in real terms

$$b_t = g_t - t_t + (1 + \bar{r}_{t-1})b_{t-1}$$

And

$$\bar{r}_{t-1} \equiv \frac{1 + i_{t-1}}{[(1 + \mu_t)(1 + \pi_t)]} - 1 \cong i_{t-1} - \pi_t - \mu_t$$

Additionally we assume that $\bar{r}_{t-1} = r$ and is positive and constant overtime. By using recursive distribution of the variables, the public debt future path for an arbitrary sequence of future government spending and taxes is then given by:

$$E_t[b_{t+n}] = \sum_{j=0}^{n} (1 + r)^{n-j} E_t[g_{t+j}] - \sum_{j=0}^{n} (1 + r)^{n-j} E_t[t_{t+j}] + (1 + r)^n b_t^*$$

Where $b_t^*$is the debt at period t.

So we rearrange to make $b_t^*$the dependent variable and then assume the discounted sum converges and taking the limit for n→∞: As well as define the primary deficit $\Delta_t = g_t - t_t$

Hence the equation

$$b_t^* = -\sum_{j=0}^{\infty} (1 + r)^{-j} E_t[\Delta_{t+j}] + \lim_{n \to \infty} (1 + r)^{-n} E_t[b_{t+n}]$$

The IBC is met when the initial debt equals the expected present value of the future surpluses. An assumption of transversality condition on the IBC is

$\lim_{n \to \infty} (1 + r)^{-n} E_t[b_{t+n}] = 0$

The government does not continuously rely on the issue of new debt to pay the old debt that matures commonly known as no Ponzi games. Hence the basis for analysis of the past behavior of the fiscal policy variables.

Chapter III: Fiscal Policy Sustainability of EAC countries

3.1 Objective of Fiscal Policy analysis

In this chapter we set to find out whether EAC countries have sustainable fiscal policies and how policy makers adjust fiscal policies to achieve a sustainable path. We apply linear and nonlinear error-correction models. The questions we address are

i) Are the public finances for the EAC countries sustainable?

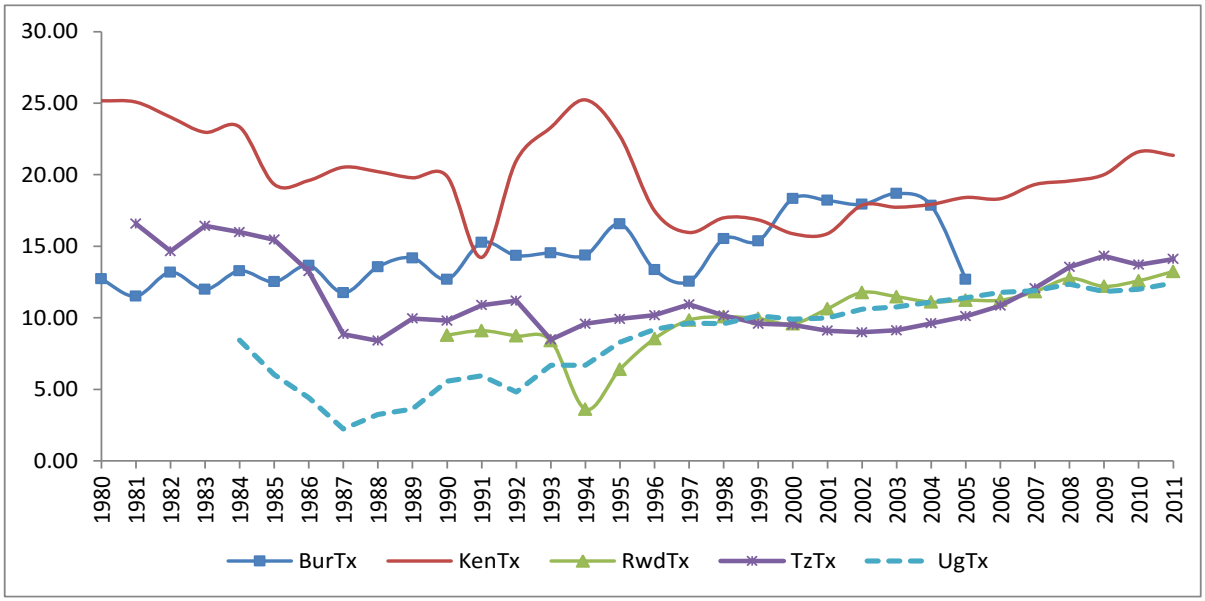
ii) How do fiscal authorities adjust fiscal policy to achieve a sustainable fiscal path?

3.2 Data and data sources

Data on macro-economic variables was obtained mainly from databases of the International Monetary Fund, the World Bank global development finance and African development indicators. Annual data from the period 1980 to 2011 was collected on GDP (Real and Nominal), Total Outlays/ Expenditure and Taxes and the expenditure and taxes was expressed as ratios of GDP. Figure 3.1 and 3.2 below show the plots of Government Expenditure and Taxes for all the countries in the EAC.

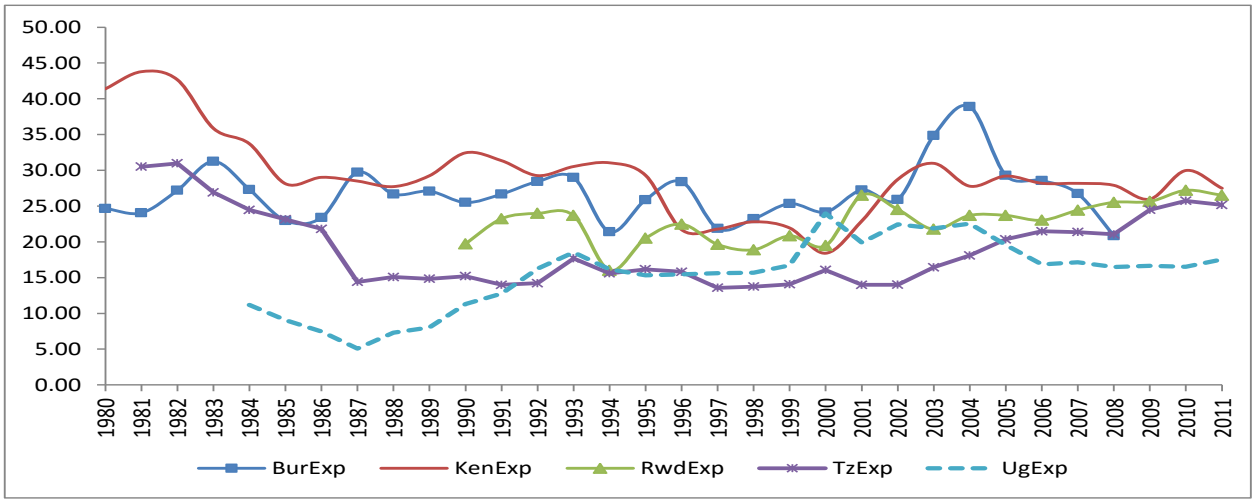
3.2.1 Trends in Government Expenditure and Taxes

Figure 3.1: A plot of the tax/GDP ratios for the East African Countries



The ratio of Tax/GDP for Kenya is highest in the region while that of Burundi is also higher on average compared to the other 3 countries Uganda, Rwanda and Tanzania. The low ratios of tax/GDP in Uganda, Rwanda and Tanzania could be attributed to a number of reasons like a possible low tax base and/or tax evasion. In 1994 we notice the lowest tax/GDP in Rwanda due to the genocide.

Figure 3.2: A plot of the Expenditure /GDP ratios for EAC countries



Kenya and Burundi have the highest expenditure to GDP ratio on average in the region. This should not come as a surprise since their ratio to tax to GDP also highest. From 2006 onwards the ratio of expenditure to GDP for Uganda is much lower than the other countries in the region. In 1994 we notice the decline in Exp/GDP in Rwanda due to the genocide but there after this ratio steadily increases becoming higher than that of Burundi and therefore the second highest in the region from 2008 onwards. This is because of the rigorous post war measures like structural reforms and infrastructural development the government took in the bid to rehabilitate, resettle and rebuild their community.

3.3 Methodology and Empirical Results PVBC concept

Our research methodology gives an insight in the fiscal sustainability for the East African countries using the PVBC approach. We use the stationarity tests and cointegration analysis to test for the fiscal sustainability of the EAC fiscal policies. We also use a non-parametric graphical tool known as the lowess smoother that further plots the relationship between the macro economic variables. This tool easily detects the nonlinear relationship in these variables.

Following the conceptual framework of Fiscal sustainability discussed earlier, the PVBC approach involves econometric techniques in stationarity and cointegration analysis. Tests were conducted for all the countries individually for both series tax to GDP and expenditure to GDP ratios. Unit root tests were conducted using the Augmented Dickey-Fuller (ADF) test[2] as one of the most commonly used tests for stationarity. The null hypothesis of the ADF test is that there is a unit root such that if we reject the null hypothesis the series is stationary.

The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests were also carried out to

[2] $Y_t = \gamma Y_{t-1} + \cdots \; s.t \; Y_t - Y_{t-1} = \gamma Y_{t-1} - Y_{t-1} = (\gamma - 1)Y_{t-1}$. Therefore $(\gamma - 1)$ is negative for $0 < \gamma < 1$.

check for consistency of the results. The null hypothesis for the KPSS test is that the series is stationary such that if we reject the null hypothesis then series is not stationary. The results from the two tests should be consistent to make any conclusions on the stationarity of the variables. Table 3.1 shows the results.

Initially in order to determine the long run relationship between taxes and expenditure of all the EAC countries, we use the linear cointegration tests based on Quintos (1995). The tests of cointegration are conducted using Johansen's and Engle and Granger the EG-ADF two-step process to test for cointegration. It is possible to consider the cointegration between non contemporaneous variables by adding up the data for every 5 years, but that would affect the sample size that would be too small. It was impractical for our case. So like most authors cited in the thesis who analyzed long run relationships between variables, the cointegration results are as presented. Table 3.2 shows the cointegration test results.

3.3.1 Unit root, stationarity and cointegration test results

Results from table 3.1 for the ADF tests suggest that for all the countries we failed to reject the null hypothesis hence all the series are non-stationary in levels apart from those of Tanzania. However when we conducted the KPSS

test for stationarity, Tanzania series came out as non-stationary in levels. This shows a contradiction in the results for Tanzania. This might point to presence of non-linearity in the series.

Table 3.1: ADF and KPSS test results

Country		ADF test		KPSS test		Integration
		Taxes	Expenditure	Taxes	Expenditure	
Burundi	Level	-0.555	-0.641	0.512	0.283	I (1)
	1st diff	-4.552	-5.055	0.0704	0.0766	
Kenya	Level	-2.656	-2.356	0.265	0.417	I (1)
	1st diff	-5.492	-4.810	0.0324	0.047	
Rwanda	Level	-1.147	-1.338	0.227	0.365	I (1)
	1st diff	-5.526	-5.347	0.0396	0.0513	
Tanzania	Level	-5.151	-4.299	0.192	0.29	I(1)
	1st diff	-14.303	-13.978	0.118	0.112	
Uganda	Level	-1.672	-2.015	0.134	0.481	I (1)
	1st diff	-6.480	-6.228	0.0227	0.0279	
Critical Values: 1% = -3.709 and 5%= -2.983				Critical Values: 1%= 0.216 and 5%=0.146		

We shall take the position that all series are I(1) since both the ADF and KPSS tests on the first differences for all the countries were found to be stationary suggesting that the taxes and expenditure series are of order of integration are

I(1). This is as expected for macro-economic variables as well as for the sustainability analysis requirements.

Table 3.2: Cointegration test Results

Country	Johansen Test		Engel-Granger Test	
	Trace Statistic at Rank 0	5% critical value	Test statistic	5% critical value
Burundi	17.3032*	12.53	-2.270	-3.540
Kenya	11.3846	12.53	-3.197	-3.540
Rwanda	5.0229	12.53	-2.042	-3.540
Tanzania	18.2646*	12.53	-4.161*	-3.540
Uganda	4.0042	12.53	-1.820	-3.540

Note: * denotes rejection of null hypothesis at 5% level of significance

These tests have a null hypothesis of no cointegration. The results show that when we consider the Johansen test, Burundi and Tanzania are cointegrated with 1 cointegrating vector while Kenya, Rwanda and Uganda are not cointegrated. While in the Engel Granger test for cointegration, we fail to reject the null hypothesis that there is no cointegration for all countries other than Tanzania at 5% level of significance. Absence of cointegration should suggest that there is no long run relationship between expenditure and taxes and hence

the fiscal policy not sustainable for most of the EAC countries. This suggests that Rwanda, Kenya and Uganda have problems with fiscal sustainability, while sustainability of Burundi depends on the test used. Tanzania has a sustainable fiscal path for the period under analysis based on the test results.

3.3.2 Limitations of cointegration analysis

The draw back with these tests is that since they use a linear relationship of the variables, fiscal authorities are expected and assumed to correct every imbalance the same way. This implies that Economic cycles and shocks are not taken into account. In addition it is possible to have corrections after a given threshold. Considering the facts above it would mean that the conclusions derived from the linear cointegration tests on the intertemporal budget constraint would be wrong. Moreover statistically a failure to reject the null hypothesis does not necessarily mean we accept it. This then means it is still possible that there is some cointegration for the rest of the countries.

In order to check for the non linearity of the macro economic or fiscal variables, we use a non-parametric method and graphical presentation called the lowess smoother.

Figure 3.3: Checking Non linearity Loess (Lowess) Smoother Results

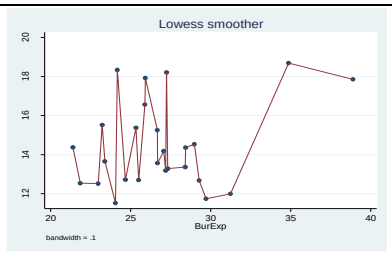
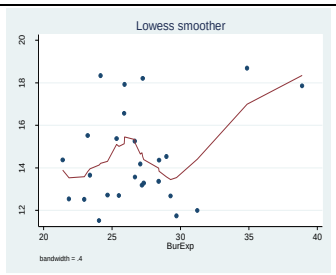
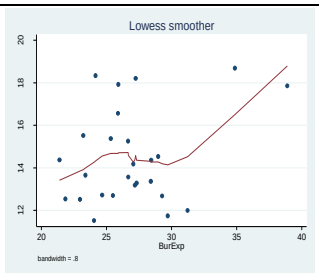
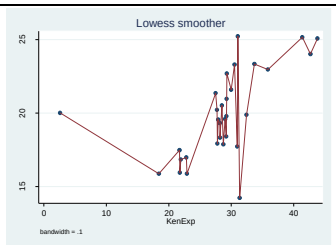
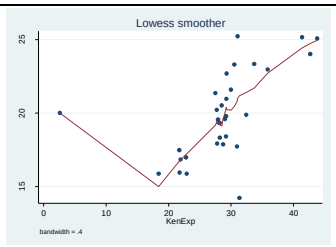
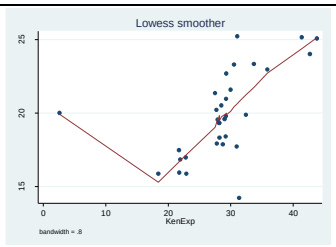
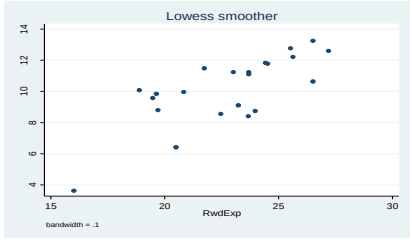
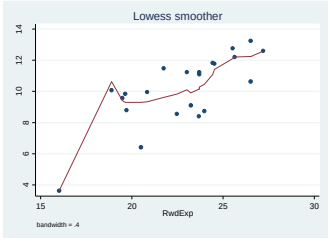
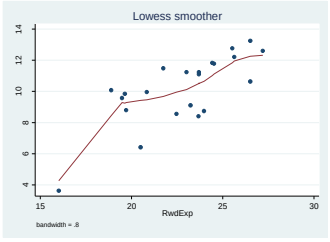
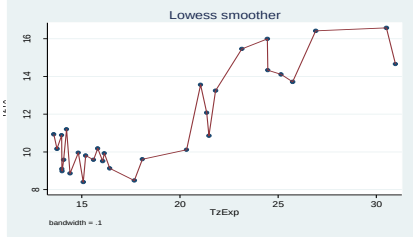
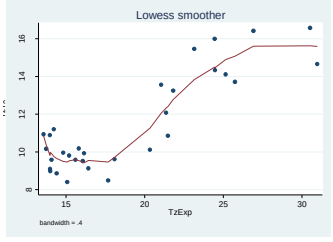
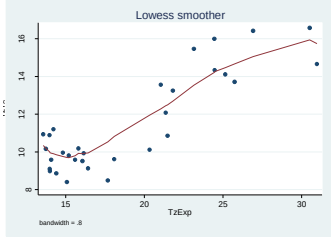
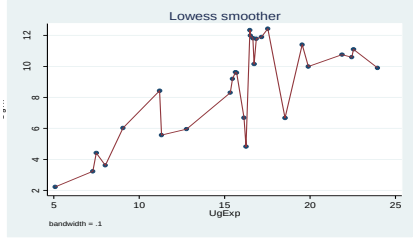
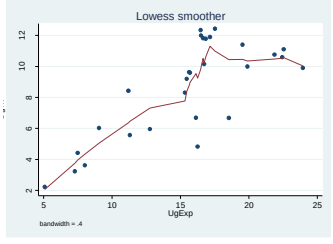
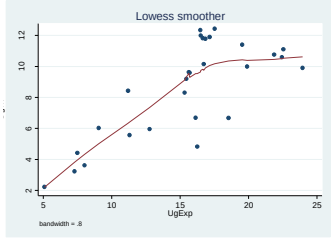
Burundi			
Kenya			
Rwanda			
Tanzania			
Uganda			

Figure 3.3 above shows that the fiscal variables are non linear. The graphs show the level of non-linearity using different bandwidths. In the next section we look at the nature of fiscal policy adjustments/ Tax reforms considering threshold behavior and different phases and state of economic cycles.

3.3.3. Methodology for Error correction model

3.3.3.1. Linear Error Correction model

We use an error correction model assuming short run adjustment of taxes that depends on the economy's state and cycle. Additionally we use a smooth transitioning condition to determine whether the EAC countries adjust their fiscal policies with changes in the economic cycle or when there is an increase in the fiscal deficit. The smooth regime transitioning function assumes that the fiscal policy adjustment mechanism is not linear but depends on the state and/or cycle of the economy among other things. That is for some countries fiscal policy adjustment depends on whether the economy is in a boom or recession. Fiscal policy adjustment may also depend on whether there is a rising deficit in the economy being analysed. These assumptions are important especially for the East African countries with high fiscal deficits and low growth.

Correction of a fiscal imbalance could depend on size and nature of imbalance as well as the economy state or cycle conditions. This implies that fiscal adjustments may not necessarily follow the linear path with continuous and state-invariant fiscal adjustment as was assumed previously. Fiscal adjustments could also occur after a given threshold. As in a paper by Bajo-Rubio et al. (2006), threshold cointegration that considers the possibility of a nonlinear relationship between government expenditures and revenues is used. They apply this to Spain, a country that has traditionally experienced high budget deficits as in most of the EAC countries. They use a two-regime threshold VAR model and find that there is significant error-correction only in the first regime. This is when government deficits are relatively high and in the second regime error-correction is minimal.

In a papers written by Legrenzi & Milas (2013) on Fiscal Policy Sustainability in the GIPS, they allowed for nonlinear corrections and showed evidence of threshold behavior for all the GIPS fiscal authorities. They also mention that in principle threshold adjustment of fiscal variables should point to non-explosive debt dynamics and hence to a sustainable fiscal policy. Ricciuti (2004) in the discussion paper about Non-Linear Characterization of Fiscal Sustainability using Italian data spanning from 1861 to 1998 concluded that a non-linear co-trend exists between the government spending and taxes. He used several

unit root and stationarity tests where conflicting results in these tests were the first evidence of non-linear trend stationarity. Then they applied a series of non-linear trend stationarity tests and finally verified the presence of long-run behavior between government expenditure and taxes.

In this paper as in that written by Legrenzi and Milas (2013) on Fiscal Policy Sustainability in the GIPS, we consider the non-linear model examining short run dynamics of taxes of the form

$$\Delta\left(\frac{TAX}{GDP}\right)_t = \beta_0 + (\beta_{11}CV_{t-1} + \beta_{12}gap_{t-1})\theta_{t-1} + (\beta_{21}CV_{t-1} + \beta_{22}gap_{t-1})(1-\theta_{t-1}) + \beta_3 fincrisis_t + u_t$$

Where CV are the residuals from the long run relationships between $\frac{TAX}{GDP}$ and $\frac{G}{GDP}$ (ie. $\frac{TAX}{GDP} - \beta\frac{G}{GDP}$) . This acts as a proxy for the fiscal deficit.

gap is the output gap (respective countries GDP detrended by Hodrick-Prescott trend)

$fincrisis$is the US GDP gap that we have taken as a measure of financial turmoil in the world.

u_t is the stochastic error term

And $\theta_{t-1} = 1 - [1 + \exp(-\frac{\gamma^s(s_{t-1} - \tau^s)}{\sigma_{s_{t-1}}})]^{-1}$ is the logistic transition function as in van Dijk et al (2002)

Table 3.3: Empirical Results Linear tax revenue Error correction model

	Tanzania	Burundi	Rwanda	Kenya	Uganda
Constant	0.6433849 (0.509)	-0.4091855 (0.453)	0.4044957 (0.346)	-0.1621299 (0.347)	0.417501 (0.305)
CV_{t-1}	-1.234502*** (0.393)	-0.1174864 (0.11)	-0.0971627 (0.281)	-0.5970933*** (0.184)	-0.2262476 (0.167)
gap_{t-1}	1.63e-12 (1.31e-12)	1.65E-12 (6.42E-12)	-1.76E-12 (4.42E-12)	3.97E-13 (6.06E-12)	3.05E-13 (3.63E-13)
$fincrisis_t$	2.78e-12 (3.26e-12)	-6.60E-12** (2.62E-12)	-3.31E-13 (1.99E-12)	-7.23E-13 (1.85E-12)	1.33E-12 (1.72E-12)

Considering the linear tax revenue error correction model, we notice a significant budgetary correction for Tanzania and Kenya, while for Burundi the tax policy adjustment is significant when there is a financial crisis. So we notice that when the financial crisis and cycle of economy are controlled for Kenya does have significant budgetary corrections in the tax policy adjustments even if there was no cointegration in the previous section. This might explain why simply taking the linear relationship between taxes and expenditure is not sufficient to show the fiscal sustainability of a country and why this error correction model shows more insight in the fiscal policy adjustments of the EAC countries.

We shall once again check for non-linearity using a lowess regression which is a tool used for checking relationships between variables as explained in Jacoby

(2000). The advantage of the lowess regression is that it follows data more closely than a linear regression line. This allows us to detect non-linearity in the relationship between two variables which are in this case taxes with the fiscal deficit and also taxes with the economic gap.

Figure 3.4 on next page shows the level of non-linearity using different bandwidths. The results show that the relationship between taxes and the economic cycle is nonlinear in general.

Figure 3.4: Checking Non linearity Loess (Lowess) Smoother Results for first difference of taxes to GDP and the economic cycle

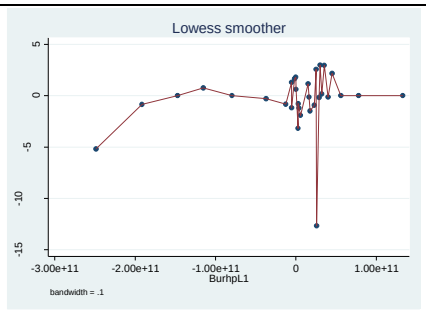
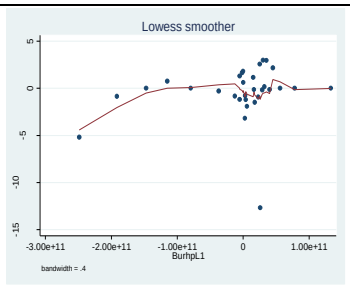
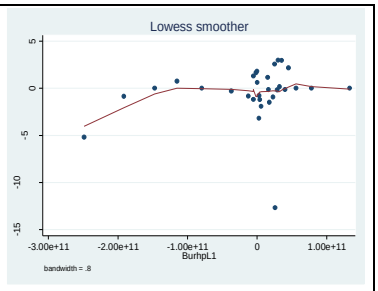
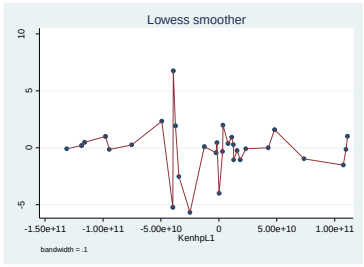
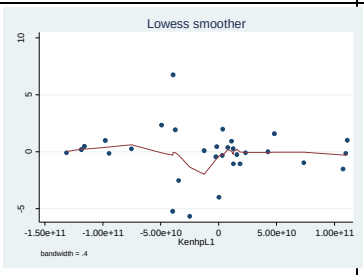
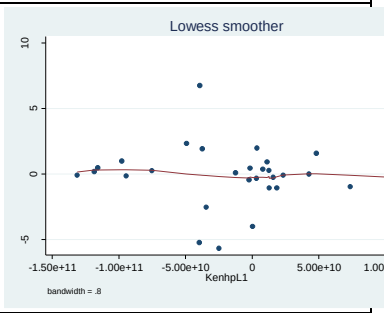
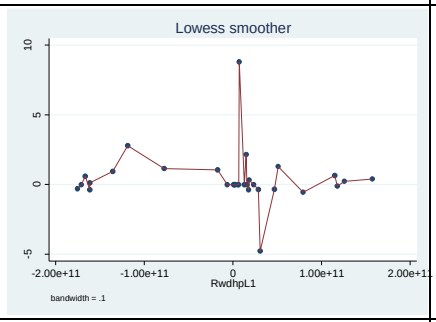
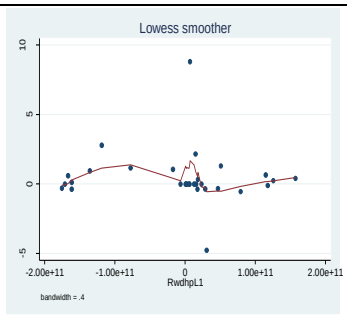
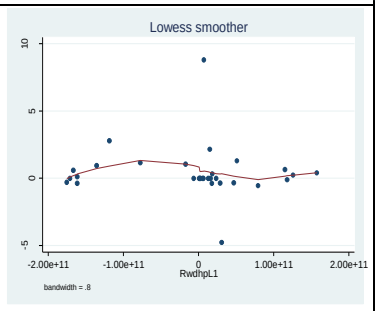
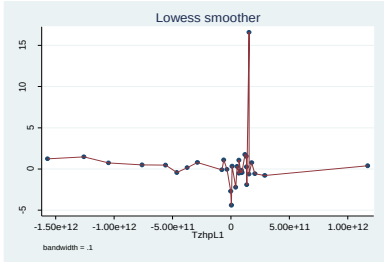
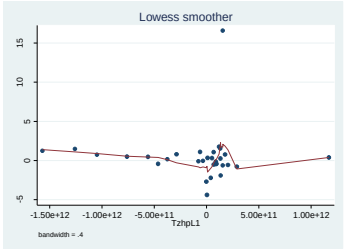
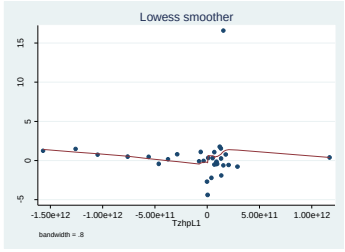
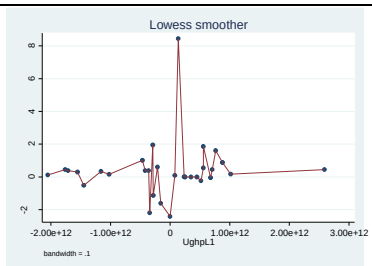
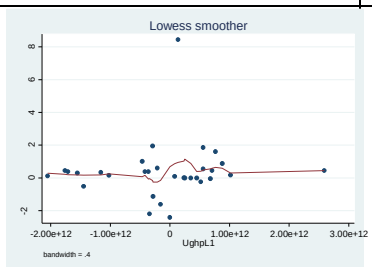
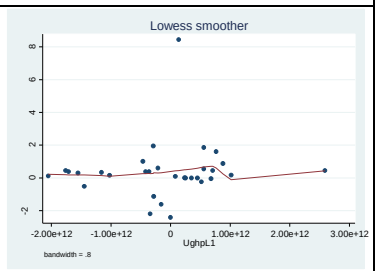
Burundi			
Kenya			
Rwanda			
Tanzania			
Uganda			

Figure 3.5: Checking Non linearity Loess (Lowess) Smoother Results for first difference of taxes to GDP and the fiscal deficit

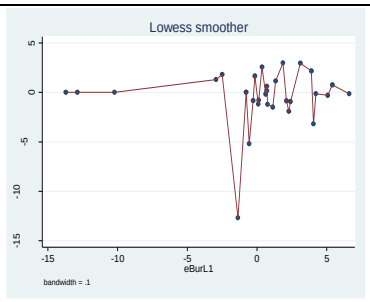
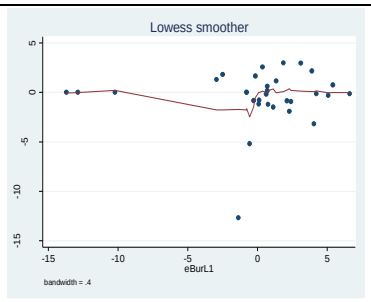
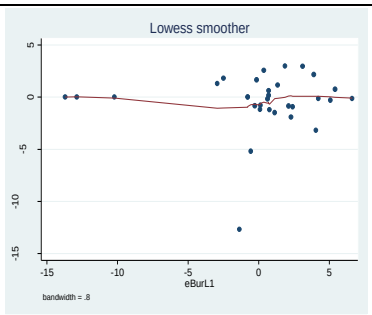
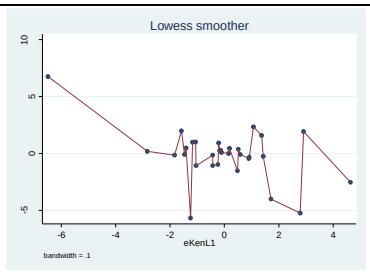
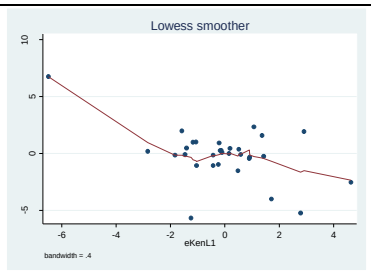
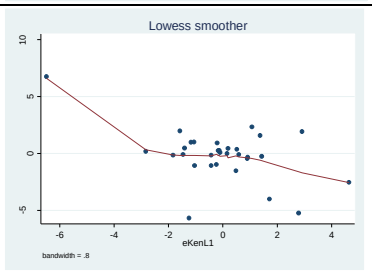
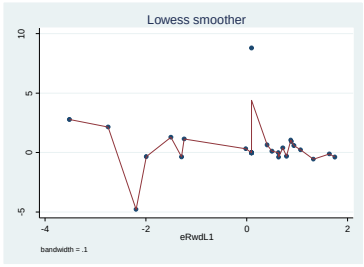
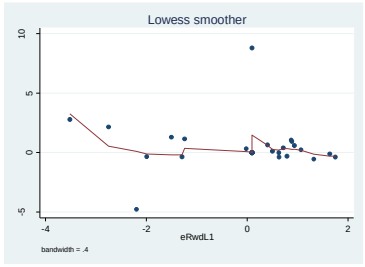
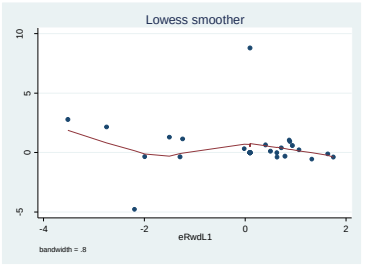
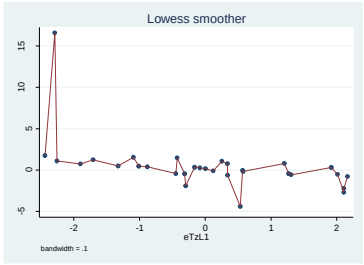
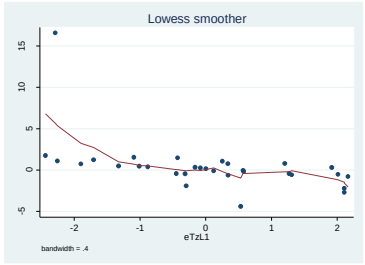
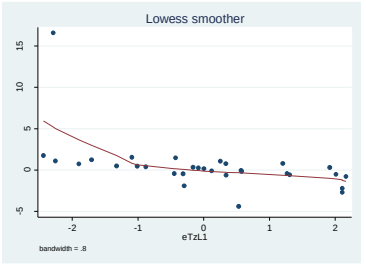
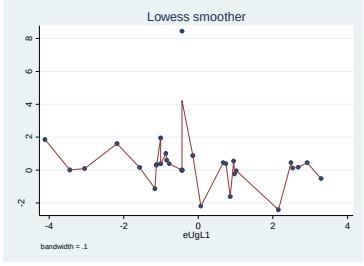
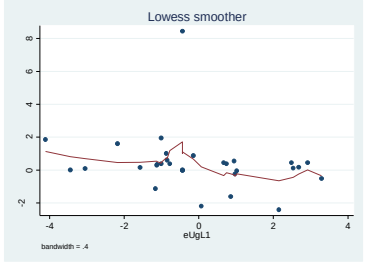
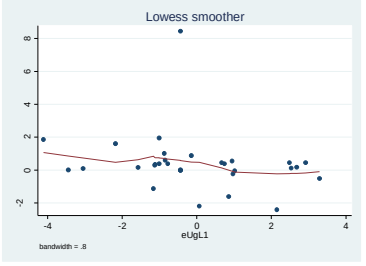
Burundi			
Kenya			
Rwanda			
Tanzania			
Uganda			

Figure 3.5 shows the level of non-linearity using different bandwidths. The results show that the relationship between taxes and the deficit is non linear in general.

We also note that the lowess smoother attempts to show the relationship of taxes with either the deficit or economic cycle but not both simultaneously. This gives an insight in the nature of relationship of variables, it does not portray the exact relationship intended in the linear regression which is our error correction model. The error correction model was run with taxes as the dependent variable and the explanatory variables included the economic cycle, fiscal deficit and financial turmoil. In the next section we look at the nature of fiscal policy adjustments ie. The tax reforms considering the different phases and state of economic cycles. We consider the nonlinear relationship between taxes , the economic cycle and deficits.

3.3.3.2 Non-linear model Empirical Results

According to the equation above, the tax policy should exhibit smooth transitioning behavior from one regime to another which depends on the transition variable s_{t-1} with weights θ_t and $(1-\theta_t)$ respectively. We consider two possible candidates for s_{t-1} which are CV_{t-1} for the deficit and

gap_{t-1} for the economic cycle. For $\gamma^s > 0$, as $(s_{t-1} - \tau^s) \rightarrow -\infty$ then $\theta_t \rightarrow 1$ and the coefficients are given by β_{11} and β_{12} and as $(s_{t-1} - \tau^s) \rightarrow \infty$, then $\theta_t \rightarrow 0$ and coefficients are given as β_{21} and β_{22}. For CV_{t-1} under the assumption $\tau^{cv} < 0$, we assess taxes in periods of rising deficits to GDP ratios ($CV_{t-1} < \tau^{cv}$) and also falling deficit to GDP ratios ($CV_{t-1} > \tau^{cv}$). In the second case we assess taxes during periods of economic downturns and expansions given by $gap_{t-1} < \tau^{gap}$ and $gap_{t-1} > \tau^{gap}$ respectively. The results are given in appendix 1 from tables A1.1 to A1.5.

1. Nonlinear model using the fiscal deficit as a transition variable

The results in table A1.1 in appendix 1 show that Tanzania fiscal authorities correct deficits only when they exceed a threshold of 1.99, and also taxes respond positively to the output gap when deficit is above the threshold. When the deficits are falling there is no statistical evidence that the Tanzania fiscal authorities do any corrective action. For Burundi in table A1.2, when deficits are below threshold, taxes respond negatively to the GDP gap however there is no evidence of correction of deficits beyond the threshold. We also note that unlike all the other countries in the case of Rwanda the threshold is statistically significant. When deficits are below the threshold of 1.99, taxes respond negatively to the output gap. For Kenya and Uganda there is no evidence of budgetary error correction the results for the nonlinear models are not

significant. Overall when using the deficit as a transition variable there is no evidence of budgetary error correction in the EAC countries. It is only Tanzania that shows significant budgetary error correction when deficits are beyond its threshold as well as taxes respond positively to the output gap. For Rwanda and Burundi taxes respond negatively to the output gap when deficit are below thresholds. Uganda and Kenya have no statistical evidence of budgetary correction or tax response to output gap.

2. Nonlinear model using the economic cycle as a transition variable

Here we assess how taxes adjust differently during periods of economic downturns and during periods of economic expansions. Results show that there is budgetary error correction in Tanzania during periods of both Economic booms and recessions and that taxes respond positively to output in the economic boom. Results for Burundi show that there is budgetary error correction during periods of Economic booms and that taxes respond positively in the economic boom and negatively in economic recessions and the threshold is significant. Results also show that there is budgetary error correction in Rwanda during periods of Economic recessions. For Kenya and Uganda there is no evidence of budgetary error correction, hence the results for the nonlinear models not significant.

When using the economic cycle as a transition variable only Tanzania shows error correction in both Economic booms and recessions while Burundi shows budgetary error correction only in economic booms. Tanzania together with Rwanda show evidence of error correction in the recessions. Taxes for Burundi respond positively in booms and negatively in recessions. For Tanzania taxes respond positively in booms. Kenya and Uganda have no statistical significance of error correction in either the economic downturns or upturns.

3. Using Government Expenditure as the dependent variable

The results showed no evidence of threshold behavior or cycle. This might be because government expenditure is not commonly used in short term fiscal adjustment. It depends on other aspects like previous year's expenditure and political regimes.

3.4 Concluding Remarks

From the results shown above we can determine the long run relationships and fiscal sustainability path for the EAC countries. Through the IBC sustainability testing we find that only Tanzania shows evidence of long run relationship between the fiscal variables using both the Johansen and Engel-Granger tests of cointegration. Burundi shows evidence of a sustainable path using only the

Johansen test of cointegration. Rwanda, Kenya and Uganda do not show any evidence of long run relationships in their fiscal varialbles using any of the cointegration tests.

We considered that fiscal adjustments may not necessarily follow a linear path with continuous and state invariant fiscal adjustment, moreover fiscal authorities do not usually correct every imbalance. Correction could depend on size and nature of imbalance as well as the cycle of the economy.

The linear tax reveue error correction model results showed significant budgetary correction for Tanzania and Kenya, while for Burundi the tax policy adjustment is significant when there is a financial crisis. Considering the nonlinear model regression, when we used CV_{t-1} as a transition variable, Rwanda showed a statistically significant threshold and the taxes respond negatively to the fiscal deficit when it is below the threshold of 1.99. Tanzania shows significant budgetary error correction and taxes response to the output gap when they exceed a threshold. Like Rwanda, Burundi taxes respond negatively to the output gap when deficits are below threshold while for Uganda and Kenya there is no statistical evidence of budgetary correction or tax response to output gap when we use CV_{t-1} as a transition variable.

In order to assess how taxes adjust differently during periods of economic downturns and during periods of economic expansions, we used gap_{t-1} as a transition variable. The results of this model had better results since we had at least two countries having statistically significant thresholds with the threshold for Uganda fixed as an average of its output gap over the period of analysis. Tanzania showed evidence of budgetary error corrections both in the economic booms and economic downturns. Burundi showed evidence of error correction only in economic booms. In Burundi taxes respond positively in booms and negatively in recessions. While in Tanzania, taxes respond positively in booms. In Rwanda there was evidence of error correction in the economic recessions. Only Uganda has no statistical significance of error correction or response of taxes either in any of the model variations in either the economic downturns or upturns.

Chapter IV: Monetary Policy effect on Uganda

4.1 Introduction

In this chapter we consider the fact that the Central Bank of Uganda upholds the long run neutrality of money as it performs its monetary policy activities and the fact that it is necessary to have a relatively well-developed financial system to facilitate the effective transmission of monetary policy for effective inflation targeting. We note that inflation expectations do not automatically become anchored as a result of the announcement of the target, because credibility has to be built up through successful application of monetary policy. This then especially for a country like Uganda blurs the distinction between having no specific monetary framework or policy rule, monetary targeting and inflation targeting.

We have already seen that the for central banks' tools used, price stability is a natural objective. We do not dwell on the difference in tools for carrying out monetary policy but the greater purpose in maintenance of price stability and consequently output. Our interest is on the best way to analyze monetary policy objectives especially since our financial sector is still in the nascent stages requiring good monetary policy monitoring tools before the contagion effects and complex financial markets operations set in.

The questions we ask ourselves are

i. What is the effect of a monetary shock on output growth and inflation?
ii. Do the alternative models outcomes match in analyzing inflation and output growth given a monetary shock in the economy?

4.2 Data and Methodology

A wide array of methods are used to assess the impact of monetary policy activities on an economy. Methods like the dynamic stochastic general equilibrium models have been implemented in developed countries from the real business cycle models to the new Keynesian models. However, we know that data from developed economies and developing economies do not have similar characteristics due to different data collection requirements, quality and completeness. This can imply that some analytical methods are more appropriate for the developed countries data as opposed to the data for developing countries.

There have been efforts to emulate the aggregate fluctuations in different economies using several models. Some of models used have included Real business cycle models as mentioned earlier. There also exist vector auto regressions (VAR) among other models. The real business cycle (RBC) models

use real side shocks as sources of business cycles that are interacted with production technologies and household preferences. The Equilibrium monetary models add monetary factors to the RBC models.

DSGE models base their conclusions on ability to recreate co movements in macro economic variables and impulse responses due to structural shocks such as unexpected changes in the growth rate of money supply or total factor productivity. This is important since it can give the monetary policy authorities an idea of the reactions of public to their policy changes and as to whether inflation expectations or anticipation of shocks varies the impact on output growth and inflation. We note that in general the monetary business cycle models differ due to preferences, technologies, and the information sets that households and firms possess when they make decisions.

There are two observables namely output growth (μ_t) and inflation (π_t). The data used in the analysis was quarterly series on inflation and output growth numbers from September 1998 to June 2013. Data was got from the Bank of Uganda statistics and World Bank African development indicators. The output growth was annual information, but we generated quarterly growth using the cubic spline in EViews while inflation numbers were already on quarterly basis.

Figure 4.1: Inflation and output growth

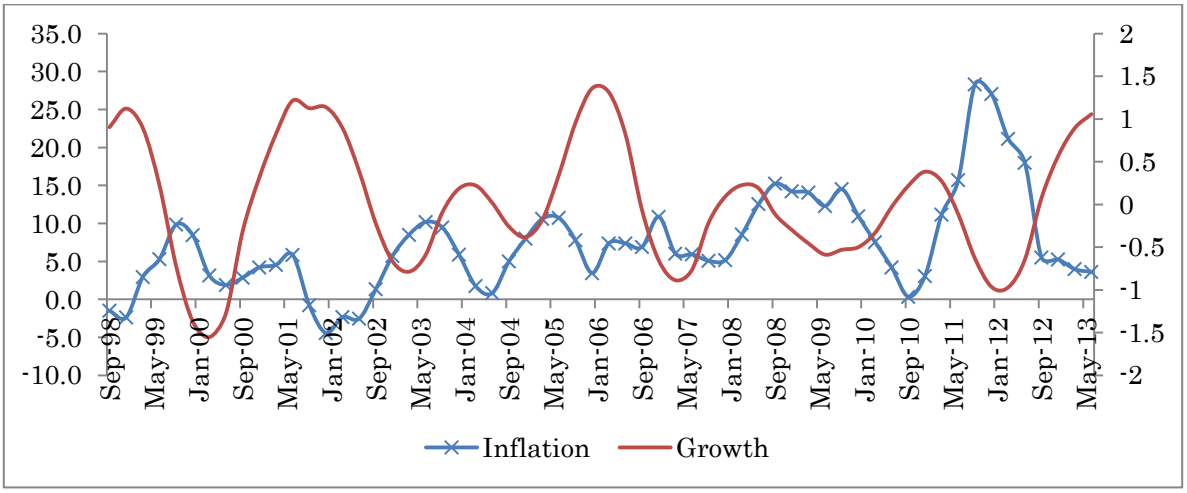


Figure 4.1 above shows that as higher growth coincides with a decline in inflation and high inflation leads to low growth. This trend is seen over the years in the analysis ie. 1998 to 2013 and is consistent with what we expect.

4.2.1 The standard Cash-in-advance (CIA) model

In this case we adopt the standard CIA monetary business cycle model, the cash-in- advance (CIA) model. A number of models allow money wages paid in period to enter the cash in advance constraint, while others allow in period money wages to be included in financial intermediaries. In some CIA models only money carried from previous periods can be used for consumption or for deposits in the financial systems. Which assumption to use is related to how long someone thinks a period is and how long lags are between receiving income and spending it. The cash in advance constraint used under the households implies the accumulated cash balance pays for all consumption purchases. In

addition a unit of nominal dividends is valued in terms of the consumption it brings during the following period.

The financial sector takes cash deposits from households and lends to firms assuming no risk to finance their working capital. They operate as if they were perfectly competitive. Money shocks then enter the economy through the financial sector rather than households. In addition it is through the financial intermediaries that the central bank or monetary authority operates its monetary policy with stochastic injection or withdrawal of money.

Firms pay for labor services before goods are sold; hence they need to borrow to cover the wage bill. We have a simple perfectly competitive financial intermediary taking money from households and lending to firms in period. Loans to firms consist of a loan taken at beginning of period and paid back at end of period when goods are sold.

In the CIA model we note that consumers earn interest on deposits but not on money therefore they will always prefer to keep the deposits and hold just enough cash to finance their consumption. As a consequence we have an assumption of a constant velocity of money, where as in reality velocity of money varies with the interest rate. In general the CIA model does not account for the

change in velocity of money. We can make an assumption that the households should hold more cash balances than deposits however, this will not be a big concern in this chapter since we are comparing the results with other estimations. Moreover velocity of money per say is not a major Economic concern atleast for developing countries. In addition authors like Schorfheide (2000) and Nason and Cogley (1995) did use the same models for analysis of output growth and inflation in the US economy and the CIA model results were found to be binding.

Households

The sum of discounted expected future utility is maximized in period t, when the household chooses consumption C_t , hours worked H_t, and non-negative deposits D_t to solve the problem

$$\max_{\{C_t, H_t, M_{t+1}, D_t\}} E_0 \left[\sum_{t=0}^{\infty} \beta^t [(1-\phi) \ln C_t + \phi \mathrm{In}(1-H_t)] \right]$$

$0 < \beta,\ \phi < 1$

Subject to cash-in-advance constraint

$P_t C_t \leq M_t - D_t + W_t H_t$, $0 \leq D_t$

And the budget constraint for money

$$M_{t+1} \leq (M_t - D_t + W_t H_t - P_t C_t) + R_{H,t} D_t + F_t + B_t$$

Where

F_t is the nominal dividends household receives from firms

B_t is the nominal dividends household receives from banks or financial institutions

$R_{H,t}$ This is gross nominal interest rate the household earn on deposits.

D_t is bank deposits.

β is the discount rate

Financial Intermediaries

The Financial intermediary solves the problem

$$\max_{\{B_t, D_t, L_t\}} E_0 \left[\sum_{t=0}^{\infty} \beta^{t+1} \frac{B_t}{C_{t+1} P_{t+1}} \right]$$

The Financial Intermediaries face three constraints.

Budget constraint for the financial intermediary is such that

$$B_t \leq D_t + L_t R_{F,t} - D_t R_{H,t} - L_t + X_t$$

Where

L_t is the nominal amount of loans the financial Institutions makes to firms

$R_{F,t}$is the gross interest rate charged on these loans

X_t is the monetary injection during date t, where $X_t = M_{t+1} - M_t$

The second constraint defines the balance sheet of the Financial Intermediaries

$$L_t \leq X_t + D_t$$

which implies that financial intermediaries should not be able to make more loans than what they receive as deposits and as monetary injection. If this were not true, they would make infinite amount of loans whenever the loan interest rate is positive.

Although while describing the model we have used different notation for $R_{F,t}$ and $R_{H,t}$, in this particular model both rates become equal in the equilibrium. This is because any gap between these rates would lead to either infinite or zero demand for deposits by financial intermediaries, which would be inconsistent with market clearing.

Also in equilibrium, as a result of profit maximization, the amounts of loans to firms (L_t) equal the maximum possible, which is X_t+D_t. Together with the equilibrium condition, this implies the following equation:

$$D_t R_{H,t} = R_{F,t}[L_t - X_t]$$

which can be interpreted as saying that in equilibrium profits on loans to firms net of the monetary injection equals to the principle and interest the financial

intermediaries owe to households period by period. Another way to put this is that intermediaries in equilibrium make a profit equal to $R_{F,t}X_t$.

Firms

Output is produced according to a cobb-Douglas production function ie. Constant returns to scale production function

$$y_t = K_t^{\alpha}(A_t N_t)^{1-\alpha}, \qquad 0 < \alpha < 1$$

Law of motion of capital defines gross investment as

$$i_t = K_{t+1} - (1-\delta)K_t, 0 < \delta < 1$$

Where

δ is the depreciation rate on capital

Firms choose the next periods capital stock $K_{t+1}$and current period's labor demand, dividends and loans denoted by, N_t, F_t, L_t respectively. Firms like the financial intermediaries are owned by households. Households value a unit of nominal dividends in terms of consumption it enables during period t+1. Thus the firm solves the problem

$$\max_{\{F_t, K_{t+1}, N_t, L_t\}} E_0\left[\sum_{t=0}^{\infty} \beta^{t+1} \frac{F_t}{C_{t+1}P_{t+1}}\right]$$

s.t.

$$F_t \leq L_t + P_t[K_t^{\alpha}(A_t N_t)^{1-\alpha} - K_{t+1} + (1-\delta)K_t] - W_t N_t - L_t R_{F,t}$$

The next constraint the firm faces reflects the fact that the firm finances its current period wage bill by borrowing. Hence the firm obeys

$$W_t N_t \leq L_t$$

Exogenous disturbances

The model has two disturbances first the monetary injection growth shock written as an exogenous stochastic process

- $In\, m_t = (1-\rho) In\, m^* + \rho\, In\, m_{t-1} + \varepsilon_{M,t} \qquad |\rho| < 1, \qquad \varepsilon_{M,t} \sim \mathcal{N}(0, \sigma_M^2)$

Where $m^*$is the unconditional mean of monetary injection growth. It is defined as $In[\, m_t] = In\,[M_{t+1}/\, M_t]$ where M_t is the stock of money base at the end of previous period.

The second shock is the technology shock A_t that follows a random walk with drift written as

- $In\, A_t = \gamma + In\, A_{t-1} + \varepsilon_{A,t} \qquad \varepsilon_{A,t} \sim \mathcal{N}(0, \sigma_A^2)$

Innovations to the technology and monetary injection growth shocks are uncorrelated at all leads and lags.

The market clearing conditions include

- $P_t C_t = M_t + X_t$, where money demand equals money supply.
- $R_{F,t} = R_{H,t} \equiv R_t$ this strict equality implies that $B_t = R_t X_t$ from the Financial Intermediares.
- $H_t = N_t$ for the labor market
- $C_t + (K_{t+1} - (1-\delta)K_t) = K_t^{\alpha}(A_t N_t)^{1-\alpha}$ for the goods market clearing showing that output equals consumption plus investment.

Equilibrium requires clearing the goods, labor, credit and money markets which are perfectively competitive in this model.

Estimating the CIA model

Optimality conditions were derived after maximizing the CIA equations above and the model was estimated using the MATLAB software. Real variables were detrended by the productivity A_t, Price level was detrended by $\frac{M_t}{A_t}$, and X_t *and* D_t were detrended by M_t. This implied that the system has a deterministic steady state.

The optimal equations are outlined below.

From maximizing the firms' equation, the euler equation in the goods market represents the trade to the economy of moving consumption goods across time.

$$\mathrm{E}_t\{-\hat{P}_t/\hat{C}_{t+1}\hat{P}_{t+1}m_t\} = \frac{\hat{\beta}e^{-\alpha(\gamma+\varepsilon_{A,t+1})}P_{t+1}\left[\alpha\widehat{K}_t^{\alpha-1}N_{t+1}^{1-\alpha}+(1-\delta)\right]}{\left[\hat{c}_{t+2}\hat{P}_{t+2}m_{t+1}\right]} \ldots\ldots 1$$

The firms' labor demand,

$$\widehat{W}_t = \hat{L}_t/N_t \ldots\ldots\ldots 2$$

Linking labor supply, labor demand and the marginal rate of substitution between consumption and leisure.

$$\frac{\phi}{1-\phi}\left[\hat{C}_t\hat{P}_t/(1-N_t)\right] = \hat{L}_t/N_t \ldots\ldots\ldots 3$$

The equilibrium interest rate given as.

$$R_t = \frac{(1-\alpha)\hat{P}_te^{-\alpha(\gamma+\varepsilon_{A,t+1})}\widehat{K}_{t-1}^{\alpha}N_t^{-\alpha}}{W_t} \ldots\ldots\ldots 4$$

The Euler equation in the credit market, which ensures that giving up one unit of consumption today for additional savings equals the net present value of future consumption.

$$\left[\hat{C}_t\hat{P}_t\right]^{-1} = \beta\left[(1-\alpha)\hat{P}_te^{-\alpha(\gamma+\varepsilon_{A,t+1})}\widehat{K}_{t-1}^{\alpha}N_t^{1-\alpha}\right]xE_t\left[\hat{L}_tm_t\hat{C}_{t+1}\hat{P}_{t+1}\right]^{-1} \ldots\ldots 5$$

The aggregate resource constraint.

$$\hat{C}_t + \hat{K}_t = e^{-\alpha(\gamma+\varepsilon_{A,t})}\hat{K}_{t-1}^{\alpha} N_t^{1-\alpha} + (1-\delta)e^{-(\gamma+\varepsilon_{A,t})}\hat{K}_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

The money market equilibrium

$$\hat{P}_t\hat{C}_t = m_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

The credit market equilibrium condition[3].

$$m_t - 1 + \hat{D}_t = \hat{L}_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 8$$

The production function.

$$\hat{Y}_t = \hat{K}_{t-1}^{\alpha} N^{1-\alpha} e^{-\alpha(\gamma+\varepsilon_{A,t})} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 9$$

Stochastic process money growth

$$In\, m_t = (1-\rho) In\, m^* + \rho\, In\, m_{t-1} + \varepsilon_{M,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 10$$

Stochastic process technology

$$\frac{A_t}{A_{t-1}} \equiv dA_t = exp(\gamma + \varepsilon_{A,t}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 11$$

$$\frac{Y_t}{Y_{t-1}} = e^{(\gamma+\varepsilon_{A,t})}\, \hat{Y}_t/\hat{Y}_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 12$$

$$\frac{P_t}{P_{t-1}} = (m_{t-1}/e^{(\gamma+\varepsilon_{A,t})})(\hat{P}_t/\hat{P}_{t-1}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 13$$

[3] m_t *in equation is growth following from the fact that in optimality* $X_t = M_{t+1} - M_t$ *is* detrended by M_t

Given a joint prior distribution on the parameters p $(\varphi, \sum)$. The prior as shown in table 4.1.

Table 4.1: The prior in CIA model

Parameters	Prior Mean	Prior Variance	Prior
α	0.310	0.020	beta
β	0.955	0.002	beta
γ	0.059	0.002	normal
m^*	1.000	0.007	normal
ρ	0.129	0.223	beta
ϕ	0.650	0.050	beta
δ	0.025	0.005	beta
δ_A	0.036	10.0	Inverted gamma
δ_M	0.009	10.0	Inverted gamma

4.2.2 Bayesian VAR

We already noted that linearized DSGE model generally have more restrictions than vector auto regressions. The Bayesian VAR will be used as a reference model. We note that in this case the Bayesian VAR is not directly comparable to

the CIA model due to data limitations so the estimations do not explicitly emulate the money shocks impact. It is assumed that the inflation shock is only due to money shock which is not always the case. However we used the ordering assumption such that the results can be used to guide our conclusion that Bayesian models give better results than DSGE models as expected. The Bayesian VAR makes use of the prior and posterior distributions to come up with a prior density. By examining the different values of the log likelihood data densities of the CIA model and Bayesian VAR, we can determine which model yields better estimates and additionally determine which lag order gives best results in the Bayesian VAR.

The Bayesian estimation method takes into account the uncertainty of the true population structure in the form of the prior probability distribution over the model parameters. The information contained in the data will then alter this degree of uncertainty. As a result Bayesian VARs are assumed to give better estimation results than structural models. However as we shall see later in our results the Structural VAR gave the best results after comparing the three methods. The Structural VAR was estimated taking the number of lags with best results in the Bayesian VAR results.

Basic model BVAR

A basic description of a Bayesian estimation that can be found in a paper by Ciccarelli and Rebucci (2003) about Bayesian VARs is written as follows.

Considering that a typical VAR is given as

$$Y_t = \varphi_1 Y_{t-1} + \varphi_2 Y_{t-2} + ... + \varphi_p Y_{t-p} + \eta z_t + \varepsilon_t \text{, t = 1,……,T}$$

Where in our empirical analysis $Y_t = \begin{pmatrix} \pi_t \\ \mu_t \end{pmatrix}$, with π_t being inflation and μ_t being Output growth. And $\varepsilon_t \sim i.i.d(0,\Sigma)$

We can rewrite the above equation in compact form as

$$Y_t = X_t\varphi + \varepsilon_t \text{;} \quad \text{t = 1,……,T}$$

Where

$$X_t = (I_n \otimes W_{t-1})$$

$$W_{t-1} = (\ Y'_{t-1},...,Y'_{t-p}, z'_t\ )'$$

$$\varphi = vec(\varphi_1, \varphi_2, ...\varphi_p, \eta)$$

The unknown parameters of the model are φ and Σ. The Bayesian estimation can be done for the compact form above. The probability density function (pdf) of the data is conditional on the model's parameters and the information contained in the data can be written in the form of a likelihood function.

$$L(Y \mid \varphi, \Sigma) \alpha \mid \Sigma \mid^{-T/2} \exp\left\{ -\tfrac{1}{2} \sum_t (Y_t - X_t\varphi)' \Sigma^{-1} (Y_t - X_t\varphi) \right\}.$$

Given a joint prior distribution on the parameters p $(\varphi, \sum)$. The joint posterior distribution of the parameters conditional on the observed is given by,

$$p(\varphi, \sum \mid Y) = \frac{p(\varphi, \sum) L(Y \mid \varphi, \sum)}{p(Y)}$$

$$\alpha \; p(\varphi, \sum) L(Y \mid \varphi, \sum) .$$

Where

α denotes 'proportional to'

$p(Y)$ is the marginal likelihood

Noting that by definition of conditional probability, the joint pdf of the data and the parameters

p $(\varphi, \sum, Y)$, can be written as

$$p(\varphi, \sum, Y) = L(Y \mid \varphi, \sum) p(\varphi, \sum)$$

$$= p(\varphi, \sum \mid Y) \; p(Y),$$

$p(Y)$ can be used for model comparison. In the software Dynare used in the empirical analysis, the log of $p(Y)$ is referred to as marginal log density or the log data density. The marginal likelihood penalizes for the number of parameters and evaluates the out of sample performance. Also the location and dispersion of p $(\sum \mid Y)$ and p $(\varphi \mid Y)$ yield point estimates measures of precision of the parameters comparable to those obtained by using a classical approach to estimation like the CIA model estimation.

4.2.3 The Structural VAR (SVAR)

In the reduced or standard form VAR, each variable is expressed as a function of its own past values and the past values of all the other variables to be considered. After accounting for the past values, the error terms would be the surprise shocks in the variables. In this case we have two variables expressed as values of their own past values 6 periods back. I chose a VAR model with 6 lags, because the results from the BVAR give the model with 6 lags as the one with the best marginal log density. The reduced form VAR is written as follows;

$$\pi_t = \varphi_{11}\pi_{t-1} + ... + \varphi_{16}\pi_{t-6} + \eta_{11}\mu_{t-1} + ... + \eta_{16}\mu_{t-6} + \varepsilon_{M,t}$$

$$\mu_t = \varphi_{21}\pi_{t-1} + ... + \varphi_{26}\pi_{t-6} + \eta_{21}\mu_{t-1} + ... + \eta_{26}\mu_{t-6} + \varepsilon_{A,t}$$

Where $\varepsilon_{it} \sim i.i.d(0, \sigma_{\varepsilon i}^2)$ and $\text{cov}(\varepsilon_{M,t}, \varepsilon_{A,t}) = 0$

π_t is inflation

μ_t is Output growth

We used economic theory to determine the contemporaneous effect between the variables. In order to see how a structural innovation would affect inflation and growth we estimate a structural VAR. A long run restriction on the model is imposed. That is the cumulative response of a shock to inflation on growth is zero in the long run. The long-run restriction that level of output is independent

of inflation shocks makes the estimation of model parameters possible.

4.3 Empirical Results

4.3.1 Results of the CIA model

The log data density is given as -263.777, the other Bayesian estimation results are shown in table below. We see a comparatively high value for rho when we compare the prior and posterior mean. That is the autocorrelation of the money growth rate in the posterior estimation results implies a high persistance in the money injection shocks. Money supply growth mstar as well as gamma are estimated at values close to their parameter prior mean. More detailed results found in appendix.

Table 4.2: CIA Bayesian estimation results

Parameters	Prior Mean	Post Mean
α	0.310	0.3327
β	0.955	0.9554
γ	0.059	0.0585
m^*	1.000	1.0013
ρ	0.129	0.7753
ϕ	0.650	0.5565
δ	0.025	0.0249
δ_A	0.035	1.4518
δ_M	0.009	3.6638

We note a big difference in prior and posterior mean of δ_A *and* δ_M which are standard deviations of the error terms. It follows that after complex calculations of the dynamic model we would have a large variance in these variables.

Impulse Response functions for CIA model

Money growth shock

After a money shock, inflation gradually returns to its steady state after about two periods. The money shock has an initial negative impact on output growth. From a negative output growth most of recovery is reached in about one year. There is slight positive increase in growth of output by end of first year. After the second year, output growth gradually returns to the long run equilibrium. We can say that the initial negative growth is as a result of high inflation expectations that temporarily reduce aggregate supply in the economy and hence reduced output. Additionally as the public gains more confidence in the central bank intervention policies and the market economy we see economy returning back to its equilibrium.

Figure 4.2: Impulse Response functions for CIA model after a money shock

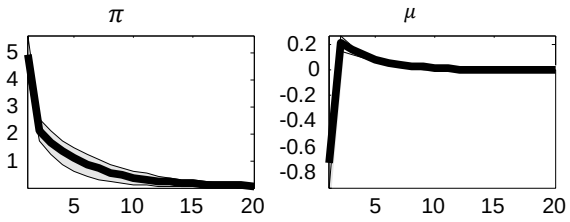
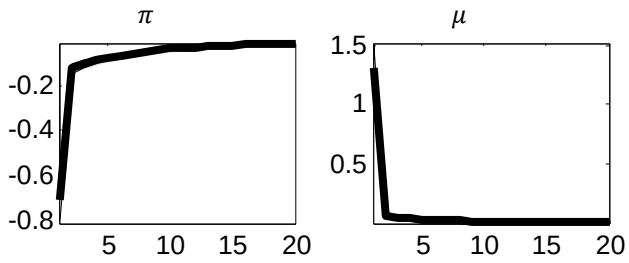


Figure 4.3: Impulse Response functions for CIA model after a technology shock



Technology shock

The initial impact of technology shock on output growth is positive but after two periods we see a return to the steady state. It is not the anticipated typical capital accumulation path. This might be due to lack of skilled labor or manpower to maintain the technology in the country such that it is only after some years when new technology can be used efficiently with more trained labor to create the permanent positive shift and increase of aggregate supply and output. The effect of a technology shock on inflation is negative and after the first year we see a steady return to the long run equilibrium.

4.3.2. Bayesian VAR Results

The marginal log density for the BVAR considering lags 1 to 9 ranges from -174.293 to -150.461 as shown in table below. The best BVAR result is at lag 6 with log density -150.4613.

Table 4.3: The marginal log densities of BVAR model

Lags	Marginal log density
1	-174.2930
2	-163.1119
3	-163.7619
4	-156.9599
5	-151.2999
6	-150.4613
7	-151.7145
8	-151.6875
9	-151.2789

When we compare the respective log densities, the log data density of the CIA model is -263.777 while that of the BVAR considering lags 1 to 9 is not less than -174.293. Hence, compared to the CIA model the Bayesian VAR estimation shows better results considering the marginal log densities. This implies that running a VAR on Ugandan data for this period would yield more reliable results when compared to the standard CIA model.

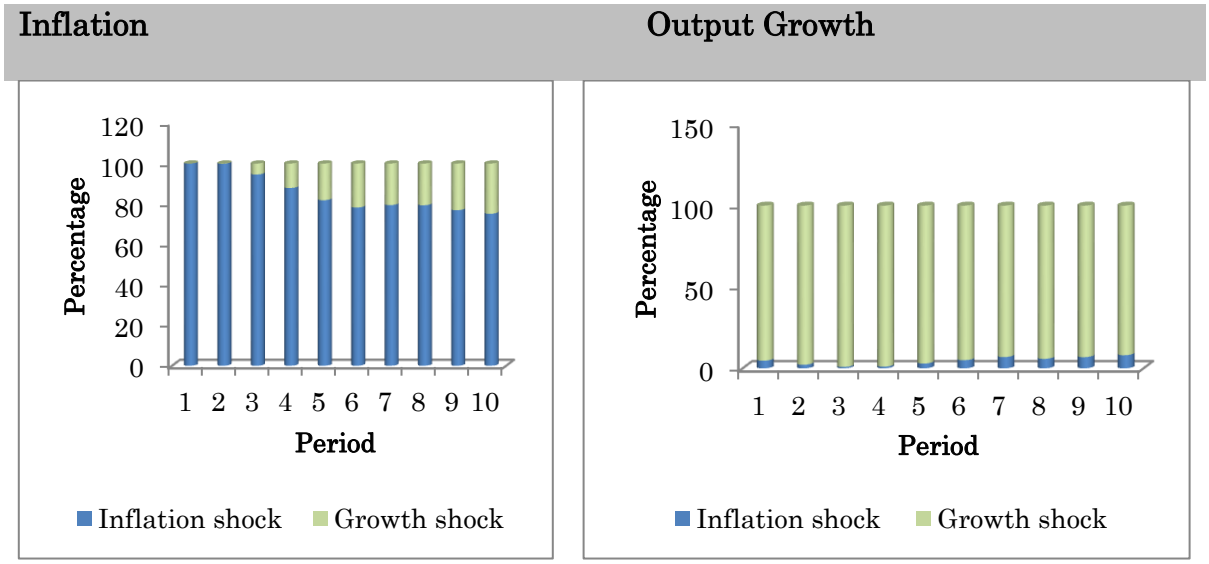
The Impulse Responses for the Bayesian VAR that will be shown in the sub sequent sections were got using the MATLAB software too have a cholesky

decomposition with ordering where Inflation comes first and growth second. The resulting impulse response graphs are shown in figures 4.5 and 4.6.

4.3.3 Structural VAR Results

Detailed results are found in the appendix 2. The impulse response functions for the SVAR using the structural decomposition are also shown in figures 4.5 and 4.6. Graphs showing the variance decomposition are shown below. In period 1, 100% of change in inflation is explained by its own shock. As periods progress from 6th to 10th period about 20-25% of the variance in inflation is explained by a shock to growth. Considering the variance decomposition of growth, from periods 1 to 10, 91-99% of variation is explained by its own shocks. This further magnifies the fact that in Ugandan economy in the money shocks have no effect on real economy in the long run.

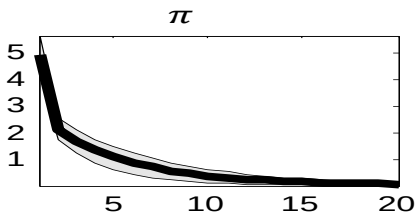
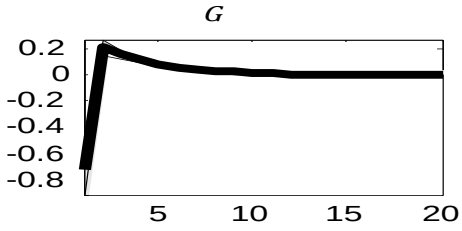
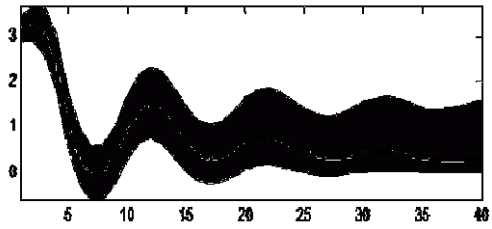
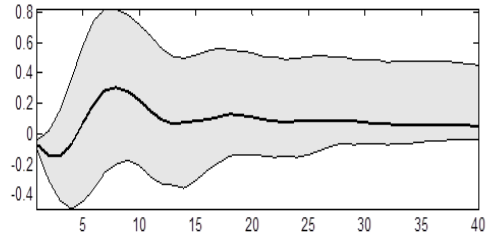
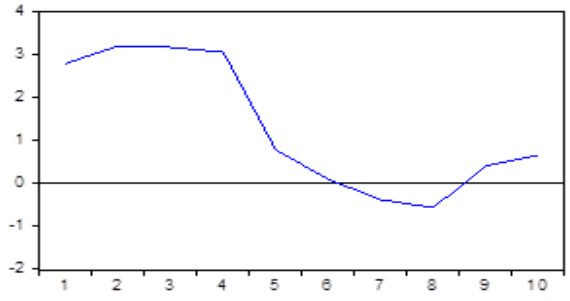
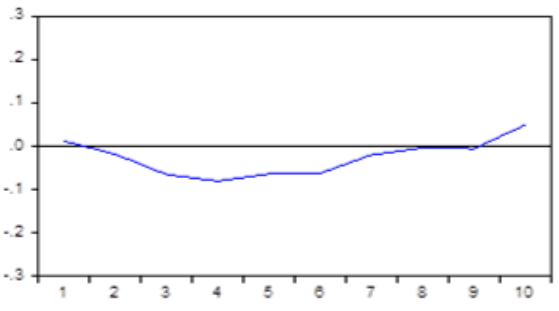
Figure 4.4: Variance Decomposition SVAR



In period 1, 100% of change in inflation is explained by its own shock. As periods progress from 6th to 10th period about 20-25% of the variance in inflation is explained by a shock to growth. Considering the variance decomposition of growth, from periods 1 to 10, 91-99% of variation is explained by its own shocks. This further magnifies the fact that in Ugandan economy in the money shocks have no effect on real economy in the long run.

4.3.4 Impulse Response Functions from the three models

Figure 4.5: Impulse response functions due to Money growth shock

CIA	
Inflation	Output Growth
	
Bayesian VAR	
Inflation	Output Growth
	
Structural VAR	
Inflation	Output Growth
	

Money shock

The Impulse response functions for the CIA, the Bayesian VAR and the Structural VAR models showing response of inflation and growth to the Money growth shock are shown in figure 4.5. We can see that inflation responds positively to its own shock or money shock for all the models. Impulse response of growth to an inflation shock is generally negative for all three before returning to the long run equilibrium. We can say that the initial negative growth is as a result of high inflation expectations that temporarily reduce aggregate supply in the economy and hence reduced output. As the public gains more confidence in the central bank intervention policies and the market economy we see economy returning back to its equilibrium.

Technology shock

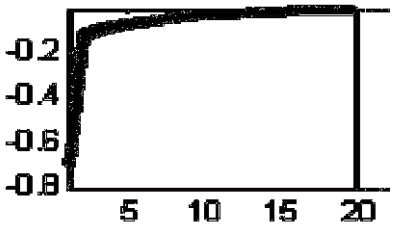
The Impulse response functions for the CIA, the Bayesian VAR and the Structural VAR models showing response of inflation and growth to the Technology shock is shown in Figure 4.6. The initial impact of technology shock (shock on output) on output growth is positive for all 3 methods and unlike the CIA, for the VARs there is a slight increase in growth before it

gradually returns to its steady state. So we do not see a typical capital accumulation path. This might be due to lack of skilled labor or manpower to maintain the technology in the country such that it is only after some years when new technology can be used efficiently with more trained labor to create the permanent positive shift and increase of aggregate supply and output. The effect of a technology shock on inflation is negative in the first periods before returning to steady state in the long run. Overall we see that high inflation expectations control the response of output to monetary disturbances in all the models which can imply that in presence of such expectations the nominal side has no direct effect on real macro variables or growth.

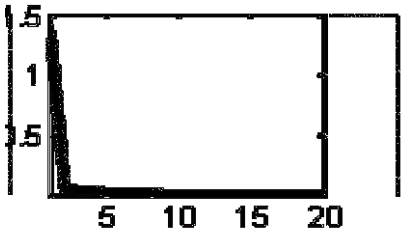
Figure 4.6: Impulse response functions due to Technology shock

CIA

Inflation

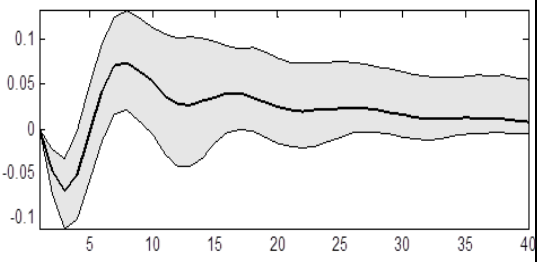


Output Growth

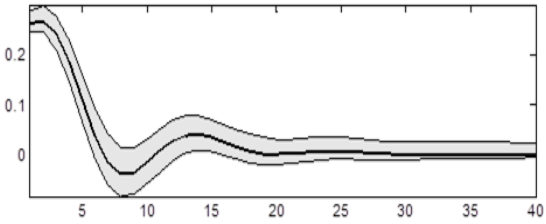


Bayesian VAR

Inflation

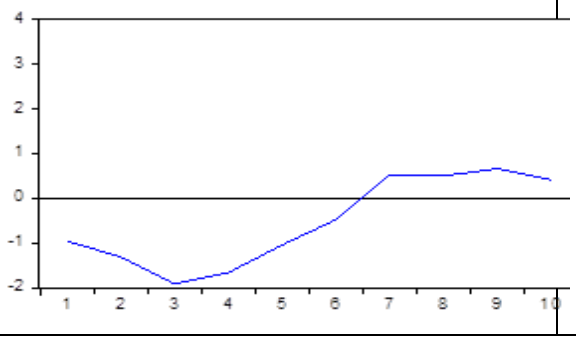


Output Growth

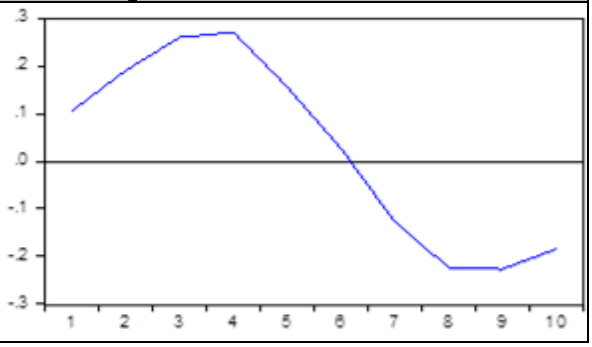


Structural VAR

Inflation



Output Growth



4.4 Concluding Remarks

As we have seen in our results from the impulse response functions, from the CIA model the anticipated inflation effect dominates the response of output to monetary disturbances. Output growth in this case is negative after a monetary shock. We recall that increased inflation expectations lead to increased nominal interest and make it more expensive for firms to get loans to increase aggregate supply. That is unanticipated shocks to the growth rate of money drive interest rates up and not down. Therefore in models in which agents employ their own money balances to finance consumption and investment, higher inflation usually leads to lower output per person and output growth. Since the SVAR explicitly uses economic theory, we would prefer the SVAR results as compared to the other models. This should encourage policy analysts as they analyse the data and outcomes, to adopt a habit of comparison of results from different models including traditional methods for better understanding of the macro economy.

Chapter V: Conclusion and Policy Implications

The results highlight the fiscal sustainability stance of the EAC countries, the fiscal policy adjustment path and compare monetary policy analytical methods for Uganda. As we saw from the linear cointegration tests Rwanda, Kenya and Uganda do not show any evidence of long run relationships in their fiscal variables. Burundi and Tanzania results showed that these two economies had sustainable fiscal policies although for Burundi it depended on the type of cointegration test that was used. Since these linear tests are based on the fact that the fiscal variables revenue and expenditure have a linear relationship assume linear adjustments of these variables, we considered that fiscal adjustments may not necessarily follow a linear path. Fiscal authorities do not usually correct every imbalance, moreover adjustments could depend on size and nature of imbalance as well as the cycle of the economy. In addition results from the loess smoother do suggest that indeed the relationship between revenue and expenditure is not linear.

The linear tax revenue error correction model controls for the cycle and state of the economy as well as a financial crisis. The results showed significant budgetary correction for Tanzania and Kenya, while for Burundi the tax policy adjustment is significant when there is a financial crisis. We also considered the

nonlinear nature of the tax revenue policy adjustment with regards to the cycle of the economy and the fiscal deficits. In this case Rwanda shows that its taxes respond negatively to the fiscal deficit when below the threshold of 1.99. Tanzania shows significant budgetary error correction and taxes response to the output gap when they exceed a threshold. Like Rwanda, Burundi taxes respond negatively to the output gap when deficits are below threshold while for Uganda and Kenya there is no statistical evidence of budgetary correction or tax response to output gap when the deficit is used as a transition variable.

In order to assess how taxes adjust differently during periods of economic downturns or expansions, we used the output gap as a transition variable. Tanzania showed evidence of budgetary error corrections both in the economic booms and economic downturns. Burundi showed evidence of error correction only in economic booms. For Burundi taxes respond positively in booms and negatively in recessions. While for Tanzania, taxes respond positively in booms. Rwanda has evidence of error correction in the economic recessions. Considering all the results on fiscal policy sustainability and adjustments, only Uganda has no statistical significance of error correction or response of taxes in any of the models, it shows no signd of fiscal sustainability nor significant tax revenue policy adjustments.

Since fiscal discipline is an important role for the implementation of monetary

policy, this analysis causes us to reexamine monetary policy for Uganda. A failure of the Ugandan economy to implement proper monetary policy can potentially create further havoc in the macro economy. In the monetary policy analysis we established the presence of a negative relationship between a monetary expansionary shock and economic growth. In general the role of money in the economy, inflationary expectations and existence of nominal institutional rigidities in the economy do affect this relationship. In general, a positive relationship between monetary expansion and economic growth can be expected with economies with low rates of inflation. This is very unlikely for economies like Uganda with high inflation otherwise we would reach the absurd conclusion that hyperinflation would drastically improve the real economy's performance.

The questions we set out to address on the fiscal side about the sustainability of public finances for the EAC countries as well as how fiscal authorities adjust fiscal policy to achieve a sustainable fiscal path have been clearly answered in the fiscal analysis. While on the monetary side we have found out the effect of a monetary shock on output growth and inflation in Uganda and we have attempted to compare the outcomes in three different models as shown in the monetary policy analysis.

The relevance of this paper and its contribution to the existing literature in analysis of the East African countries is in the richness of the additional analytical methods used in determining the fiscal sustainability and verifying fiscal policy adjustments in the East African economies as well as verifying the impact of monetary policy in Uganda. Although all the East African countries mentioned have Fiscal deficits most of the analysis on fiscal deficits that we are aware of is in form of individual country reports on fiscal deficits as well as on the determinants of the increase or improvement of the deficit. There is no analysis on a fiscal sustainability plan for the fiscal policies in these countries, unlike the countries in West Africa. Our research methodology in the fiscal analysis gives an insight in the fiscal sustainability for the East African countries using the PVBC approach. We also use a non-parametric graphical tool known as the lowess smoother that further plots the relationship between the macro economic variables. This tool easily detects the nonlinear relationship in these variables. Then we use a regime switching model that transitions smoothly from one regime of fiscal deficit to another or from an economic recession to an economic boom.

Unlike most monetary policy analysis papers on the Ugandan economy that deal with the monetary policy tools or transmission mechanism, this paper contributes to the analysis of monetary policy effect on Uganda's economy by

use of the Bayesian techniques. Results are then compared with the structural VAR model that assumes long run neutrality of money. It is the only paper to the best of my knowledge to analyse the effect of monetary shocks on the Ugandan economy using the monetary business cycle models and Bayesian techniques. It also takes into account that these models can be misspecified and hence the introduction of so a reference VAR model.

Some of the policy implications we can derive from this analysis are increased sensitization and sharing of policy plans and ideas as these countries move towards synchronizing their economies. Sensitizing the EAC countries policy makers on different fiscal policy measures required for different cycles. That is more sensitization on need to have budgetary correction measures in both economic booms and recessions as well as when the deficit is rising. Encouraging EAC countries to conduct further analysis on determining economic thresholds and monitoring them so as to maintain fiscal sustainability. EAC countries should also learn from each other on what good fiscal policy measures entail. Especially for the case of Tanzania it can share its fiscal policy strategy with rest of East African countries. In addition credibility of the central bank also is important since policies should be able to control inflationary expectations from public. Monetary policy experts should endeavor to improve on their credibility to the public especially with the bold stance of an inflation

targeting lite monetary policy regime. Monetary policy activities are very fundamental for not only financial stability of the economy but also the entire macro-economic environment. Well executed and analyzed monetary policy decisions and outcomes can mitigate impact of a failure in fiscal policy rules in the Ugandan economy.

References

1. Adam, C. (2009). *The conduct of monetary policy in Uganda: an assessment* (No. 101712). Economic Policy Research Centre (EPRC).
2. Atingi-Ego, M., & Egesa, K. A. (2008). Interest and exchange rate effects on output: implications for Uganda's monetary policy instrument mix'. *The Bank of Uganda Staff Papers Journal*, *2*, 211-231.
3. Bajo-Rubio, O., Díaz-Roldán, C., & Esteve, V. (2006). Is the budget deficit sustainable when fiscal policy is non-linear? The case of Spain. *Journal of Macroeconomics*, *28*(3), 596-608.
4. Bowdler, C., & Radia, A. (2012). Unconventional monetary policy: the assessment. *Oxford Review of Economic Policy*, *28*(4), 603-621.
5. Burret, H. T., Feld, L. P., & Köhler, E. A. (2013). Sustainability of Public Debt in Germany–Historical Considerations and Time Series Evidence.*Jahrbücher für Nationalökonomie und Statistik*, *233*(3), 291-335.
6. Caraiani, P. (2009). Forecasting the Romanian GDP in the long run using a monetary DSGE. *Romanian Journal of Economic Forecasting*, *11*(3), 75-84.
7. Castro, D.F. and Hernandez, P.D.C. (2002) 'On the sustainability of the Spanish public budget performance. *Instituto de Estudios Fiscales',*

Hacienda Pública Española_ Revista de Economía Pública, 160(1), 9-27.

8. Ciccarelli, M. M., & Rebucci, M. A. (2003). *Bayesian VARs: A survey of the recent literature with an application to the European Monetary System* (No. 3-102). International Monetary Fund.
9. Christiano, L. J., & Eichenbaum, M. (1992). Liquidity Effects and the Monetary Transmission Mechanism. *The American Economic Review*, *82*(2), 346-353.
10. Doi, T. (2004) To Establish Sustainability of Government Deficits: Methodology and Application, *Macroeconomics Working Papers.*
11. Hamilton, J.D. and Flavin, M.A. (1986). On the limitations of government borrowing: A framework for empirical testing. *American Economic Review*, 76(4), 808-819.
12. Hausman, J.K. and Wieland, J.F. (2014). Abenomics: Preliminary Analysis and Outlook. *Brookings Papers on Economic Activity* 48(1), 1-76.
13. Jacoby, W.G. (2000) 'Loess: a nonparametric, graphical tool for depicting relationships between variables', *Electoral Studies* 19(4), 577–613.
14. Legrenzi, G., & Milas, C. (2012). Nonlinearities and the sustainability of the government's intertemporal budget constraint. *Economic Inquiry*, *50*(4), 988-999.

15. Legrenzi, G., & Milas, C. (2013). Fiscal Policy Sustainability in the GIPS: New Evidence from Non-Linear Models with State-Varying Thresholds.
16. Legrenzi, G., & Milas, C. (2013). Modelling the fiscal reaction functions of the GIPS based on state-varying thresholds. *Economics Letters*, *121*(3), 384-389.
17. Nason, J. M., & Cogley, T. (1994). Testing the implications of long-run neutrality for monetary business cycle models. *Journal of Applied Econometrics*, *9*(S1), S37-S70.
18. Gastorn, K. (2016). The Progressive Liberalization of Trade in Services under the East African Community Common Market Protocol: Reviewing its Trends in the Light of the World Trade Organization General Agreement on Trade in Services. *RiA Recht in Afrika / Law in Africa / Droit en Afrique*, *18*(2), 199-224.
19. Oshikoya, W.T. and Tarawalie, A. (2010) 'Sustainability of fiscal policy: The West African Monetary Zone (WAMZ) experience', Journal of Monetary and Economic Integration, 9(2), 1-29.
20. Outlook, A. E. (2014). Global Value Chains and Africa's Industrialisation. *Organisation for Economic Co-operation and Development, United Nations Development Programme: African Development Bank*.
21. Oyeleke, O.J. and Ajilore, O. (2014) 'Analysis of Fiscal Deficit Sustainability in Nigerian Economy: An Error Correction Approach',

Asian Economic and Financial Review, 4(2), 199-210.

22. Quintos, C.E. (1995) 'Sustainability of the Deficit Process with Structural shifts', Journal of Business and Economic Statistics, 13(4), 409-417.

23. Ricciuti, R. (2004). A non-linear characterisation of fiscal sustainability. *Discussion papers in economics*, (2004-06).

24. Schorfheide, F. (2000). Loss function-based evaluation of DSGE models.*Journal of Applied Econometrics*, *15*(6), 645-670.

25. Wilcox, D. W. (1989). The sustainability of government deficits: Implications of the present-value borrowing constraint. *Journal of Money, credit and Banking*, *21*(3), 291-306.

Appendix 1: Non-Linear Empirical Results

Table A1.1: Tanzania Empirical results

	Logistic model	Logistic model
	$s_{t-1} = CV_{t-1}$	$s_{t-1} = gap_{t-1}$
Constant	0.0042836 (0.431)	0.0342998 (0.183)
$fincrisis_t$	1.76e-12 (2.51e-12)	8.57E-13 (8.86E-13)
	$CV_{t-1} < \tau^{cv}$	$gap_{t-1} < \tau^{gap}$
CV_{t-1}	-1.197812*(0.653)	-12.41966* (7.024)
gap_{t-1}	4.94e-11***(1.24e-11)	-51.57512 (33.721)
	$CV_{t-1} > \tau^{cv}$	$gap_{t-1} > \tau^{gap}$
CV_{t-1}	-0.4839206 (0.380)	-0.3886606*** (0.149)
gap_{t-1}	1.04e-13 (1.02e-12)	5.220302*** (1.740)
τ^{cv}	-1.98643 (1.663115)	
γ^{cv}	60.1484 (1116.899)	
τ^{gap}		0.177* (0.094)
γ^{gap}		-9.09 (19.949)

Table A1.2: Burundi Empirical Results

	Logistic model	Logistic model
	$s_{t-1} = CV_{t-1}$	$s_{t-1} = gap_{t-1}$
Constant	-0.6784638(0.542)	0.5437291 (0.492)
$fincrisis_t$	-9.15E-12*** (2.45E-12)	-1.19E-11*** (2.69E-12)
	$CV_{t-1} < \tau^{cv}$	$gap_{t-1} < \tau^{gap}$
CV_{t-1}	0.0286422 (0.216)	0.071077 (0.117)
gap_{t-1}	6.98E-12 (5.82E-12)	-5.75E-11*** (2.01E-11)
	$CV_{t-1} > \tau^{cv}$	$gap_{t-1} > \tau^{gap}$
CV_{t-1}	-0.0010135 (0.14)	-4.63E-01***(1.59E-01)
gap_{t-1}	-4.60E-11*** (1.74E-11)	1.06E-11* (6.36E-12)
τ^{cv}	-1.156658 (42.679)	
γ^{cv}	-322.8909 (63379)	
τ^{gap}		0.0096594*** (0.002)
γ^{gap}		-4.30E+01 (1.28E+02)

Table A1.3: Rwanda Empirical Results

	Logistic model	Logistic model
	$s_{t-1} = CV_{t-1}$	$s_{t-1} = gap_{t-1}$
Constant	0.5921904 (0.374)	0.7494216*(0.426)
$fincrisis_t$	2.51E-13 (1.89E-12)	2.55E-13 (1.92E-12)
	$CV_{t-1} < \tau^{cv}$	$gap_{t-1} < \tau^{gap}$
CV_{t-1}	-0.331173 (0.447)	0.6957167* (0.423)
gap_{t-1}	5.32E-13 (4.36E-12)	-1.15E-11 (8.71E-12)
	$CV_{t-1} > \tau^{cv}$	$gap_{t-1} > \tau^{gap}$
CV_{t-1}	0.422778 (0.438)	-0.5237883 (0.348)
gap_{t-1}	-3.51E-11** (1.66E-11)	1.73E-12 (5.08E-12)
τ^{cv}	-1.991441***(0.035)	
γ^{cv}	-102.5765 (7044.384)	
τ^{gap}		0.0163274 (0.021)
γ^{gap}		-126.592 (2576.681)

Table A1.4: Kenya Empirical Results

	Logistic model	Logistic model
	$s_{t-1} = CV_{t-1}$	$s_{t-1} = gap_{t-1}$
Constant	-0.37849 (0.382)	
$fincrisis_t$	-1.30E-13 (1.83E-12)	
	$CV_{t-1} < \tau^{cv}$	$gap_{t-1} < \tau^{gap}$
CV_{t-1}	19.58444(254.031)	
gap_{t-1}	-1.93E-10 (2.99E-09)	
	$CV_{t-1} > \tau^{cv}$	$gap_{t-1} > \tau^{gap}$
CV_{t-1}	-20.66319 (254.028)	
gap_{t-1}	1.97E-10 (2.99E-09)	
τ^{cv}	-0.0688314#	
γ^{cv}	-0.0134731 (0.170)	
τ^{gap}		
γ^{gap}		

Table A1.5 Uganda Empirical Results

	Logistic model	Logistic model
	$s_{t-1} = CV_{t-1}$	$s_{t-1} = gap_{t-1}$
Constant	0.6174577 (0.498)	0.708444** (0.337)
$fincrisis_t$	1.01E-12 (1.80E-12)	2.05E-12 (1.73E-12)
	$CV_{t-1} < \tau^{cv}$	$gap_{t-1} < \tau^{gap}$
CV_{t-1}	-0.08409 (0.318)	32.24243 (3.41E+02)
gap_{t-1}	6.05E-13 (8.36E-13)	-7.55E-11 (8.00E-10)
	$CV_{t-1} > \tau^{cv}$	$gap_{t-1} > \tau^{gap}$
CV_{t-1}	-0.3697862 (0.319)	-32.79579 (341.389)
gap_{t-1}	1.70E-13 (4.68E-13)	7.64E-11 (8.00E-10)
τ^{cv}	-0.0913299#	
γ^{cv}	3.522603 (10.903)	
τ^{gap}		-0.0017168#
γ^{gap}		-0.0195617 (0.205)

STATA code

```
capture program drop pasodoble
program pasodoble
        args lnf theta1 theta2 theta3 theta4 theta5 theta6 theta7 theta8 theta9
        tempvar m1 m2 m3 thetheta m u
        quietly generate double `m1'= `theta2'*eUgL1 + `theta3'*UghpL1
        quietly generate double `m2'= `theta4'*eUgL1 + `theta5'*UghpL1
        quietly generate double `m3'= `theta6'*finpress
        quietly generate double `thetheta' = 1 -((1 +exp(-`theta7'*(eUgL1 -
`theta8')/s.d))^(-1))
        quietly generate double `m'= `theta1' + `m1'* `thetheta' +`m2'*(1-
`thetheta')+`m3'
        quietly gen double `u' = UgTxD1 - `m'
        quietly replace `lnf' = lnnormalden(`u', 0,`theta9')
end
ml model lf pasodoble () () () () () () () () ()
ml init
ml maximize
```

Appendix 2: Structural VAR

Structural VAR Estimates

Sample (adjusted): 3/01/2000 6/01/2013
Included observations: 54 after adjustments
Estimation method: method of scoring (analytic derivatives)
Convergence achieved after 8 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I
Restriction Type: long-run pattern matrix
Long-run response pattern:

C(1)	C(2)
0	C(3)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	13.44257	1.293512	10.39230	0.0000
C(2)	-5.581199	1.906507	-2.927448	0.0034
C(3)	0.399520	0.038444	10.39230	0.0000

Log likelihood -89.71032

Estimated A matrix:

1.000000	0.000000
0.000000	1.000000

Estimated B matrix:

2.801873	-0.951508
0.011817	0.106032

Table A2.1

Variance decomposition Inflation

Period	S.E.	P_OBS	Y_OBS
1	2.664282	100.0000	0.000000
2	3.472555	99.91291	0.087086
3	4.173620	94.60674	5.393265
4	4.627222	87.92908	12.07092
5	4.937674	81.89172	18.10828
6	5.283826	78.27445	21.72555
7	5.436225	79.47280	20.52720
8	5.532367	79.39268	20.60732
9	5.683810	76.94838	23.05162
10	5.944803	75.16137	24.83863

Variance decomposition Growth

Period	S.E.	P_OBS	Y_OBS
1	0.071597	4.715820	95.28418
2	0.144031	2.202337	97.79766
3	0.233327	0.859127	99.14087
4	0.317890	1.071139	98.92886
5	0.358403	2.969683	97.03032
6	0.369927	5.001422	94.99858
7	0.378643	6.931345	93.06866
8	0.413538	5.838464	94.16154
9	0.472307	6.890851	93.10915
10	0.522489	8.056233	91.94377