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Sectoral effects of monetary policy in Uganda

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Abstract

The paper investigates the sectoral effects of monetary policy in Uganda over the period 1999 to 2011. Sectors which are the key drivers of Uganda's GDP growth were analyzed. These included agriculture, manufacturing and service sectors. The analysis based on pair wise granger causality test and estimating a recursive VAR reveals that the exchange rate channel is the most effective monetary policy transmission channel to all the three sectors studied, while the interest rates and bank credit channels remain relatively weak channels of monetary policy especially within the manufacturing sector. Furthermore, a positive shock in exchange rates results into growth of agriculture and service sectors' GDP. The contrast is realized in the manufacturing sector. Thus, based on these findings, emphasis should be put on maintaining a stable exchange rate that favors both exports and imports to ensure growth of both the manufacturing sector which mainly relies on imported-inputs and the agricultural and services sectors' exports.

Mathematics Subject Classification: B23

Keywords: Monetary Policy Transmission Mechanism; Vector Auto-regression (VAR); sectoral growth; Uganda

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1 Introduction

Uganda's economy has experienced impressive growth rates averaging about 7 percent over the past two decades. This has been achieved through a macroeconomic management strategy aimed at securing price stability as the anchor for realization of growth. However, this strategy has focused on mitigating aggregate demand through restrictive monetary policy and hence high interest rates that continue to hurt private investment and growth. The extent of the impact of monetary policy on growth has raised issues of concern among policy makers. Particularly, the channels through which the monetary policy impulse is transmitted to the productive sectors of the economy, has been a subject of debate among policy makers.

Literature shows that, monetary policy may have adverse effects on sectoral growth and consequently on overall growth and that; different sectors of the economy react differently to monetary policy shocks (Serju, 2003; Alam and Waheed, 2006 and Dhal, 2011). Therefore, it is necessary to know which sectors respond first to a policy shock and whether the effects could be more prominent in some sectors than in others. This may provide relevant information for policy purposes (Ganley and Salmon, 1997). For the case of Uganda, as is clearly stated in the National Development Plan, emphasis is put on developing agriculture and manufacturing as the primary growth sectors that will drive the economy to economic transformation (NDP 2010). Thus, empirical evidence on how these sectors react to monetary policy shocks is relevant for policy direction on how to boost growth. Indeed, studies on sectoral analysis of monetary policy transmission channels in other developing countries, particularly, Nigeria and Jamaica, indicate that contractionary monetary policy adversely affects agriculture and manufacturing, which are regarded as the primary growth sectors for most developing economies (Serju, 2003 and Ifeakachukwu and Olufemi, 2012).

In Uganda, studies on monetary policy and growth, for example Mugume (2011), have focused on the effect of monetary policy on overall real output growth. However, empirical evidence and the documentation pertaining to the effect of monetary policy at the sector level in Uganda is scanty and less studied. This raises two important research questions: How do the different sectors of the economy react to monetary policy effects in Uganda? Has this got any policy implications on overall growth? Based on the identified empirical gap and the research questions, this study sets out to examine the sectoral effects of monetary policy in Uganda. To this effect, three sectors that are key drivers of Uganda's GDP growth are analyzed. These include; agriculture, manufacturing and service sectors. Unlike many similar studies in other developing countries that focus on one transmission channel, this study is distinctive as it uses an extensive approach based on the three relevant channels of monetary policy transmission (exchange rate, interest rate and bank credit) for Uganda. The asset price channel is not effective in Uganda due to a small and under developed capital market, thus is not examined in this study.

This study builds on Mugume (2011) to investigate the impact of monetary policy at the sectoral level. It employs a structural recursive Vector Autoregressive framework, which, following Sims (1980), has become the methodology of choice for investigating the impact of monetary policy in the economy. This framework has the advantage that it offers an empirical link between data and theory in economics. In a developing country context in particular, it is even more appropriate since the intricate functioning of the economy at a macro-level makes the exclusion restrictions required in structural approaches implausible. The findings of this study will build on the existing literature surrounding the effects of monetary policy on growth, and will be relevant for policy purposes.

The rest of the paper is organized as follows: section 2 looks at the theoretical framework, section 3 looks at the review of related literature and section 4 highlights the methodology and estimation procedures. The empirical results, conclusions and policy considerations are presented in sections 5 and 6 respectively.

2 Theoretical framework

Monetary policy transmission mechanism is defined as the channel through which changes in money supply affects the decisions of firms, households, financial intermediaries, investors and ultimately alters the level of economic activity and prices (Mishikin 1996 and Kuttner 2001). This study employs the Keynesian approach of monetary theory transmission mechanism to real sector growth. It focuses on the analysis of monetary policy transmission channels from the aggregate demand side of the economy. This is so because aggregate supply is assumed to be fixed in the short run and flexible in the long run due to automatic adjustments in the economy arising from monetary policy shocks (Ifeakachukwu *et al*, 2012). However, these Keynesian assumptions do not realistically apply to Uganda as the structure of the economy is not sufficiently developed to allow for the required automatic adjustments.

On the aggregate demand side, monetary policy effects are channeled through the exchange rates, interest rates and asset prices or wealth channels which consequently affect bank credit channels. Thus, the transmission effect of monetary policy to growth will be explored through analysis of these channels.

The interest rate channel is bench-marked on the conventional Taylor (1993) rule in equation 1, which reflects the actions of the monetary authority to adjust policy rates in relation to inflation and output movements.

$$r_t = \beta\pi_t + \delta y_t \tag{1}$$

where; r_t is the short term interest rate, π_t is the inflation rate and y_t is the output

Under this framework, a contractionary monetary policy reflected through a positive shock to the short term interest rate leads to a rise in the domestic real interest rates. This in turn, increases the cost of capital and further reduces; the amount of credit to the private sector hence forcing households to cut back on their expenditures, which constrains investment and eventually results in positive inflationary pressures hence negative output growth (Mishikin, 2004).

In open economies, the effects of the policy induced rate (short term interest rate) are most pronounced through the exchange rate channel (Ireland, 2005). This mainly arises from interest rate differentials between domestic interest rates and foreign interest rates. A contractionary monetary stance creates an appreciation of the exchange rate. This is due to increasing capital inflows arising from the high domestic interest rates relative to foreign rates. The exchange rate appreciation poses negative implications for investment and export demand since it makes local goods more expensive as compared to foreign goods. Appreciation therefore reduces output on account of lesser investment and net exports. The exchange rate channel is inspired by the uncovered purchasing power parity in equation 2, which clearly relates short term interest rates and output growth to exchange rate movements.

$$e_t = \varphi e_{t-1} + \varphi e_{t+1} + \beta i^* + \delta y_t \qquad (2)$$

where; e_t is the nominal exchange rate, i^* is the interest rate differential and y_t is the output.

Equation 3 is the Phillips curve which reveals that inflation depends on the expected inflation, the domestic output gap and the real exchange rate. Further to equation 2, we conclude from equation 3 that exchange rates directly affect inflation through its effect on the prices of net exports.

$$\pi_t = \beta \pi_t^e + \delta y^*_t + \varphi e_t + \varepsilon_t \qquad (3)$$

Where; π_t^e is the expected inflation rate, y^*_t is the domestic output gap e_t is the real exchange rate and ε_t is the stochastic error term.

The bank credit channel has an indirect transmission effect from monetary policy upon growth. A contractionary monetary policy stance, through reducing bank reserves and bank deposits, constrains the quantity of bank loans available to borrowers (Bernanke and Gertler, 1989). This ultimately reduces private investment and output.

Regarding the asset price channel, the transmission mechanism effect is analyzed based on two aspects: the Tobin (1969)'s q theory of investment and the wealth effect. The Tobin's q theory of investment defines q as the market value of firms divided by the cost of depreciation. Therefore, a contractionary monetary policy will trigger a rise in asset prices, given the increase in domestic interest rates relative to foreign interest rates. The high asset prices imply a high value of q-as defined above. As the market value of firms increases, so will investment expenditure. On the wealth aspect, an increase in asset prices increases the financial wealth of consumers and thus increases consumers' life time resources, which in turn increases household's consumption expenditures (Mishkin, 1996). But recall that the asset price channel is not relevant to Uganda due to a small and under developed capital market.

Overall, the level of economic activity in an open economy is summarized in equation 4 - the IS aggregate demand model. This model follows that developed by Ireland (2005) and Sznajderska (2011). Based on this model, economic activity is majorly determined by; the level of economic activity in the previous and future periods; the real interest rates; the real exchange rates and any other factors arising mainly from supply related shocks in the economy. As discussed earlier, high interest rates constrain the level of economic activity whereas, depreciation in the real exchange rates promotes growth through its effect on net exports. With regard to monetary transmission mechanism, equation 4; clearly points out the channels of monetary policy transmission. The interest rate and asset price channels are reflected in the coefficient of real interest rates (β); the exchange rate channel is reflected in the coefficient of the real exchange rate (λ); and the credit channel is reflected in the coefficient of the interest rate spread (δ).

$$y_t = \lambda_t + \alpha_1 y_{t-1} + \alpha_2 y_{t+1} + \beta r_t + \lambda e_t + \delta i^* + \varepsilon_t \tag{4}$$

where; y_{t-1} and y_{t+1} is the previous and expected growth in output respectively; r_t is the real interest rates, e_t is the real exchange rate, i^* the spread between interest on loans and the market interest rate and ε_t is the error term reflecting other stochastic shocks to the economy.

3 Review of related literature

There is increasing interest between researchers and policy makers on the transmission effects of monetary policy on the real sector. As a result, numerous studies on the transmission channels of monetary policy on overall real sector growth have been conducted for both developed and emerging economies. However, there are ever increasing debates upon how monetary policy affects the different sectors of the economy. There is scanty literature surrounding the impact of monetary policy on the real sector at a disintegrated level.

Mugume (2011) analyzes the transmission channels of monetary policy in Uganda using a structural VAR model. The results from the impulse responses and variance decomposition analysis revealed that monetary policy influences inflation[2] and real economic activity. However, the distribution of the impact at

[2]The overall objective of monetary policy is price stability.

the sectoral level was not considered. Hence, a sectoral analysis of monetary policy is necessary to guide the appropriate policies to spur Uganda's economic growth.

Studies undertaken in other emerging economies indicate that indeed monetary policy has significant and distinct impacts upon different sectors of the economy. Ifeakachukwu and Olufemi (2012) use an unrestricted VAR approach to analyze the impact of monetary policy on the Nigerian economy at the multi-sectoral level. The results of their study reveal that the agriculture and manufacturing sectors are most affected by interest rates, while other sectors such as building/construction, mining, and wholesale/retail sectors are more affected by exchange rate shocks. The study further concludes that interest rate and exchange rate policies were the most effective monetary policy measures in stimulating sectoral output growth in Nigeria.

Cardia and Murcia (2004) uses a dynamic stochastic general equilibrium (DSGE) model to analyze the transmission of monetary policy in a multi-sector economy. Their results show a strong sensitivity to monetary policy shocks on the part of construction and durable manufacturing. These results confirm the findings of Serju (2003) who showed that the manufacturing sector experiences the largest and quickest decline in response to an interest rate shock in Jamaica. Furthermore, Ilker (1999), using a VAR estimation method found that small manufacturing firms are more affected by interest rate shocks while large manufacturing firms are prone to exchange rate shocks. This may also apply to Uganda, as it is equally a small open economy that has a manufacturing sector characterized by both small and large domestic and international firms.

Sahinoz and Cosar (2009) investigate the response of output in the Turkish manufacturing sector to a contractionary monetary policy shock using a vector autoregressive framework. Their findings show that the manufacturing sector largely responds to a contractionary monetary policy shock via the exchange rate channel. Similarly, Mehdi and Reza (2011) use the auto regressive distributed lag (ARDL) model to establish the effect of monetary policy on Iran's industrial sector. Their results also indicate that monetary policy affects Iran's industrial sector mostly through the exchange rates and bank credit channels. The significant impact of exchange rate shocks to the manufacturing sector points to the nature of manufacturing firms within these economies: large in size both in terms of exports and imports of their product and inputs respectively.

A tight monetary policy deters growth throughout the different sectors of the economy. This is confirmed by Karim et al (2006) who use a VAR approach to study the impact of contractionary monetary policy on different sectors of the Malaysian economy. Their findings suggest that the negative impact of contractionary monetary policy has the largest effect upon the agriculture, manufacturing and mining sectors in Malaysia. In Uganda, the relationship between agriculture, manufacturing, mining and monetary policy may be even greater given that these have a much larger weight in the Ugandan economy.

Lawson and Rees (2007) use a structural VAR to analyze the effect of monetary policy on production and expenditure in Australia. They argue that on the expenditure side, dwelling and machinery & equipment investment are the most interest-sensitive sectors of gross domestic product in the Australian economy, while construction and retail trade are the most interest-sensitive sectors on the production side of the economy.

In summary, the monetary policy transmission mechanisms largest channel of influence upon growth varies at the sector level. This has implications for aggregate growth, depending on a sector's contribution to national GDP. The agriculture and services sectors are mostly affected by interest rate and exchange rate channels. The effect of monetary policy shocks on the manufacturing sector is most prounced through the exchange rate channel. We can also conclude from the literature that VAR, DSGE and ARDL methodologies are the widely used approaches to investigate monetary policy effects upon growth. This study will adopt the VAR approach. The strength of the VAR approach over the other approaches suggested in the literature is that it provides a link between the estimated model residuals and the structural shocks of the underlying macro economy which are relevant for the identification of specific innovations of the variables within the estimated model (Garratt.*et.al*, 1998). Besides, it is the preferred approach for short run iterations between different variables (Jamilov, 2012).

4 Data and Methods

4.1 Model specification

The empirical approach employed in this study is the VAR framework. This approach is widely used in economic analysis because it provides a link between economic theory and macroeconomic variables. In this study, three VAR systems were estimated. Each system consists of six endogenous variables including: 91- day Treasury bill interest rate (Tb), regarded as the reference rate and used as a proxy to signal the monetary policy stance; the lending interest rate (LR), included to capture the interest rate channel; the nominal exchange rate (EXT), included to capture the dynamics of the monetary policy transmission mechanism through the exchange rate channel; credit to private sector (PR), included to capture the bank credit channel; CPI inflation (CPI), included to capture inflation; and finally sectoral GDP for agriculture (AGRIC), manufacturing (MAN) and services (SER), included to capture the sectoral outputs.

The analysis was based on quarterly data spanning from 1999Q1 to 2011Q2. The data was de-seasonalised to take care of the seasonal elements in the model. The VAR model for this study was specified as follows:

$$Ax_t = B(L)Lx_t + \varepsilon_t \qquad (5)$$

where:
x_t is a *k x1* – dimensional Vector of the endogenous variables, A is a *k x k* - dimensional autoregressive coefficient matrices, L is the lag operator, that is; $Lx_t = x_{t-1}$ and $B(L)$ is $B_0 + B_1L + B_2L^2 + ... + B_kL^k$ is the autoregressive lag order polynomial; while, ε_t is dimensional vector of the stochastic error term nominally distributed with white noise properties N (0, σ2).

In order to capture the impact of shocks within the monetary policy variables upon sectoral output, a structural recursive VAR model is estimated from the reduced VAR form. Thus, from equation (5), the reduced form VAR is estimated in equation (6)

$$x_t = A^{-1}B(L)Lx_t + \mu_t \qquad (6)$$

where: μ_t is A^{-1}, e_t is a vector of reduced form residuals with E ($u_t u_t$') =**Ω**. Structural shocks are generated using cholesky decomposition of the variance-covariance matrix of the reduced form VAR residuals, **Ω**, from equation (6). The relationship between the reduced form VAR residuals and the structural disturbances is presented in equation (7).

$$\begin{bmatrix} \varepsilon^{tb} \\ \varepsilon^{lr} \\ \varepsilon^{pr} \\ \varepsilon^{ext} \\ \varepsilon^{cpi} \\ \varepsilon^{gdp} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} \mu^{tb} \\ \mu_t^{lr} \\ \mu_t^{pr} \\ \mu_t^{ert} \\ \mu_t^{cpi} \\ \mu_t^{gdp} \end{bmatrix} \qquad (7)$$

Where μ_t^{tb} denotes monetary policy shocks, μ_t^{lr} interest rate shocks, μ_t^{pr} credit to the private sector shocks, μ_t^{ext} exchange rate shocks, μ_t^{GDP} aggregate demand/sectoral output shocks and μ_t^{CPI} inflation shock. The structural model is identified because the *k (k-1)*/2 restrictions are imposed on the matrix A as zero restrictions where k denotes the number of endogenous variables in the VAR system.

The resulting matrix implies that in the first equation, a monetary policy shock is not a reaction to changes in the other variables in the model. In equation 2, lending rates respond to monetary policy shocks only, in equation 3, private sector credit responds to the monetary policy and resultant lending rate shocks only; in equation 4, the nominal exchange rate responds to the monetary policy shocks, the lending rates shocks and shocks due to private sector credit only;. in equation 5 and 6, inflation and aggregate demand/sectoral outputs reacts to all the shocks due to other variables in the system.

Based on this specification, the model is estimated as structural recursive VAR using cholesky decomposition. Impulse response analysis will be used to show the response of aggregate demand/sectoral outputs and core inflation to shocks in the other variables in the model. From this analysis, the effective transmission channels of monetary policy shocks will be identified. Additionally, variance decomposition analysis will enable us to determine the importance of each of the variables on influencing the sectoral outputs and inflation.

4.2 Data source

Data was collected from the Uganda Bureau of Statistics (UBoS) and Bank of Uganda (BoU) database. Data on sectoral GDP for agriculture, manufacturing and services was collected from UBoS. Data on interest lending rates, nominal exchange rates, credit to the private sector and 91-day treasury bill rates was collected from the BoU database. All variables were transformed to logarithmic form except for the lending rates (LR) and treasury bill rates (TB).

4.3 Estimation procedure

Based on the above model specification, it is appropriate to determine the time series properties in the VAR specification. The time series properties of the endogenous variables are plotted in appendix 2. All variables appear to contain a deterministic trend save for the lending rate. Further, the variables in the model were subjected to unit root tests using the Augmented Dickey-Fuller (ADF) test. The results of the ADF test were compared with the Philips Peron (PP) test to confirm the order of integration. The unit root tests confirm that the outputs for the three sectors considered in the analysis are I(0), whilst the monetary policy variables are I(1). In other words, the monetary policy variables become stationary after first differencing. The results of the unit root tests are presented in Annex 2. Despite the stationarity tests conducted on the variables, the VAR model was estimated in levels in order to avoid losing information surrounding possible long-run relationships among the variables. This was confirmed by Sims, Stock and Watson, 1990.

The appropriate lag length was selected based on the LR test and the Akaike Information Criteria (AIC). Based on this criterion a common lag length of 2 quarters for each VAR model was adopted. The selection of this lag length is appropriate for whitening the errors in the model as confirmed with the LM test for serial autocorrelation (*Annex 3*). The results of the lag selection criteria are presented inTable 1 below.

Table 1: Lag selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: LR LPR LEXT LCPI LSER LAGRIC LMAN

Exogenous variables: C

Lag	LogL	LR	FPE	AIC	SC	HQ
0	428.0372	NA	7.09e-17	-17.32073	-16.49407	-17.00965
1	588.7920	253.1032	6.38e-19	-22.07625	-19.32071*	-21.03933*
2	642.7054	68.82566*	6.29e-19*	-22.28534*	-17.60092	-20.52256

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

This study uses a structural analysis of the VAR model based on three approaches namely granger causality, impulse response analysis and the forecast variance decomposition. To estimate the power of forecasting among variables, the granger causality test is performed to determine whether lags of one endogenous variable significantly improved the forecasting performance of another variable for each VAR model. In other words bivariate granger causality tests are conducted to show the direction causation between variables.

The impulse response analysis is estimated to examine how the impact of a shock in one variable transmits through the dynamic lag structure of the VAR model to other endogenous variables in the VAR model, while the forecast error variance decomposition estimates the proportion of a shock to a given variable due to its own shock or shocks to other variables within the VAR model in a given forecasting time period.

4.4 Analysis of robustness

a) Testing the model stability

A VAR model is said to be stable if the roots of the characteristic polynomial have a modulus of less than one and also lie within the radius of the circle.

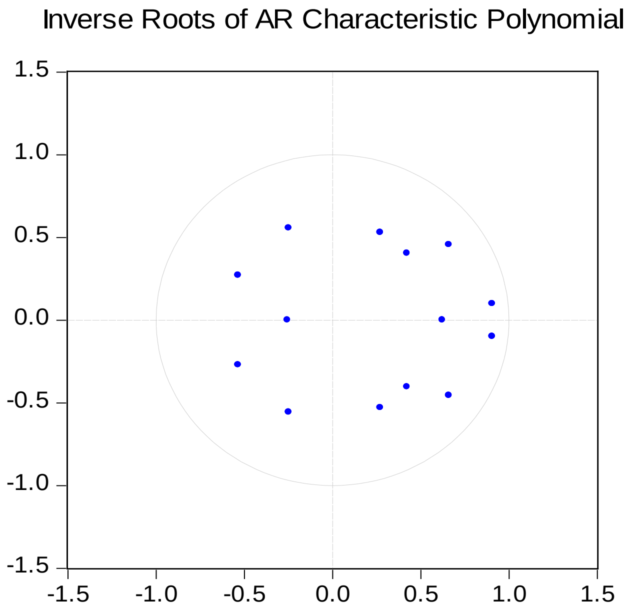


Figure 1: The AR test for model stability

The AR graph in figure 1 reveals that the coefficients matrix characteristic roots have modules of less than unit. In addition, the AR graph also indicates that the roots lie within the unit circle. This confirms the stability of the VAR model.

b) Diagnosis of residual terms

Another important element in robustness checks for VAR models is ensuring that the error terms are white noise. That is, there should be no issues of autocorrelation, the error terms should have constant variance (homoscedastic) and most importantly the model should be normally distributed. In this analysis, the portmanteau test was used to test for serial correlation of the residuals. According to Table 2, the probability values allow us to accept the null hypothesis that there is no serial correlation in the model. This finding is also confirmed in by the LM test which reveals no serial correlation among the error terms (*Annex 3*).

The white's test was conducted to test for homoscedacity of the residuals in the model. The null hypothesis states that all the residuals have constant variance or are homoscedastic. The results in Table 3 reveal that the probability value remains higher than the 5 percent level of confidence hence we accept the null hypothesis that the residuals are homoscedastic.

Table 2: Testing for residual autocorrelation using the Portmanteau Test

Null Hypothesis: no residual autocorrelations up to lag h
Sample: 1999Q1 2011Q2
Included observations: 48

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	33.65932	NA*	34.37548	NA*	NA*
2	77.12946	0.8669	79.73562	0.8154	92
3	140.2834	0.5012	147.0998	0.3454	141
4	191.8270	0.4492	203.3292	0.2412	190
5	239.4346	0.4799	256.4726	0.2087	239
6	277.5252	0.6606	300.0047	0.3012	288
7	317.7340	0.7676	347.0784	0.3409	337
8	350.0031	0.9056	385.8013	0.4933	386
9	390.5241	0.9382	435.6733	0.4819	435
10	427.5419	0.9692	482.4326	0.5116	484

* The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution
* df and Prob. may not be valid for models with exogenous variables

Table 3: Testing the residual homoscedasticity

Joint test:

Chi-sq	df	Prob.
914.6672	896	0.3250

Individual components:

Dependent	R-squared	F(32,14)	Prob.	Chi-sq(32)	Prob.
res1*res1	0.743162	1.265909	0.3276	34.92862	0.3306
res2*res2	0.610742	0.686433	0.8155	28.70487	0.6341
res3*res3	0.787051	1.616986	0.1702	36.99142	0.2493
res4*res4	0.712499	1.084232	0.4539	33.48744	0.3950
res5*res5	0.842786	2.345336	0.0461	39.61096	0.1668
res6*res6	0.770753	1.470921	0.2237	36.22539	0.2779
res7*res7	0.662919	0.860407	0.6519	31.15718	0.5090
res2*res1	0.690871	0.977766	0.5432	32.47093	0.4436
res3*res1	0.804341	1.798531	0.1216	37.80402	0.2212
res3*res2	0.471507	0.390325	0.9863	22.16083	0.9030
res4*res1	0.801597	1.767603	0.1287	37.67504	0.2255
res4*res2	0.693271	0.988839	0.5335	32.58372	0.4381
res4*res3	0.925918	5.468103	0.0008	43.51814	0.0842
res5*res1	0.746156	1.285997	0.3157	35.06932	0.3246
res5*res2	0.484205	0.410706	0.9816	22.75765	0.8858
res5*res3	0.847022	2.422385	0.0405	39.81003	0.1615
res5*res4	0.721934	1.135865	0.4145	33.93088	0.3746
res6*res1	0.565609	0.569657	0.9075	26.58361	0.7372
res6*res2	0.717543	1.111409	0.4328	33.72453	0.3840
res6*res3	0.612808	0.692431	0.8102	28.80198	0.6292
res6*res4	0.729464	1.179662	0.3833	34.28482	0.3587
res6*res5	0.767060	1.440664	0.2368	36.05181	0.2846

Table 4: Testing for normality of the VAR Residuals

Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Sample: 1999Q1 2011Q2
Included observations: 48

Component	Skewness	Chi-sq	df	Prob.
1	-0.050459	0.019945	1	0.8877
2	0.074167	0.043090	1	0.8356
3	-0.168052	0.221224	1	0.6381
4	-0.011896	0.001109	1	0.9734
5	-0.294465	0.679226	1	0.4099
6	-0.580251	2.637418	1	0.1044
7	-0.332690	0.867012	1	0.3518
Joint		4.469022	7	0.7244
Component	Kurtosis	Chi-sq	df	Prob.
1	2.740291	0.132087	1	0.7163
2	2.060466	1.728666	1	0.1886
3	4.068043	2.233901	1	0.1350
4	2.551183	0.394480	1	0.5300
5	4.840621	6.634607	1	0.0100
6	3.318607	0.198791	1	0.6557
7	2.885145	0.025834	1	0.8723
Joint		11.34837	7	0.1241
Component	Jarque-Bera	df	Prob.	
1	0.152032	2	0.9268	
2	1.771756	2	0.4124	
3	2.455125	2	0.2930	
4	0.395589	2	0.8205	
5	7.313833	2	0.0258	
6	2.836209	2	0.2422	
7	0.892845	2	0.6399	
Joint	15.81739	14	0.3247	

5 Results and discussion

a) Pair wise granger causality

The pair-wise granger causality test was employed to identify the possible transmission channels of monetary policy to sectoral outputs. For this purpose, pair wise granger causality tests were employed between each sectoral GDP and each monetary policy variable (lending interest rates, bank credit and the exchange rate). The results are presented in table 6. The results reveal a unidirectional causation from each monetary variable to the sectors' GDP save for the manufacturing sector, which reveals no causation between lending interest rates and manufacturing GDP. This implies that all channels of monetary policy are fundamental in transmitting monetary policy effects to sectoral GDP growth. However, the lending interest channel may be weak in the manufacturing sector.

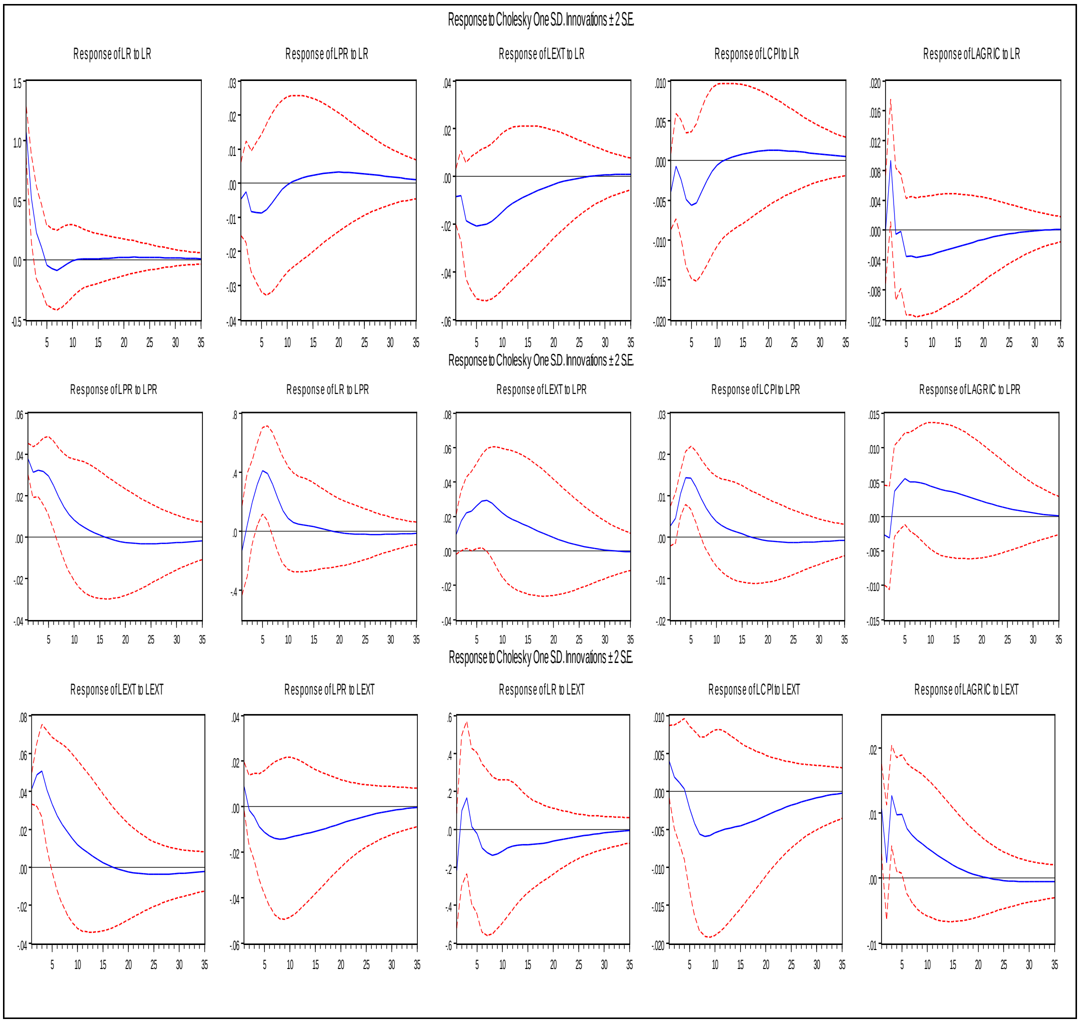
Table 6: Pair-wise granger causality tests for sectoral outputs

Ho	*F-statistic*	*P-value*	*Conclusion*
Agriculture GDP does not Granger Cause interest rates	*0.363*	*0.70*	*Accept*
Interest rates do not Granger Cause Agriculture GDP	*3.627*	*0.03*	*Reject*
Agriculture GDP does not Granger Cause private sector credit	*0.606*	*0.55*	*Accept*
Private sector credit does not Granger Cause Agriculture GDP	*4.052*	*0.02*	*Reject*
Agriculture GDP does not Granger Cause exchange rate	*1.657*	*0.20*	*Accept*
Exchange rate does not Granger Cause Agriculture GDP	*3.09*	*0.05*	*Reject*
Manufacturing GDP does not Granger Cause interest rates	*0.663*	*0.52*	*Accept*
Interest rates do not Granger Cause Manufacturing GDP	*0.007*	*0.99*	*Accept*
Manufacturing GDP does not Granger Cause private sector credit	*0.811*	*0.45*	*Accept*
Private sector credit do not Granger Cause Manufacturing GDP	*3.751*	*0.03*	*Reject*
Manufacturing GDP does not Granger Cause exchange rate	*1.386*	*0.24*	*Accept*
Exchange rate do not Granger Cause Manufacturing GDP	*3.128*	*0.08*	*Reject*
Service GDP does not Granger Cause interest rates	*1.93957*	*0.14*	*Accept*
Interest rates do not Granger Cause services GDP	*3.08507*	*0.04*	*Reject*
Service GDP does not Granger Cause private sector credit	*0.64300*	*0.43*	*Accept*
Private sector credit does not Granger Cause services GDP	*5.66815*	*0.02*	*Reject*
Services GDP does not Granger Cause exchange rate	*1.68331*	*0.20*	*Accept*
Exchange rate does not Granger Cause services GDP	*2.59634*	*0.09*	*Reject*

b) Impulse response functions

The impulse response analysis was based on the impact of a positive one standard deviation shock from the monetary policy variables upon agricultural, manufacturing and services GDP. The effect of shocks from the monetary variables upon sectoral outputs was considered to examine the transmission channels of monetary policy at the sectoral level. The results of the impulse response functions for the three sectors are presented in figures i), ii) and iii)

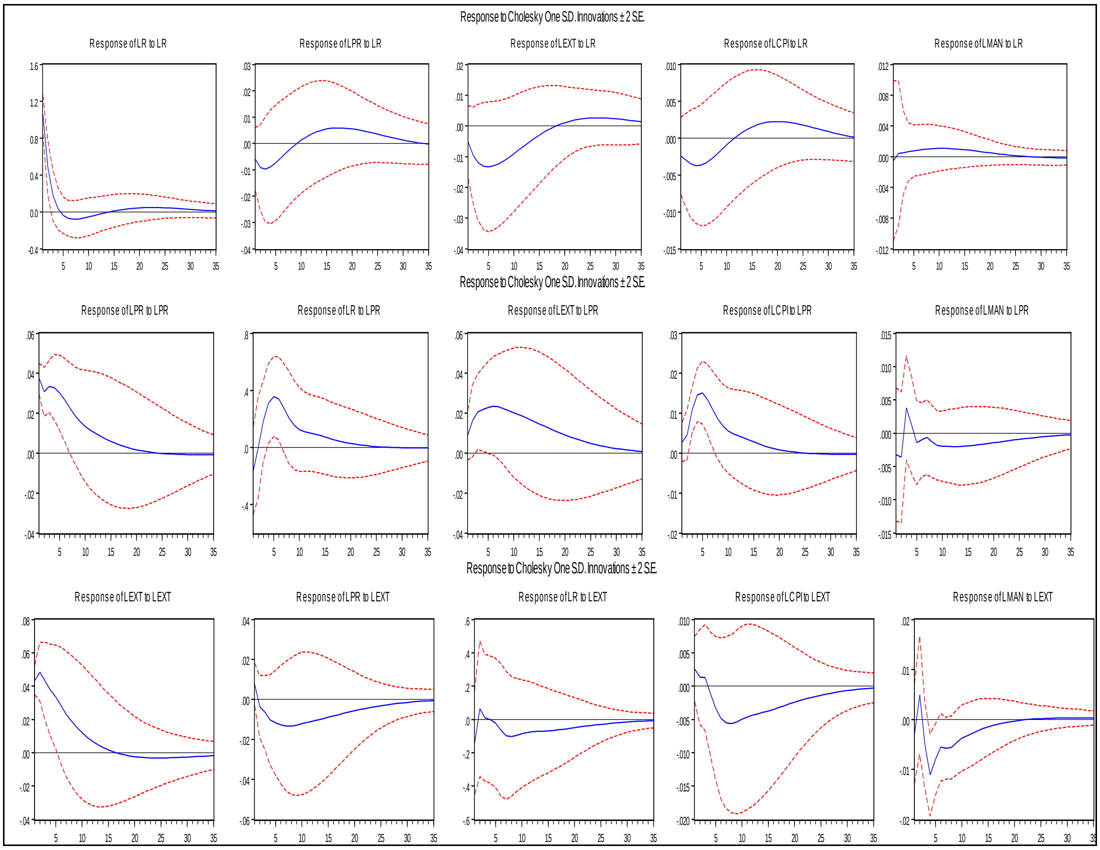
i) Agricultural sector



Source: Authors' own computations

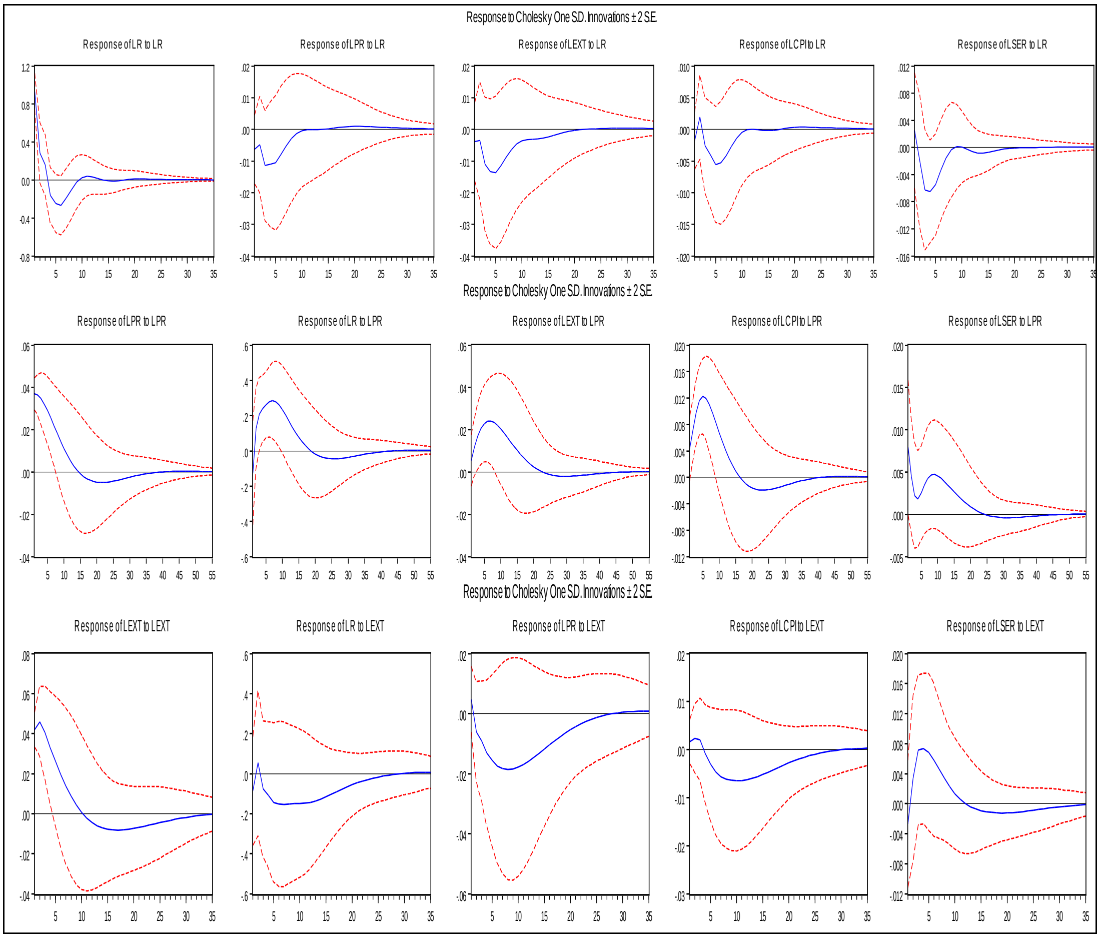
In the agricultural sector, the impulse response functions reveal that a one standard deviation positive shock in lending interest rates results into a reduction in agricultural GDP. A rise in lending interest rates reduces agriculture GDP and takes full effect after about 6 quarters. On the other hand, a positive shock in credit to the private sector results into growth in the sector's GDP as shown in the impulse responses above. The maximum impact of the shock to the sector is realized after 5 quarters. Similarly, a positive shock in the exchange rates (exchange rate depreciation) results into an increase in the sector's GDP with the maximum impact felt after about 4 quarters. The results of the impulse response analysis in the agricultural sector reveal that whereas the sector is negatively affected by high lending rates, an increase in credit and exchange rate depreciation spurs growth in the sector. We can further conclude that the interest rate, credit and the exchange rate channels are effective monetary policy transmission channels in the agricultural sector.

ii) Manufacturing sector



A positive shock in lending interest rates reveals a weak response in manufacturing GDP growth as shown in figure ii). Thus, the impulse response agrees with the granger causality test results which revealed that there is no causation between the manufacturing GDP and lending interest rates. These findings are consistent with Ilker (1999). Similarly, the response of the sector's GDP to a positive shock in private credit shows more-or-less a weak reaction. Exchange rate depreciation (a positive shock in exchange rates) however, results into a decline in manufacturing GDP which takes full effect after about 4 quarters. We therefore conclude that exchange rate is a more significant channel in transmitting monetary policy in the manufacturing sector while other channels (interest rates and credit) remain relatively weak in transmitting monetary policy in the sector. This is true for Uganda's case because the manufacturing sector depends mainly on imported inputs therefore; an increase in the exchange rate increases the cost of production for the sector hence low production.

iii) Services sector



Finally within the services sector, the impulse response functions reveal that a one standard deviation positive shock in the lending interest rates results into a reduction in the services sectors' GDP. The most significant fall in the services sector GDP is experienced after about 3 quarters. Regarding the bank credit channel, a one standard positive shock in bank credit results into an increase in the sector's GDP. This takes full effect after about 7 quarters. Turning to the effect of increasing the exchange rate on sectoral growth, a positive shock in exchange rates, that is, a depreciation of the exchange rate increases services GDP growth reaching a maximum increase in GDP after about 4 quarters. The rise in services

GDP may be on account of increased earnings from services exports due to increased competitiveness arising from exchange rate depreciation. These findings are consistent with Ilker (1999), Sahinoz *et al* (2009), Medhi *et al* (2011) and Ifeakachukwu *et al* (2012).

c) Variance decomposition analysis

Forecast error variance decomposition describes what proportion of a shock to a specific variable is related to either its own innovations or to those associated with other dependent variables at various forecast time horizons in the system. For the purpose of this analysis, variance decompositions are used to measure the fraction of sectoral output movements attributable to monetary policy shocks. The results of the variance decomposition analysis across the three sectors are presented in *Annex 1*. The results reveal that, the exchange rate channel is the most significant channel of transmitting monetary policy effects in the three sectors studied while the interest rate and the bank credit channels are relatively weak channels of monetary policy across the sectors. For instance, considering the 9^{th} quarter horizon when monetary policy effects are expected to take full effect; within the manufacturing sector, about 88.9 percent of variations in the sector's GDP was attributed to its own shock, 9.8 percent was due to the exchange rate innovations, 0.43 percent was due to shocks in bank credit and only 0.42 percent was attibuted to shocks arising from lending interest rates. Regarding the agricultural sector, about 61.2 percent of variations within the sector were attributed to its own shocks, followed by shocks due to exchange rates at about 14.5 percent, shocks to lending interest rates contributed about 10.8 percent while bank credit shocks accounted for about 7.4 percent of innovations within the sector. Turning to the services sector, within the same horizon (9^{th} quarter), 69 percent of variations in the sector's GDP were due to its own shocks, while 11.3, 9.1 and 6.7 percent were due to innovations from exchange rates, bank credit, and lending interest rates respectively.

6 Conclusions and policy implications

This paper investigates the sectoral effects of monetary policy in Uganda over the period 1999 to 2011. Precisely the key sectors which are the leading contributors of Uganda's GDP were analyzed. These include agriculture, manufacturing and service sectors. The approach used was based on granger causality test and a structural recursive VAR framework. The results of the analysis demonstrate that the exchange rate channel is the most effective channel of monetary policy to all the three sectors analyzed. The interest rates and the bank credit channels are relatively weak channels of monetary policy to all the sectors studied especially the manufacturing sector. A positive shock in exchange rates (an exchange rate depreciation) negatively affects the manufacturing sector simply because the sector relays heavily on imported inputs while agriculture and service sectors benefit from an exchange rate depreciation mainly through the exports realized from these sectors.

Thus, in terms of policy, caution should be put on maintaining a stable exchange rate that favours both Uganda's exports and imports; putting into consideration that Uganda is a developing economy that relys mostly on imported raw materials to produce for exports and also the need to maintain the competitiveness of its exports.

Annex1: Variance decomposition of agriculture, manufacturing and the services sectors

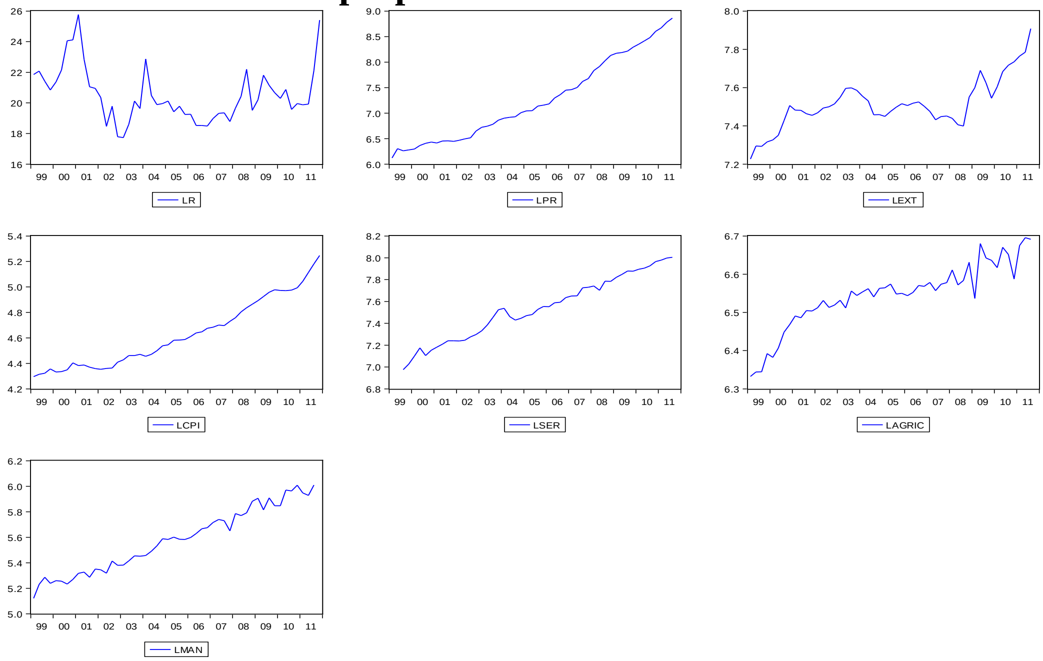
Variance decomposition of LSER (Services)						
Period	S.E.	LSER	LCPI	LR	LPR	LEXT
3	0.035781	84.64848	3.723084	3.581455	2.437291	5.609688
6	0.040026	73.17455	3.619744	7.212140	5.729137	10.26443
9	0.041830	68.97831	3.866078	6.715581	9.104347	11.33568
12	0.042273	68.18922	3.803941	6.608358	10.17263	11.22585

Variance decomposition of LARIC (Agriculture)						
Period	S.E.	LAGRIC	LCPI	LR	LPR	LEXT
3	0.031020	76.64566	0.675103	10.25348	2.686672	9.739085
6	0.036155	70.63647	0.598880	9.374771	4.794259	14.32100
9	0.038625	66.74547	0.561490	10.78009	7.412402	14.45024
12	0.039941	66.5555	0.721884	10.74945	7.206366	14.30346

Variance decomposition of LMAN (Manufacturing)						
Period	S.E.	LMAN	LCPI	LR	LPR	LEXT
3	0.037630	95.93751	0.332099	0.066148	0.303192	3.361046
6	0.038515	91.62157	0.447789	0.215667	0.367802	7.347173
9	0.039115	88.91321	0.444735	0.422802	0.433429	9.785821
12	0.039506	88.85583	0.440985	0.391975	0.411852	9.588791

Source: Authors' own computations

Annex 2: Time series properties



Annex2…Unit root tests

	In levels		First difference		
	ADF	**PP**	**ADF**	**PP**	
variable	Intercept & trend	Intercept & trend	Intercept & trend	Intercept & trend	Conclusion
Lending rate	-1.8202	-1.8058	-7.3299	-7.3112	I(1)
T-Bill rate	-4.3179	-2.7957	-7.5665	-7.5548	I(1)
Lext	-1.0598	-1.4778	-6.2118	-6.0443	I(1)
LPR	-0.8306	-1.0202	-8.7523	-8.8064	I(1)
Lman	-5.8177	-5.8339	-	-	I(0)
Lagric	-4.3966	-4.3304	-	-	I(0)
Lser	-3.8714	-3.9432	-	-	I(0)

Critical values; -4.1525, -3.5024 & -3.1807 at 1, 5 & 10 percent levels of significance

Annex 3:

LM Test

VAR Residual Serial Correlation LM Tests Null Hypothesis: No serial correlation at lag order h Sample: 1999Q1 2011Q2 Included observations: 48		
Lags	**LM-Stat**	**Prob**
1	63.63484	0.0780
2	48.29458	0.5016
3	71.22552	0.0207
4	58.50285	0.1659
5	61.78202	0.1039
6	43.36823	0.6999
7	44.96043	0.6376
8	41.35597	0.7728
9	55.93562	0.2307
10	49.93212	0.4361
11	39.20658	0.8403
12	53.80773	0.2955

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