



Monetary Policy and Inflation Dynamics: *An empirical case study of Tanzanian economy.*

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To my parents, Captain Said Ayubu and Lucia

Abstract

The monetarist places a strong weight on the growth rate of money supply in explaining inflation dynamics. Although widespread empirical evidence exists validating this rationale, there is ongoing criticism arguing that, the monetarist might have exaggerated the role played by money supply in fueling inflation. The purpose of this study is to examine to which degree inflation is a result of monetary phenomena in the case of the Tanzanian economy. This goal is achieved by comparing money supply and other potential determinants of inflation which include output, the exchange rate and international oil price. The analysis is done using impulse response function on SVAR and VECM econometric models with data set ranging between 1993Q4 to 2011Q4. The empirical results suggest that inflation in Tanzania is more of an output factor than a monetary phenomenon. The study calls for parallel coordination of monetary policy and deliberate strategy for fostering economic growth.

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1. INTRODUCTION

The monetarist proclaims that inflation is purely a domestic monetary driven phenomenon. That is, inflation arises when the central bank creates an excessive supply of money over its demand. As a result, abundant credit will be extended by the public sector pushing up the aggregate demand (Akinboade et al., 2004). With no parallel reaction from the production side, the increase in aggregate demand will force the prices to go up (Pindiriri, 2012). Monetarists stress the adoption of restrictive monetary policy as a short run strategy of dealing with inflation. Often, the central question is whether excess money supply is always accompanied with high inflation rates. Among the earlier monetarist supporting this rationale was Friedman in 1963 (as cited by Grauwe & Polan, 2005). Rooted in Quantity Theory of Money (QTM), Friedman believed that “*inflation is always and everywhere a monetary phenomenon*”.

Quantity theory of money provides the theoretical platform justifying the magnitude to which inflation dynamics can be purely explained as the result of monetary phenomena. The theory incorporates four components that include; the growth rate of money supply, the velocity of money, real output and price level. According to the theory, there exist a positive relationship between the growth of money supply and price level. Furthermore, the theory assumes that in the long run a permanent growth in money supply will proportionally bring about an equal change in price level while holding real output and velocity of money constant. Whereas the positive reaction of real output on money supply growth could only be realized in the short run (Grauwe & Polan, 2005).

Controlling inflation within acceptable rates is one of the major macroeconomic policies in Tanzania. To secure macroeconomic stability, in 1990s the country implemented several institutional liberalization (Laryea & Sumaila 2001). These reforms include the approval of the Bank of Tanzania (BOT) Act of 1995. The act was designed to strengthen the capacity of the central bank (BOT) in fighting inflation. The new BOT act directed the obligation of formulating and implementing monetary policy with the purpose of pursuing price stability as the primary objective of the central bank (Masawe, 2001).

Despite that, price stability was made a primary concern of the BOT, the country is experiencing volatility in inflation rates and is yet to permanently secure the target average of 0 to 5 percent annual rate. Statistically, the country’s inflation rates recorded a decrease of 7% from 1995 to 1996 and throughout 2000 to 2007 the economy maintained single digits inflation levels with the low rates being 4 percent in 2004. In 2008 and 2009 the annual percent inflation level was recorded above 10 percent but in 2010 it fell back to single digit followed by a very sharp increase to almost 20 percent in the following year (World Data Bank 2012).

However, at this point the performance of monetary policy in Tanzania points to a central complex question. How much of inflation is a result of monetary phenomena in Tanzania?

This question creates the objective of the study. Therefore this paper attempts to empirically examine the extent to which changes in money supply can account for inflation variation in Tanzania. This will be achieved by comparing the impact of money growth with other major determinants of inflation dynamics in the economy. The knowledge on money and inflation is a relevant starting point in studying determinants of inflation. Understanding the degree to which monetary phenomena influence inflation in Tanzania, would give some valuable clues about the BOT's ability to control the inflation process and the relative effectiveness of a monetary policy framework.

The empirical analysis will be conducted using quarterly time series data covering a period between 1993Q4 and 2011Q4. Unlike earlier studies on money and inflation in Tanzania (Aikaeli, 2007, Ndanshau, 2010 & Ndanshau, 2012), this paper employs a different methodology of impulse response function on Structural Vector Autoregressive Model (SVAR) and Vector Error Correction Model (VECM). The models will be used to forecast the reaction of inflation due to shocks on its major determinants. The SVAR model proves to be a better systematized methodology since it permits the imposition of restrictions which are consistent with the economic theory and give sensible findings that can be interpreted and easily compared (Bjørnland, 2000).

The remainder of the paper is as follows; Section 2 gives an overview of the monetary policy framework, inflation trends in Tanzania and literature review. Section 3 presents the methodology and description of the data. Section 4 presents the results and analysis while the last section discusses conclusion and policy implications.

2. BACKGROUND AND LITERATURE REVIEW

2.1 Monetary Policy Framework in Tanzania

This section is intended to give an overview of how the central bank tracks and controls the growth of general price level through the operation of monetary policy. The current system of formulation and implementation of monetary policy in Tanzania which aims at price stabilization was adopted as the primary role of the central bank in 1995 through Bank of Tanzania (BOT) act. During the same period, the central bank moved from implementing direct to indirect monetary policy instruments to ensure maximum efficiency in the regulation of money supply. The indirect monetary policy used in Tanzania includes foreign exchange market operation, discount policy, reserve requirements, repurchase agreements, gentlemen's agreement, moral suasion and open market operation as the principal monetary policy instrument (Bank of Tanzania, 2012).

The central bank controls the quantity of money in the economy through tracking the development of the base money by using an operation framework called "The Reserve Money Programme". The central bank conducts this operation by relying on the assumption that the relationship between money supply and base money is constant, that is:

$$M_2 = mM_0 \quad (1)$$

Where M_2 is the broad money supply, M_0 is base money and m is the money multiplier. A change in money supply is obtained by a change in either base money or the money multiplier (Masawe, 2001).

Noted by Masawe (2001), the BOT's base money (M_0) is made up of either the central banks assets (source) or liabilities (uses). The assets include net foreign assets (NFA), net domestic credit (NDC) and other items net (OIN) i.e.

$$M_0 = NFA + NDC + OIN \cdot \quad (2)$$

While the liabilities incorporate the commercial banks deposits at the central bank and currency in circulation. The money multiplier takes a form of;

$$m = \frac{(1 + c/d)}{\left(rr + er / \frac{c}{d} \right)} \cdot \quad (3)$$

Where m is the money multiplier, c denote currency in circulation, d is demand deposits, er is the excess reserves while rr is the required reserve ratio (Masawe, 2001).

In June every year, the central bank prepares annual monetary programme. This programme is then used as a basis for establishing the Reserve Money Programme. The formation of annual monetary programme depends on the QTM equation which says,

$$MV = PQ \ , \quad (4)$$

where M stands for M_2 , V is money velocity, P is general price level and Q is output. In growth rates the above equation takes the form;

$$\Delta M_2 + \Delta V = \Delta P + \Delta Q \cdot \quad (5)$$

Assuming constant velocity of money, given P and Q are proxy by CPI and GDP , the growth of money supply will be determined as

$$\Delta M_2 = \Delta CPI + \Delta GDP \cdot \quad (6)$$

The annual stock of money supply is then estimated by multiplying the amount of money at the end of the financial year with the growth of money supply,

$$M_2 (\Delta M_2 = \Delta CPI + \Delta GDP) \cdot \quad (7)$$

Therefore the annual growth rate is; $M_2 - M_2 (\Delta M_2 = \Delta CPI + \Delta GDP)$, but since the establishment of reserve money programme requires a monthly rate, the annual growth rate of

money supply is then divided by 12 to get the monthly growth rate. The monthly stock of money supply is derived by adding the stock of M_2 at the closing of the current year with the calculated monthly growth rate (Masawe, 2001)

The calculated monthly stock of money supply (M_2) is then used in the reserve money programme formula ($M_2 = mM_0$) to derive month to month base money (M_0), hence tracking its growth.

The task of making a decision on which monetary policy to adopt is the responsibility of the BOT body committee called the Monetary Policy Committee. The committee meets on a monthly basis. The monetary policy committee is expected to evaluate the performance of the month ended monetary policy and make a decision on the monetary policy measures to be adopted for the next coming month (Masawe, 2001).

2.2 Inflation dynamics in Tanzania

In this section a summary is given of inflation performance of the Tanzanian economy from 1970s to 2011. The computation of the country's inflation is executed under Tanzania Bureau of Statistic (BOS). BOS computes inflation in two different key measures, the first measure compute year to year headline inflation that includes food prices called the National Consumer Price. While in the second measure, food prices are excluded in the computation (Laryea & Sumaila 2001). The historical inflation trends discussed in this paper will rely only on National Consumer Price Index.

As illustrated in the graph (figure 1) below, in general the Tanzanian inflation levels have recorded to be volatile since 1970s. Reaching the high level of 26% in 1975, single digits were recorded in 1970 (3%), 1971 (4%) and in 1978 the annual inflation rate was 7%. Furthermore, the overall period of 1980s was characterized by relatively high inflation rates. The rates accelerated to as high as 36% in 1984 and maintained levels above 25% throughout the period (World Data Bank 2012). It was noted that the high inflation rates of this period were mainly generated from both the output and monetary side. Therefore, from the beginning of the second half of 1980s, the government has been concentrating both on tight monetary policy and deliberate strategy to foster production as one of the strategies of combating high inflation in Tanzania (Solomoni & Wet 2004).

Even though in 1990s, the country continued to suffer from high inflation rates, the positive results of the government's efforts began to show some signs in 1995. During which the rates started to go down, recording a drop of 7% from 1995 to 1996 and towards the end of 1990s the government managed to reduce inflation to 7%. This achievement could as well be explained by the BOT strategy of adopting price stability as a primary objective of the bank in 1995 BOT act. However, it was noted that between 1994 and 1998 the central bank had managed to reduce the growth of money supply from 33% to 7.7% (Solomoni & Wet 2004). The single digit inflation rates were maintained until 2008 when inflation rose again to double

digit (10%). The double digit inflation persisted continuously until 2010, when it fell to 6%, followed by a sharp increase to almost 20% in 2011 (Adam et al., 2012).

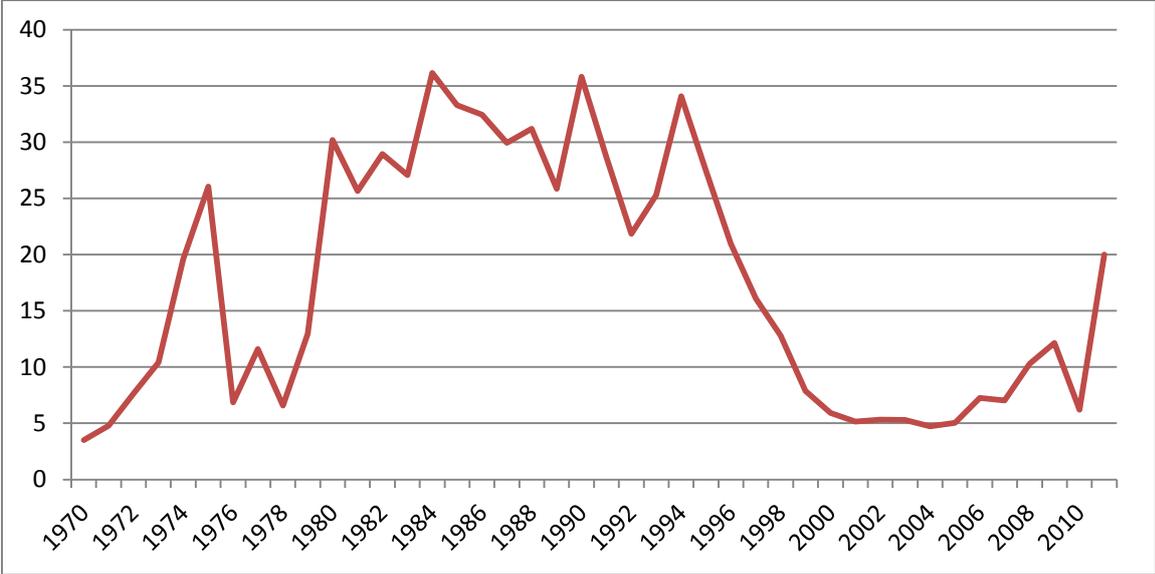


Figure 1: Trends of Inflation rates expressed as annual percentage change in consumer price index (CPI) from 1970 to 2011. Source: World Data Bank.

2.3 Empirical Review

In this section the paper turns to the empirical literature to review the findings from different researchers regarding the applicability of the monetarist determinants of inflation approach. The empirical literature shows that like many other macroeconomic theories, the subject has received much attention from economics researchers throughout the world. The Quantity Theory of Money (QTM) theorem among others motivated empirical researchers to examine the validity of a possible linkage between inflation and growth of money supply.

In 2005, Graude and Polan examined the link between money supply and inflation in 160 countries using 30 years data range. Although they accepted that inflation is a monetary phenomenon, they claimed that the link between inflation and money supply is much stronger only in the countries with high inflation rates. They further noted that in countries with a relatively low inflation rate the long run linkage cannot be easily identified. Thornton (2008) found evidence to support Graude and Polan (2005) claim, after employing panel and cross section analysis to empirically estimate the applicability of QTM on 36 countries in Africa. He concluded that, money strongly determines inflation in countries with more than 10 percent inflation and money growth rates.

The findings of Us (2004) contradict this claim after detected a zero correlation between money and inflation in country with high inflation rates. According to Us (2004), for more than 30 years Turkey has been facing high and increasingly inflation rates. The author’s empirical findings suggested that the higher rates are mainly as a result of the depreciating of the country’s currency and increases in the prices in the public sector.

In Tanzania, there are several studies done on money supply and inflation. Aikaeli (2007) examined the money supply and inflation relationship in the country by employing a GARCH model while M_2 and M_3 monetary aggregates were used as proxies for money supply. The analysis was made basing on monthly data ranging between 1994 and 2006. From the study, the author identified that it takes a period of 7 months for any fluctuations in money supply to have an impact on inflation rates in Tanzania. Ndanshau (2010) applied an Autoregressive Distributed Lag (ADL) and Error Correction Model (ECM) on quarterly data ranging from 1967 to 2005 to examine the role of money in explaining inflation dynamics in Tanzania. Using M_0 , M_1 and M_2 as money aggregates, the regression couldn't identify any relationship between money and inflation. He concluded by giving less importance to money as a determinant of inflation in Tanzania. Unlike his previous study, Ndanshau (2012) included budget deficit in the investigation of the impact of changes in money supply on inflation rates in Tanzania. The study used pair-wise Granger causality test, Vector Error Correction model and data for the period between 1967 and 2010. The findings revealed that changes in monetary policy regime have an influence on the inflation rates in Tanzania.

The following table summaries the empirical findings of some studies with different data set, monetary variables and time period. Some papers employ cross-section data on a group of countries for a period of time where mostly those countries have the same stage of economic development. While others use time series data examining the correlation of money supply and inflation in a single country for a long period of time. The common monetary variables that are often employed in the chosen papers are M_1 , M_2 and M_3 . The general conclusion that can be drawn from the surveyed articles is that, as postulated by the monetarist most authors detected a long run impact of changes in money supply on inflation rates. Nevertheless most papers ignored all other possible determinants of inflation and concentrated only on money growth in the analysis as the main determinant of inflation.

Table 1; presents a summary of selected studies on the linkage between money supply and inflation.

| Author | Monetary Variable | Data coverage(country) | Data period | Findings |
|--------------------------|--|------------------------|----------------------|---|
| Vuslat Us (2004) | Base money (Mo) | Turkey | 1990:01–2002:04 | No relationship |
| Altimari (2001) | M_1, M_2 & M_3 | Euro Area | 1980-1997 | Positive relationship |
| Diouf (2007) | Broad money | Mali | 1979:1-2006:1. | Long and short run correlation |
| Pindiriri (2012) | M_3 | Zimbabwe | 2009-2011 (monthly) | Positive |
| Jones & Khilji (1998) | M_1 & m_2 | Pakistan | 1973 to 1985 | Positive |
| Nikolic (2000) | Extended broad money (M_2X), M_2 , m_b & M_0 | Russia | 1992- 1998 | Weak correlation |
| Darrat (1986) | Narrow money | North Africa | 1960-980 (quarterly) | Positive |
| Saini | M_1 & M_2 | Six Asian countries | 1951-1980 | Very week relation |
| Thornton (2008) | Money in circulation, M_1 and M_2 | African economies | 1960-2007 | Weak for counties with inflation and money growth below 10% |
| Dreval & Ndung'u (2001) | M_1 & M_2 | Kenya | 1974 – 1996 | Exist only in the short run |
| Simwaka et.al (2012) | M_2 | Malawi | Monthly (1995 -2007) | Positive relationship |
| Morana & Bagliano (2007) | M_1 , M_2 & M_3 | USA | 1959:1- 2003:2 | Positive long run correlation |
| Kabundi, A (2012) | M_3 | Uganda | Monthly (1991-2011) | Positive |
| Akinbobola (2012) | M_1 & m_2 | Nigeria | 1986:1-2008:4 | Positive |
| Zhang (2012) | M_2 | China | 1980 -2010 | Positive |

Source; the table is author's creation from chosen empirical papers.

2.4 Theoretical Inflation model

In this section the paper presents a simple theoretical model that explains the determinants of inflation in a developing country. One could define inflation as the change of overall prices of goods and services which is estimated by the annual percentage change of the national consumer price index. The model is derived following previous studies by Ubide (1997), Moser (1995), Adu & Marbuah (2011) Laryea & Sumaila (2001) and (Akinboade et.al 2004). According to the mentioned previous papers, inflation in an open developing economy is assumed to be theoretically derived from weighted average prices of tradable (p^t) and non tradable goods(p^{nt});

$$\log p_t = \beta(\log p_t^{nt}) + (1 - \beta)\log p_t^t \quad (8)$$

Where $0 < \beta < 1$

The tradable goods price is estimated on the world market with the assumption that the purchasing power parity applies. The price of tradable goods depends on the exchange rates (e) and foreign prices(p^f). Therefore the price of tradable goods can be captured by the following log linear equation;

$$\log p_t^t = \log e_t + \log p_t^f \quad (9)$$

According to theory, both the exchange rate appreciation and decrease of foreign prices will lead to a decline of domestic prices. On the other side, the depreciation of the exchange rate and increase in foreign prices increases the domestic prices. Additional, the model assumes the existence of a parallel movement between the overall demand of the country and the demand of non-traded goods. Given that, the overall demand is determined by real money balances then it is assumed that the price of non-tradable goods is modeled in the domestic money market. Therefore, one can conclude that the price of non-tradable goods P^{nt} is determined by real money balances. The real money balances defines the equilibrium condition in the money market, where the real money demand (m^d) equals to real money supply (m^s);

$$\log p_t^{nt} = \theta(\log m_t^s - \log m_t^d) \quad (10)$$

Whereby m_t^d is real money demand, m_t^s represents real money supply and θ is a scale factor denotes the correlation between the overall demand of a country and the demand of non-tradable goods. Furthermore, real income, nominal interest rates and inflationary expectations are variables assumed to be the determinants of real money demand:

$$m_t^d = f(y_t, r_t, E(\pi_t)) \quad (11)$$

+ - +

Where π_t and r_t are expected rate of inflation and nominal interest rates both representing domestic opportunity cost while y_t is the real income. According to economic theory, the partial derivative of real money demand with respect to interest rates is negative whereas the real income and expected rate of inflation is positively correlated to real money demand.

Considering the fact that inflation expectations can be modeled in different ways, guided by Moser (1995), for simplicity the paper adopts on adaptive expectation model to estimate the functions of inflation expectation in Tanzania. According to the model, inflation expectation rate is specified as:

$$E(\pi_t) = d_1(\Delta \log p_{t-1}) + (1 - d_1)\pi_{t-1}. \quad (12)$$

Where $\Delta \log p_{t-1}$ and π_{t-1} denotes inflation and expected inflation rate respectively both in period $t - 1$. To retain simplicity in the derivation procedure the model assumes that $d_1 = 1$. Substituting and rearranging the overall inflation equation can be expressed in log linear form as follows:

$$\log p_t = \beta_1 \log m_t + \beta_2 \Delta \log p_{t-1} + \beta_3 \log y_t + \beta_4 \log e_t + \beta_5 \log r_t + \beta_6 \log p_t^f + \varepsilon_t. \quad (13)$$

However, since Tanzania is among the countries characterized by underdeveloped financial sector, the interest rate is considered to be inappropriate as a measure of domestic opportunity cost (Ubide, 1997). As such it is argued that, the domestic opportunity cost in countries with less developed financial markets should be measured by the expected inflation rates. Furthermore due to data limitation it is difficult to specify the prices of which countries among the Tanzanian's trading partners to be used as foreign price (Laryea & Sumaila 2001), therefore the paper uses oil price index as the proxy of foreign price. Thus the main model that will be used in the study to identify the influence of money on inflation in Tanzania compare to other determinants is as follows:

$$\log p_t = \beta_0 + \beta_1 \log m_t + \beta_2 \Delta \log p_{t-1} + \beta_3 \log y_t + \beta_4 \log e_t + \beta_5 \log oilp + \varepsilon_t. \quad (14)$$

Whereby p_t is the general price level, m_t is money supply proxy by m_2 . *Ceteris paribus* the theory of the monetarist anticipates a positive partial derivative of general price level with respect to money supply. This is due to the quantity theory of money which assumes a constant velocity of money when the economy is operating under full capacity. During such a state, any sustainable increase in money supply will lead to an increase of the general price level which will eventually create inflationary pressure (Laryea & Sumaila 2001). Depreciation of the exchange rate (e) and foreign price measured by the world oil price index are expected to positively related with domestic inflation. The income is expected to have a negative partial derivative with the general price level.

3. Methodology, Data and Results

3.1 Structural Vector Auto-regression Model

The main model used in the estimation process is Structure Vector Auto Regression (SVAR). Noted by Verheyen (2010), the introduction of Structural Vector Auto-regression model was through the works of Bernanke in 1986, Watson & Blanchard in 1984 and Sims in both 1981 and 1986. The SVAR was introduced for the purpose of addressing the criticisms of the standard Vector Auto Regression (VAR) model. The Standard VAR is criticized by its unrestricted tendency that permits the model to absorb too many parameters with no theoretical framework to verify the accuracy of the findings. To overcome that, the error term from SVAR is guided by restrictions that are adopted from economic theory. The model assumes that the error terms of the variables exhibit recursive relationship. That is, the error terms in the regression are constructed to be uncorrelated to each other. As presented by Verheyen (2010), equation 15 displays the structural VAR model that includes n number of endogenous variables, a constant and a structural shock (ε_t);

$$B \cdot y_t = C_0 + C_1 y_{t-1} + \varepsilon_t \quad (15)$$

To derive the reduced form of the model, we multiply the above equation by the inverse of B to get $y_t = \Omega_0 + \Omega_1 y_{t-1} + \mu_t$. Where by y_t denotes the variables in the system, Ω_0 is $C_0 B^{-1}$ while Ω_1 stands for $C_1 B^{-1}$ and μ_t represents $B^{-1} \varepsilon_t$. The model allows a number of $n(n-1)/2$ restrictions to be imposed on the parameter matrix B which is defined as a function of structure shock given by

$$\varepsilon_t = B\mu_t = \begin{pmatrix} \varepsilon_t^{oip} \\ \varepsilon_t^{y_t} \\ \varepsilon_t^{m_t} \\ \varepsilon_t^{e_t} \\ \varepsilon_t^{p_t} \end{pmatrix} = \begin{pmatrix} 1 & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & 1 & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & 1 & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & 1 & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{pmatrix} \begin{pmatrix} \mu_t^{oip} \\ \mu_t^{y_t} \\ \mu_t^{m_t} \\ \mu_t^{e_t} \\ \mu_t^{p_t} \end{pmatrix}$$

Following Moriyama (2008) and Almounsor (2010), this paper assumes SVAR model with a recursive structure. That is the error terms in the model are constructed not to correlate with each other but allowed to be correlated with the regressors in the set of liner equations. Following this, the model allows the paper to make the following assumptions explaining the relationship between variables in the model. (1) International oil price is assumed to be exogenous in the model, thus its shock is assumed to affect all other variables in the model. (2) Shocks generated by output affect all variables excluding international oil price. (3) Money supply shock is assumed to influence only exchange rate and inflation. (4) Shock formulated by exchange rate is assumed to affect only the current inflation rates given that the growth of money supply is considered to be under the control of the central bank. These

assumptions will be used as a guideline in setting restrictions in the model. According to Almounsor (2010) with the underlying provided assumptions, the SVAR model can as well be represented in the following linear equations,

$$oilp_t = F_{t-1}oilp_{t-1} + \varepsilon_t^{oilp_t} \quad (16)$$

$$y_t = F_{t-1}y_t + \theta 1 \varepsilon_t^{oilp_t} + \varepsilon_t^{y_t} \quad (17)$$

$$m_t = F_{t-1}m_t + \theta 2 \varepsilon_t^{oilp_t} + \theta 3 \varepsilon_t^{y_t} + \varepsilon_t^{m_t} \quad (18)$$

$$e_t = F_{t-1}e_t + \theta 4 \varepsilon_t^{oilp_t} + \theta 5 \varepsilon_t^{y_t} + \theta 6 \varepsilon_t^{m_t} + \varepsilon_t^{e_t} \quad (19)$$

$$p_t = F_{t-1}p_t + \theta 7 \varepsilon_t^{oilp_t} + \theta 8 \varepsilon_t^{y_t} + \theta 9 \varepsilon_t^{m_t} + \theta 10 \varepsilon_t^{e_t} + \varepsilon_t^{p_t} \quad (20)$$

Where by θ represents coefficients for impulse response function and F_{t-1} is the linear function of lags for all the variables in the model. Impulse response is a function that shows the reaction of endogenous variables on shocks generated from exogenous variables (Mitchell, 2000). Equation number 5 represents the main inflation model in this paper. According to the model, the current inflation rates can be explained by the past shocks generated from international oil price, money supply, output and exchange rates.

Thus with the given assumptions, the equations and 5 variables in the system, the paper sets 10 restrictions on the parameter matrix B in order to identify the SVAR model as follows;

$$B = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ \theta 1 & 1 & 0 & 0 & 0 \\ \theta 2 & \theta 3 & 1 & 0 & 0 \\ \theta 4 & \theta 5 & \theta 6 & 1 & 0 \\ \theta 7 & \theta 8 & \theta 9 & \theta 10 & 1 \end{pmatrix}.$$

The impact of money in determining inflation in Tanzania will be examined by comparing the impulse response of inflation to shocks on international oil price, money supply, output (GDP) and exchange rates. The findings from impulse response will be supported by elasticity and variance decomposition. Almounsor (2010) described variance decomposition as the percentage of forecast error variance of the dependent variables that can be as a result of shocks on exogenous variables.

3.2 Data and Measurement of Variables

This analysis uses a quarterly data series covering 1993Q4 to 2011Q4 of five variables including inflation, money supply, output, exchange rate and international oil price. This paper uses the year to year percentage change in Consumer price Index (CPI) as the proxy for

headline inflation. The headline inflation that includes food prices is preferred as opposed to the underlying inflation. This is due to less development nature of the economy whereby the bigger proportion of the country's population depends on subsistence existence. As noted by Adam et.al (2012) in such a stage, a consumption basket is mainly subjected by food which is characterized by income and demand inelasticity. Hence this stresses the relevance of food prices in explaining the inflation variation in Tanzania.

The BOT regulate inflation through its influence on the growth rate of money supply (both M_2 & M_3). Due to the underdeveloped nature of the financial sector, M_2 is the most preferred monetary aggregate in this paper. As noted by Aikaeli (2007) and in the BOT monetary policy statement (2004/2005), M_2 is estimated to have the highest correlation with inflation in comparison to other monetary aggregates. Therefore money supply will be measured by the broad definition of money (M_2) in millions of the national currency. M_2 accounts for currency in circulation outside banks and total deposits (excluding foreign currency) held by commercial banks (BOT monetary policy statement, 2004/2005).

The real GDP (y) in national currency (in millions) is used as a measure of output, the exchange rate (e) is the National currency per US dollar and international oil price is measured by world oil price index (oilp). Real GDP and appreciation of the exchange rate are expected to have a negative relationship with the inflation rate whereas inflation is expected to relate positively with world price index and M_2 . Data on CPI, M_2 and e is extracted from International Financial Statistics (IFS), real GDP data is sourced from World Data Bank (WDB) and data on world oil price index is taken from Global World International (GWI).

Table 2; Description of Variables

| Indicators | Variable Measured | Source |
|--|--------------------------------|--------|
| Y = Real GDP (million TZS) | Economic Performance (output) | WDB |
| M_2 = Ratio of extended broad money to GDP (million TZS) | Money supply | IFS |
| CPI = % of the Consumer price by Index | Inflation rates | IFS |
| Oilp = World oil price Index | International oil price | GWI |
| E = National currency per US dollar | Exchange rate | IFS |

4. Results and Analysis

4.1 Structural Vector Auto-regression Results

Since most macroeconomic time series data are believed to be non-stationary, the first step taken was to carry out a unit root test to check whether the variables are stationary or non-stationary (Almounsor , 2010). Testing for unit root is crucial since running regression on non-stationary data may tend to yield a biased standard error. A biased standard error might mislead the findings especially when estimating the link between variables (Mahadera & Robinson (2004)). Thus the paper adopted Phillips-Perron unit root test to test the time series data in trend, without trend and in differences.

According to the unit root results in levels, the null hypothesis of the existence of unit root could not be rejected for almost all variables at the 5% level except world price index. The data on the world price index was detected to be stationary in levels. But since Phillips-Perron unit root test does not capture structure break, the data on world price index was then plotted in order to see how the trend goes and to make sure that the results are not influenced by any structure break. Although some break points were detected, the plotted series indicated an upward trend in levels hence non-station. The time series data for all the variables was then transformed into its first difference and the second unit root test was performed. After the first difference all variables were classified as stationary sequence. Therefore the variables in the model are found to be integrated of order 1(1) (see appendix no.1 for unit root results).

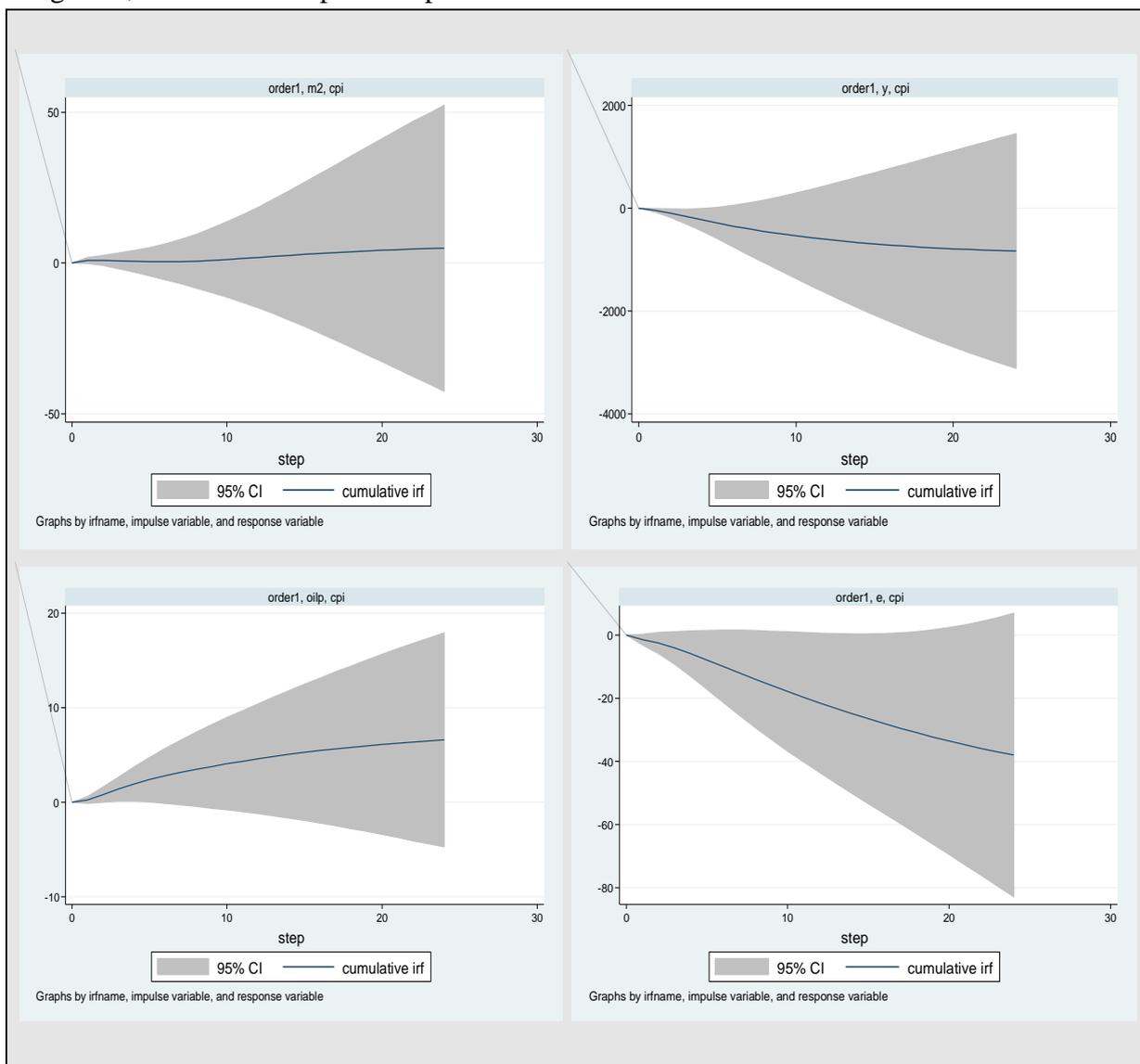
Once the integrating order of the variable has been classified, the next step taken was to check for a long run equilibrium relationship between variables by testing for co-integration. Testing for co-integration is necessary since if the variables are found not to have the same long run trends processes, the estimation of long run relationship between data series can not be performed (Sjö, 2008). But before the variables were tested for their long run relation, several lag length selection criteria were employed to determine the optimal lag order for all the variables in the model. The optimal lag length used in the analysis based on Likelihood Ration, Final Prediction Error and Schwarz information criterion is 4.

The paper uses Johansen co-integration test to check for the co-integrating vectors in the system. According to the results the test identified at least 3 co-integrating vectors in the model, thus confirming a long run relationship between inflation and its determinants in Tanzania (information on lag length and co-integration is shown in appendix no.2 &3).

The next step taken before the estimation of impulse response function under the Structure Vector Auto regression (SVAR) Model was to test for the stability of the model. The estimated graph proved the stability of the model given all the points appeared to be within the main circle (see appendix no.4 for stability graph).

The impulse response graphs and elasticity within SVAR approach using a period of twenty four quarters is shown in Figure (2) and Table (4) below. The graph can be interpreted as follows; each of the four graphs in the figure shows the response of inflation (*cpi*) to shocks in money supply (*m₂*), output (*y*), oil price (*oilp*) and exchange rate (*e*) respectively for the first, second, third and fourth graph.

Figure 2; Cumulative impulse response of inflation for SVAR framework



Note:

- On the x-axis is the time period in quarters implying that 4 quarters is equivalent to a year, 8 quarters to 2 years and so on.
- The grey area is the 95% confidence interval, while the solid lines represent the response rate of each of inflation to shocks to a respective variable

Table 4; Inflation elasticities to the shocks within SVAR framework

| period | M ₂ | y | e | oil |
|--------|----------------|---------|----------|----------|
| 4 | 0,196538 | -7,4304 | -2,05253 | 0,670826 |
| 8 | 0,185813 | -12,028 | -3,90648 | 0,97104 |
| 12 | 0,454887 | -14,585 | -5,29371 | 1,131575 |
| 16 | 0,714468 | -15,403 | -6,24709 | 1,217012 |
| 20 | 0,878631 | -16,776 | -6,889 | 1,255202 |
| 24 | 0,942388 | -15,596 | -7,29564 | 1,265303 |

The cumulative impulse response graphs above shows that the short run respond of inflation to money supply shocks is significantly weak. As it can be seen from the graph, inflation shows a relatively small but positive responds to monetary shocks which appear to persist overtime as the solid line is slightly above the zero line across the 20 quarters. On the other hand the calculated elasticities indicate that, after one year, a one percent increase in money supply will push the price levels up by 0, 2%. Nevertheless, the regression indicates that, the magnitude of money supply shocks to inflation is more pronounced in the following years as compared to the first year i.e. a one percentage increase in m_2 in the fifth and sixth year will push inflation levels by 0, 9% and 0, 94%.

Furthermore, regarding GDP shocks, the estimates suggests that, inflation began to react to shocks in the first quarter although a clearly negative response of inflation to GDP shocks starts to emerge in the second quarter. The signs of the calculated elasticities of inflation's response to GDP shocks are consistent with the inflation theory. This implies that a persistent increase in the country's real income by one percent decreases the inflation rates by -7,4, -12, and -15,6 over the first, second, and sixth year respectively. The graph shows the magnitude of inflation reacting to changes in the real GDP keeps increasing with time.

This paper detected a contemporaneous relationship between inflation and its cost push determinants in Tanzania. The estimated graph shows an immediately and significant decline and rise in inflation levels due to an appreciation of Tanzania Shilling and increase in international oil price respectively. Empirically, the elasticities shows that by the fourth quarter a one percent decreases in exchange rate and a one percent increase in the international oil price would result in a -6.2% decrease and 1.2% increase in inflation, respectively. However the figure shows that the response of inflation to exchange rate and international oil price shocks is continuously decreasing for exchange rate and rising for oil price index.

Table 5; Variance Decomposition of inflation within SVAR framework

| period | cpi | M_2 | Y | e | oil |
|--------|---------|--------|---------|---------|---------|
| 4 | 52,7267 | 3,3015 | 21,7176 | 10,3386 | 11,9156 |
| 8 | 39,2377 | 2,3704 | 23,4624 | 16,008 | 18,9214 |
| 12 | 33,6366 | 2,6583 | 23,8154 | 19,8724 | 20,0173 |
| 16 | 30,158 | 3,1879 | 23,7841 | 22,2498 | 20,6202 |
| 20 | 29,2514 | 3,5333 | 23,85 | 22,5483 | 20,8171 |
| 24 | 28,515 | 3,664 | 24,9146 | 22,029 | 20,8774 |

Table (5) presents the variance decomposition for the quarterly sample period of twenty four quarters. According to the findings, for the first two years, variations in inflation is largely explained by its own shocks which accounts for more than 50 percent in the first year and 39,2 percent in the second year. During the same period, real GDP, exchange rate and international oil price are found to have pronouncing influence on inflation dynamics as well. As noted from the table real GDP contributed 21.7 and 23.4, international oil price by 11 and

18 while exchange rate contributed 10.3 and 16 percent within the first two years. Nevertheless the estimate shows that, unlike for other determinants, the magnitude of inflation response on its own shocks keeps diminishing with time. However, in comparison with exchange rate, international oil prices and money supply, the estimated sample showed that, real GDP accounts for the highest percentage of inflation fluctuations in Tanzania i.e. shocks in real GDP contributed approximately 25 percent of the inflation dynamics in the sixth year. Whereas within the whole estimated period, the variance decomposition results shows that shocks on money supply accounted the least in explaining variation in the county's inflation rates.

4.2 Vector Error Correction Model Results and Analysis

The paper found the existence of long run equilibrium relationship between variables in the model after the earlier estimation of Johansen co-integration test. Given that SVAR model doesn't have the error correction term to capture the co-integration properties of the time series data, the paper employs Vector Error Correction Model (VECM) analysis. This is for the purpose of testing if the two models would produce exactly the same results. The VECM analysis adjusts the short run variations and deviation of variables from the long run equilibrium. As presented by Moriyama (2008) the VECM equation is specified as follows;

$$y = \phi(L)y_t + y_t\lambda + \varepsilon$$

Where y presents the set of variables in the system that includes inflation (cpi), real GDP (y), money supply (m_2), exchange rate (e) and international oil price ($oilp$). The coefficient matrices for lag operators L are represented by $\phi(L)$ and the long run equilibrium relationship between variables in the model are captured by the co-integrating vector denoted by λ .

Figure 3; Cumulative impulse response of inflation based on VECM framework

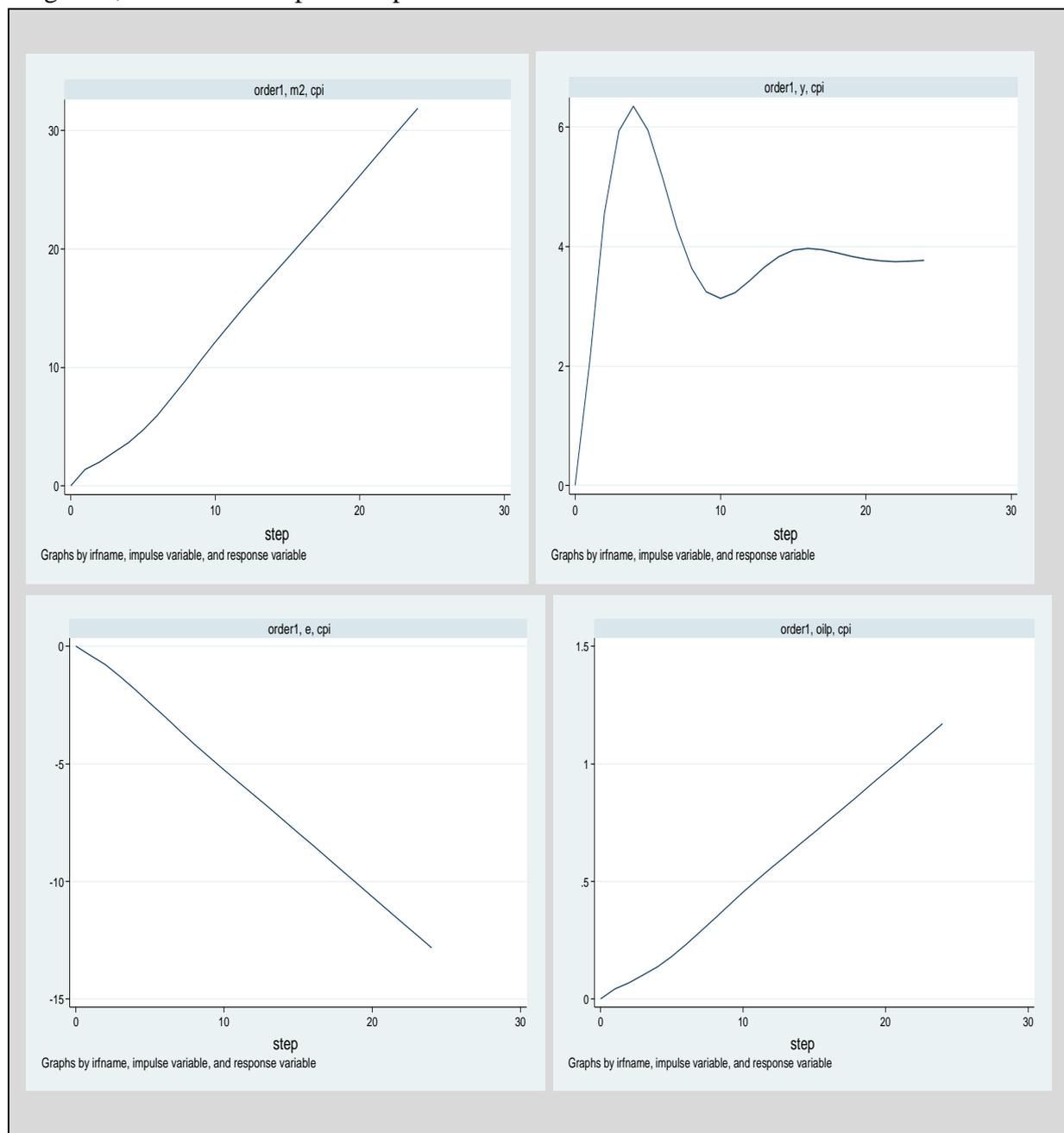


Table 6; Variance Decomposition of inflation within VECM framework

| period | cpi | M ₂ | Y | e | oil |
|--------|---------|----------------|--------|---------|--------|
| 4 | 65,4051 | 0,9963 | 0,3424 | 32,0184 | 1,2377 |
| 8 | 64,8915 | 0,7521 | 0,3617 | 32,717 | 1,2777 |
| 12 | 66,4596 | 1,0252 | 0,448 | 30,615 | 1,4522 |
| 16 | 66,6791 | 1,0699 | 0,4654 | 30,2974 | 1,4881 |
| 20 | 66,7782 | 1,0802 | 0,4722 | 30,1667 | 1,5027 |
| 24 | 66,8927 | 1,098 | 0,4792 | 30,0128 | 1,5173 |

Figure (3) and table (6) present results of the impulse response graphs and its respective variance decomposition of changes in price due to shocks in m_2 , y , $oilp$ and e estimated within VECM approach using a period of twenty four quarters. Unlike in SVAR model, the estimated graphs detected a contemporaneous relationship between inflation and money supply. As evidenced from the graphs above, inflation showed an immediately and positive reaction on money supply shocks. The results detected also a sharp and positive response of inflation due to shocks in real GDP which is not only inconsistency with the SVAR analysis but also with the economic theory. Apart from m_2 and y the respond of inflation to shocks on the other remained variables on VECM model doesn't deviate much from those based on SVAR. The response of inflation to shocks on exchange rate and international oil price index confirms an immediately and continuously impact.

The variance decomposition estimated by VECM framework suggests that the inflation fluctuation in Tanzania is mostly explained by its own shocks. However, even though its own shock still accounting for more than 50 percent of the variation, unlike in the SVAR model, the exchange rate showed to dominate the second with more than 29 percent. While real GDP appears to have the least contribution on inflation variations. Even though there are some similarities of the outcome provided by the two estimated models, the accuracy of their outcomes was not expected to be exactly the same.

The difference of the results produced under VECM from SVAR model could be explained by the unrestricted nature of VECM analysis, whereas the model does not control the economic dynamics of the shocks. Due to that, VECM does not completely trace out the direction of shocks (which shock affects which shock) that may tend to produce mislead results. Hence the paper relies more on results under SVAR model since it controls for dynamic structure of time series data.

The general empirical outcomes evidenced the existence of a positive long run relationship between inflationary process and changes in money supply in Tanzania. This supports the law of QTM stressing the significant of money in explaining the long run inflationary dynamics. This result is as well consistent with the findings of earlier studies in Africa, such as Diouf (2007) for Mali, Moser (1995) Nigeria and Sumaila & Laryer (2001) in the case of Tanzania.

Nevertheless monetarist view typically assumes that in the long run, a permanent increase in money supply will in turn leads to an equal rise in the inflation rates. However as evidenced from the findings this could be proven in the case of Tanzania i.e. the long run elasticity predicted an equal change in inflation as a results of change in money supply. The findings predicted one percent increase in money supply would increase the inflation rates by approximately 1percent in the sixth year.

Additionally the results confirm that the impact of real GDP on inflation appears to be much stronger in comparison to money supply and all other variables in the estimated models. This could be evidenced from the SVAR variance decomposition results indicating that in the fifth and sixth year output accounted for approximately 23,8 and 24,9 percent of inflation variation

in comparison with 3,5 and 3,7 percent accounted by money supply. The large and significant influence of output on inflation in Tanzania was as well stressed by previous empirical findings done by Ndanshau (2010).

However the significant of other variables such as exchange rate and international oil price in explaining inflation dynamics in Tanzania could not be denied. Using both VECM and SVAR empirical frameworks, the results suggested both contemporaneous and a long run impact of the two variables on inflation variations. It is worth noting that the short run impact of exchange rate could be as well supported by the market dependence nature of exchange rate in Tanzania that allows any shock in exchange rate to have an immediately impact on domestic prices (Rutasitara, 2004).

Furthermore, for the purpose of validating the results, a sensitivity analysis was employed comparing the above results with findings derived from another model employing m_3 as a proxy of money supply. The models appeared to have no big discrepancy of results. The short run results within the main framework (SVAR) using both m_2 and m_3 indicate a delaying impulse response of inflation on domestic money supply shocks. This stands to corresponds to the theoretical postulates of Friedman's quantity of money theorem arguing that changes in money supply have its influence on inflation only after a given period of time (Culbertson (1960)). In addition to that, Aikaeli (2007) also found that inflation takes approximately seven month to respond to money supply shocks in Tanzania in an earlier empirical study. Nevertheless GDP appeared to be the most important in explaining the long run and short run variations in inflation in both models (see Appendix no5. for the results on m_3 model).

5. Conclusion and Policy Implications

This study aimed at examining the monetarist view on the significant role of money in explaining inflation dynamics in Tanzania. The problem was approached by comparing the influence of money supply with other major determinants of inflation. The analysis was made using impulse response function under the adoption of two different econometric models. The main model being Structural Vector auto-regression (SVAR) and the other is Vector Error correction model (VECM). Money supply (M2), output (real GDP), exchange rate and International oil price (World oil price Index) were used and estimated using quarterly data for the period ranging between 1993Q4 to 2011Q4.

Even though the accumulated impulse response confirmed the relationship between inflation and money supply, the overall empirical results revealed that money supply is not the key source of inflation in Tanzania. According to the findings, all the estimated variables are found to play a vital role in fueling inflation in the economy. In comparison, money supply is found to be among the variables with the smallest share, especially in the short run, while inflation tended to be more sensitive to shocks in real GDP both in short and long term. Therefore, this study concludes that inflation in Tanzania is more of a real factor than a monetary phenomenon.

These findings could be supported by the under development nature of the country's financial sector such that any shock in this sector may not have such big impact on the economy. Unlike shocks on the financial sector, shocks on output especially on agriculture products would be expected to have a dominant influence on inflation given that more than 79 percent of the population depends on agriculture.

Given the empirical findings, the study stresses the significance of close cooperation of supply and monetary policies. Through monetary policy, the central bank should control the growth of money supply in order to create appropriate equilibrium that is in line with the price stability and economic growth. The big challenge here is for the authorities to put in place policies that would boost productivity especially in agriculture sector since food is said to have the biggest weight in the *CPI* consumption basket.

It is also worth noting that, the results detected a strong contribution of other exogenous factors in engineering inflation in the country. Therefore, even though monetary policy may not be able to deal with such shocks directly, it stills under the duty of the BOT to ensure that the magnitude of exogenous shocks is constrained. The central bank should consider policies aiming at cutting down the prices of non-food items. For instance, the results detected a clear impact of exchange rate on inflation. Given this, measures on controlling fluctuations in domestic money market would be of a great help in alleviating exogenous inflationary pressures in Tanzania.

Lastly, the outcomes and policy implications of this study are conditional on the included variables in the study, time span of the data and the underlying conditions of the model used for the estimations thus should be taken with caution. This is so, given the exclusion of relevant determinants such as fiscal factors and the relative low data sample used in the regression. Second this paper did not analyze in depth the effectiveness of monetary policy in different regimes. It is as well important to specify the magnitude of the response of prices due to restrictive or expansionary monetary policies to assess the effectiveness of monetary policy in stabilizing prices in particular. Thus further studies could take that into consideration.

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<http://www.docstoc.com/docs/133051453/ISSN-MONETARY-POLICY-Bank-of-Tanzania>

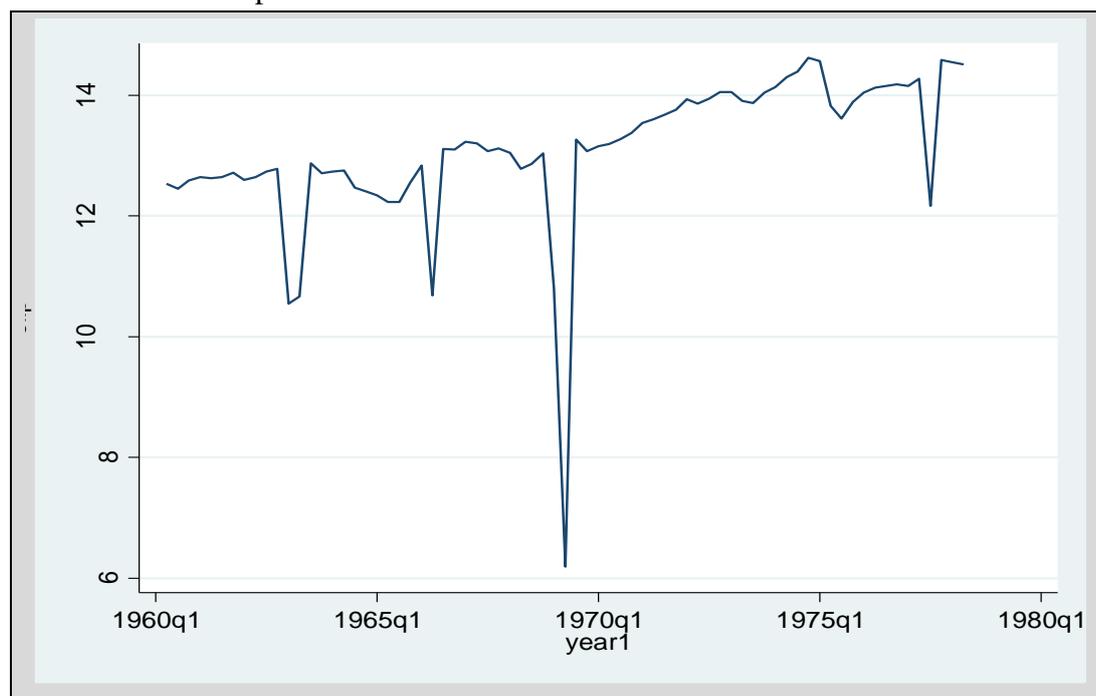
7. Appendix

1. Unit root

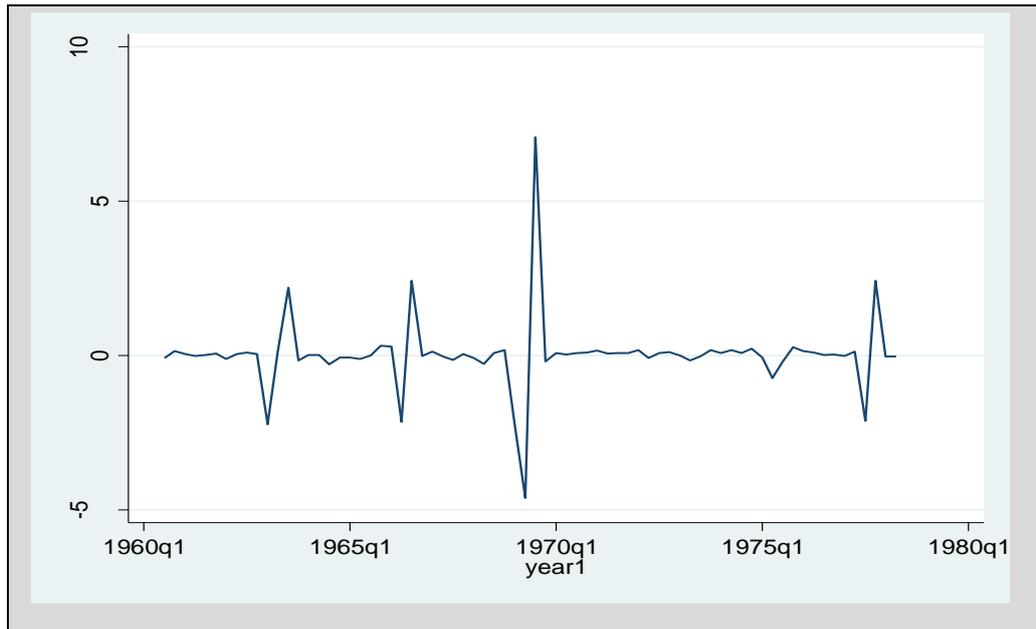
| Time series | Test statistics Z(t) | | Test statistics Z(t) | |
|-------------|----------------------|----------|----------------------|----------|
| Variables | Pp constant | P values | Pp With trend | P values |
| lcpi | -1.748 | 0.4064 | -0.943 | 0.9513 |
| d. lcpi | -8.643 *** | 0.0000 | -9.063*** | 0.0000 |
| LM2 | 1.623 | 0.9979 | -0.369 | 0.9878 |
| d.LM2 | -9.468 | 0.0000 | -9.761 | 0.0000 |
| IM3 | -0.011 | 0.9594 | -1.929 | 0.6394 |
| d. IM3 | -9.162*** | 0.0000 | -9.088 *** | 0.0000 |
| ly | -2.040 | 0.2694 | -1.751 | 0.7278 |
| d. ly | -3.506** | 0.0078 | -3.438* | 0.0465 |
| le | -0.842 | 0.8066 | -2.309 | 0.4291 |
| d. le | -8.073 | 0.0000 | -8.025 | 0.0000 |
| IOil p | -4.728 | 0.0001 | -6.204 | 0.0000 |
| d.I IOil p | -13.858 | 0.0000 | -13.750 | 0.0000 |

***, ** & * indicate a rejection of the null hypothesis at the 1%, 5% - and 10% levels. P is the probability,

1a: A trend of oil price index in levels



1:b Trend of oil price index in first difference



2. Lag Length

```
. varsoc cpi m2 y e oilp
```

Selection-order criteria

Sample: 1961q2 - 1978q2

Number of obs = 69

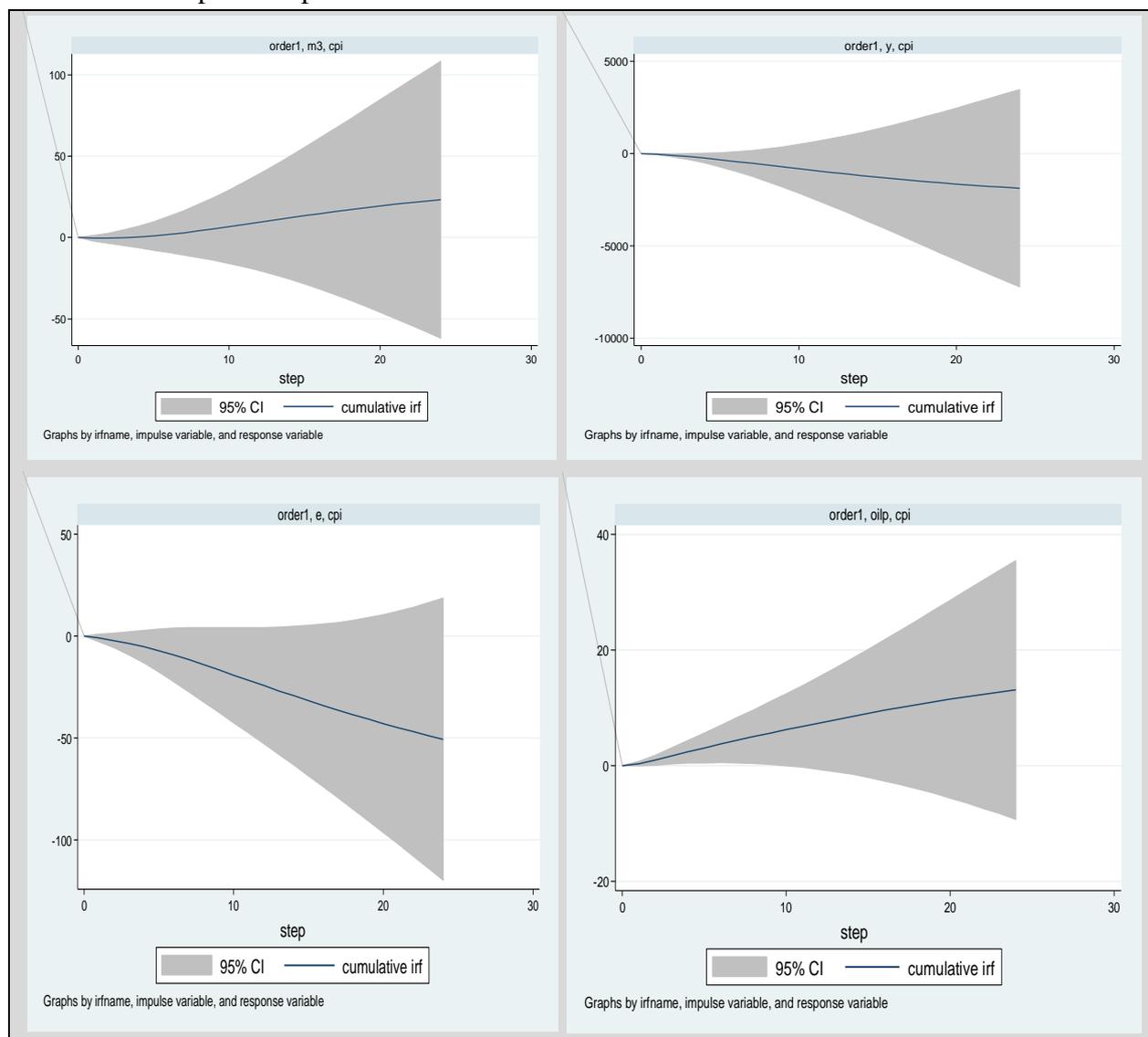
| lag | LL | LR | df | p | FPE | AIC | HQIC | SBIC |
|-----|---------|---------|----|-------|----------|-----------|-----------|-----------|
| 0 | 114.362 | | | | 2.9e-08 | -3.1699 | -3.10568 | -3.00801 |
| 1 | 659.172 | 1089.6 | 25 | 0.000 | 8.3e-15 | -18.2369 | -17.8515 | -17.2655 |
| 2 | 713.762 | 109.18 | 25 | 0.000 | 3.6e-15 | -19.0946 | -18.388 | -17.3137* |
| 3 | 762.03 | 96.536 | 25 | 0.000 | 1.9e-15 | -19.769 | -18.7413* | -17.1787 |
| 4 | 789.455 | 54.849* | 25 | 0.001 | 1.8e-15* | -19.8393* | -18.4905 | -16.4395 |

Endogenous: cpi m2 y e oilp

Exogenous: _cons

5. Empirical Results for M3 Model

Cumulative impulse response of inflation for SVAR framework



6. Inflation Elasticities to the shocks within SVAR framework

| period | M3 | Y | e | oil |
|--------|---------|-----------|----------|----------|
| 4 | 0,00421 | -0,108517 | -0,16758 | 0,755592 |
| 8 | 0,00168 | -0,14411 | -0,06036 | 0,24675 |
| 12 | 0,00426 | -0,166818 | -0,04226 | 0,188434 |
| 16 | 0,0132 | -0,1826 | -0,04171 | 0,19034 |
| 20 | 0,0255 | -0,27323 | -0,04481 | 0,210484 |
| 24 | 0,0395 | -3,698499 | -0,04982 | 0,242597 |

7. Variance Decomposition of inflation within SVAR framework

| period | cpi | m3 | Y | e | oil |
|--------|---------|--------|---------|---------|---------|
| 4 | 59,7549 | 0,374 | 18,1903 | 9,2654 | 12,4154 |
| 8 | 39,4088 | 0,3563 | 26,5723 | 13,111 | 20,5516 |
| 12 | 29,7556 | 0,7254 | 30,1697 | 16,6587 | 22,6906 |
| 16 | 24,6646 | 1,0621 | 31,5435 | 18,9494 | 23,7804 |
| 20 | 21,8858 | 1,2576 | 31,9252 | 20,4798 | 24,4515 |
| 24 | 20,3703 | 1,3483 | 31,8311 | 21,572 | 24,8783 |