MONEY AND OTHER DETERMINANTS OF INFLATION: THE CASE OF TANZANIA

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ABSTRACT

This paper seeks to establish the relative importance of money and other factors in explaining inflation in Tanzania. The analysis was based on quarterly data for the 1967 – 2005 period. Both long run regression results failed to establish existence of positive one-to-one correspondence between growth rates of three monetary aggregates (M1, M2, M0) and (headline) inflation in Tanzania. The lack of the one-to-one correspondence as predicted by the Quantity Theory of money also emerged form estimated dynamic autoregressive distributed lag (ADL) error correction model (ECM). Instead, other factors, particularly growth in real income, were found to exert the expected depressive influence on inflation. This finding underscores the importance of the demand for money in explaining inflation. Other important structural factors found to influence inflation in Tanzania include nominal exchange rate and inflation inertia. In aggregate the long run influence of changes in money was found to be very small if compared to that exerted by structural factors. This suggests limitations to monetary policy and importance of structural factor in explaining the dynamics of inflation in Tanzania. On account of theoretical controversies and innovations that have characterized inflation theory to-date coupled with methodological issues of interest, more research on inflationary process in Tanzania is called for to anchor or better the results of this paper.

JEL Classification Numbers: E31, E52

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I. Introduction

In 1995 the government of Tanzania amended the 1965 central bank charter through the central bank by the Bank of Tanzania Act, 1995, that revived use of indirect

[1]The author benefitted from tuition on MATLAB based data interpolation technique offered by Dr. John Mduma (University of Dar es Salaam, Tanzania), comments on final draft by Prof. Asmeron Kidane (University of Asmara, Eritrea), Dr. Eliab Luvanda (University of Dar es Salaam, Tanzania), Prof. Mukwanason Hyuha (African Economic Research Consortium, Kenya), and support by Mr. Willy Kitima. The usual disclaimer applies that the author is solely responsible for the views and any error and/or shortcoming in this paper.

monetary policy instruments. Later in 2006, the 1995 Act was also amended, due regard having been, among others, to "provide for more responsive regulatory role of the Bank of Tanzania (BoT) in relation to the formulation and implementation of monetary policy" (United Republic of Tanzania, 2006, p. 119). One theoretical and policy issue of interest in the two amendments is categorical declaration of "the primary mission of the bank "to formulate, define and implement monetary policy directed to the economic objective of maintaining price stability, conducive to a balanced and sustainable growth of the national economy of Tanzania" (United Republic of Tanzania, 2006, p. 123; Bank of Tanzania, 2001, p. viii).

Delivery by the BoT as per its entrusted mission requires a good understanding of the determinants of inflation in Tanzania. It is evident from available anecdotal evidence that the BoT only subscribes to an often quoted view held by Friedman (1960) that "inflation is always and everywhere a monetary phenomenon"; and, as a result, "no country can succeed in "stemming inflation without adopting measures directed at restraining the growth of the stock of money" (p. 2). Some studies on Tanzania, mostly carried out prior to the launch of economic reforms in mid-1986, show that inflation is not entirely a monetary phenomenon.[2] Rather, they found that structural factors also enter significantly in explaining inflation but mostly during the period prior to the launch of economic reforms in mid-1986. In this regard, this paper tests the conventional null hypothesis that "inflation is mainly a monetary phenomenon" against an alternative hypothesis that "structural factors matter" more in explaining short and long run inflation dynamics in Tanzania.

Apart from this introductory section, Section 2 presents the monetarists'

[2]Among others, see specific studies on Tanzania by Hyuha and Ndulu (1990); Hyuha and Osoro (1989); Rwegasira (1977, 1976). For evidence on Tanzania from cross-country studies, see Laryea and Sumaila (2001) and Canetti and Green (1991).

theory of inflation and reviews related empirical literature. Section 3 presents a descriptive analysis of the developments of inflation in Tanzania during the sample period. The usual econometric model and discussion of data are presented in Section 4. Section 5 presents, discusses and compares the econometric results. Section 6 concludes, highlighting policy implications of the findings and areas for further research.

II. REVIEW OF RELATED LITERATURE

In the monetarist theory, inflation is always and everywhere a monetary phenomenon (Friedman, 1960). Stated otherwise, in the monetarists' view, the *Alfa and Omega* of the cause and cure of inflation is the control of money supply; and, "anything that affects the price level must do so through changes in the stock of money, its velocity, or the volume of transactions" (Selden, 1959, p. 19).

The monetarist view of inflation rests on the Classical Quantity Theory of Money (QTM) based on two main assumptions (Lucas, 1980; Friedman, 1956). First, is constancy of the income velocity, defined as an average number of times a unit of money circulates in an economy in a given period. On this account, changes in money supply lead to proportional changes in nominal output; and, as it is maintained, a monetary authority would be able to predict, almost with certainty, the nominal output growth on the basis of planned money growth rates. Second, it is assumed that the economy always operates at full employment, that is, the aggregate supply curve is perfectly inelastic.

Several studies on sub-Saharan Africa (SSA) have used the monetarist model initially used in Latin America, among others, by Harberger (1978, 1963), and Vogel (1974). Seemingly, the majority carry evidence in favour of the monetarists'

hypothesis. A series of studies on Kenya found that inflation is driven by money supply (Durevall and Ndung'u, 2001; Ndung'u, 1994; Ryan and Milne, 1994; Mwega, 1990; Killick and Mwega, 1989; and, Tegene, 1989). Similar result emerged from studies that simultaneously focused on Kenya, Ghana, and Tanzania (Chhibber and Shafik, 1990; Adam, Ndulu and Sowa, 1996; Kilindo, 1998), and also Nigeria (Egwaikhide, Chete and Falokun, 1991), Uganda (Edward, 1996), Mozambique (Ubide, 1997), Malawi (Ndhlovu and Ndeferakhande, 2004), Guinea (Blavy, 2004) and the Dominican Republic (Williams and Adedeji, 2004).

It is worth noting that the monetarists' theory is challenged in theoretical models developed by, among others, Wallace (1981), and Sargent and Smith (1987). Moreover, some studies provide evidence that suggests lack of or existence of very weak causal effect of money on inflation in SSA countries. These include studies by Canneti and Green (1991) in Kenya, Suliman (2003) in Sudan, London (1989) in Tanzania and other 22 ADB (African Development Bank) countries, and Kallon (1992) in Sierra Leone. Not least, empirical evidence from a series of studies on Ghana failed to support strongly the monetarists' position (Sowa, 1994, 1996; Sowa and Kwankye, 1993). Instead, these studies and others carry evidence that supports the structuralist view of inflation. Other studies carry evidence in favour of both monetarists' and structuralist's views of inflation (Barnichon and Peiris, 2007; Moser, 1995; Hyuha and Osoro, 1989).

III. METHODOLOGY

III.1. Estimation model

The empirical analysis is based on a model developed by Harberger (1963) and

extended by Cagan (1956) and Vogel (1974) to study inflation in Latin America and augmented by structural factors to study inflationary experiences in some sub-Saharan African countries (London, 1989; Killick and Mwega, 1989; Ndung'u, 1994).[3] In its semi-log-linear format, the long run inflation equation for estimation reads as,[4]

$$(1) \qquad \pi_t = \beta_0 + \beta_1 \Delta m_t + \beta_2 \Delta y_t + \beta_3 \pi_t^e + \beta_4 R_t + \beta_5 ER_t + \beta_6 D + e_t$$

where π_t is the inflation rate obtained as the first difference of the price level, Δm_t is the growth rate of nominal money supply, Δy_t is real income growth, π_t^e is expected inflation, R_t is nominal interest rate, ER_t is nominal official exchange rate, D is a measure of structural break possibly occasioned by the liberalization of the economy, and e_t is a white noised stochastic error term.[5] In theory, β_1 and β_3 are expected to be positive; and, on account of the monetarist's long run proportionality prediction, $\beta_1 = 1$ (Lucas, 1980). Real income reduces "output gap" and therefore inflation in the economy such that $\beta_2 \leq 0$. If superneutrality of money is assumed, $\beta_2 = 0$, as de Grauwe and Polan (2005) notes, and m_t and y_t should not be correlated. Moreover, perverse interest and exchange rates adversely affect demand for money balances. Specifically, low nominal rates (R) and exchange rate (ER) respectively engender substitution of domestic currency in favour of physical assets/real estate and capital flight/currency substitution such that inflation increase from excess money supply. Accordingly, in theory it should be that $\beta_4 < 0$ and $\beta_5 < 0$. Economic liberalization is

[3]According to Aghevli and Khan (1978) until the 1970s the model served as the basic foundation in studies on money and inflationary process in developing countries. For an incisive critique of the model used in Latin America, see Nugent and Gleziakos (1979).

[4] Velocity has not been included in (1) on assumption that it is constant and that if it is variable it enters the residual term as expected of any other relevant variable that should be included but "wrongly" excluded from equation (1).

[5]Lower case variables are in natural logarithms.

expected to have complemented anti-inflation policy stance pursued in Tanzania since 1986.[6] Accordingly, β_6 is expected to be negative and very statistically significant.

The short-run dynamics of inflation in Tanzania are explored by unrestricted autoregressive distributed lag (ADL) error correction model (ECM) based on equation (2). The equation for estimation reads as,[7]

$$(2\quad \Delta\pi_t = \beta_0 + \sum_{i=1}^{k}\gamma_{i-1}\Delta\pi_{t-i} + \sum_{i=0}^{k}\delta_i\Delta m_{t-i} + \sum_{i=0}^{k}\varphi_i\Delta y_{t-i} + \sum_{i=0}^{k}\psi_i\Delta ER_{t-i} + \sum_{i=0}^{k}\omega_i\Delta\pi^e_{t-i} + \sum_{i=0}^{k}\phi\Delta R_{t-i} + \vartheta ec_{t-1} + u_t$$

where all the variables are as already defined. Additionally, u_i is an *iid* stochastic error term, k is the lag length, and ec_{t-1} is the error correction term whose coefficient should be negative signed to demonstrate adjustment process towards the long run equilibrium.[8]

Consistent with the QTM, the short-run elasticity of money with respect to price (δ_0) should be zero and $\sum_{i=0}^{k}\delta_i \geq 1$. Moreover, the short-run income elasticity (φ_0) is equal or less than unity; and, in the long run $\sum_{i=0}^{k}\varphi_i \leq 0$. The elasticity of expected

[6] The measure of structural break (D) takes on a value of zero before economic liberalization in 1986: II and a value of unity afterwards.

[7] On the naïve approach of letting data to speak for itself, the equation has entries for both $\Delta\pi^e$ and ΔR. On this account it is not ruled out a priori that portfolio decisions of economic agents are restricted to a choice between money and goods, as maintained by Khan (1980) and others.

[8] According to Nugent and Glaziakos (1979), β_0 could be interpreted as a proxy for suppressed structural elements in an equation in growth form. Alternatively, the constant could be taken as an average or expected rate of growth. Thus, Nugent and Glaziakos (1979) maintain that the constant term in a monetarist equation is inappropriate because it biases the coefficient of money towards zero (p.433). This argument was not defended by the pre-test carried out. A constant term was therefore retained in the estimated equations.

inflation is such that $\sum \omega_i \geq 0$; and, if inflation inertia exists, $\sum_{i=1}^{k} \gamma_i = 1$, otherwise zero.

In the strict monetarist view inflation would only be a monetary phenomenon if the coefficient of the error correction term (ϑ) is statistically significant (Durevall and Ndung'u, 2001; Enders, 1995).

III.2. The Data

The analysis in this paper is based on quarterly time series data for the period 1967: IV - 2005: IV. The data for money stock and inflation were obtained from the *Quarterly Economic Bulletin* (various) and the annual *Economic and Operations Report* (various) of the Bank of Tanzania (BoT). Linear interpolation method in MATLAB was used to generate quarterly series data from the annual real GDP. The latter was a product of the nominal GDP that was deflated by the general price level (p) measured by the consumer price index (CPI) for Tanzania. While the data for the nominal GDP were obtained from the June 2008 CD-ROM of *International Financial Statistics* of the International Monetary Fund (IMF), the data for the CPI were obtained from BoT publications.

Inflation is measured as (hundred times) the first difference of the surrogate measure of p, that is, the CPI. This implies that the focus in this paper is on the headline inflation rather than core inflation considered more responsive to monetary policy. The CPI rather than any other measure of price level was preferred because its data were consistently available and were used as the measure of inflation in previous studies on Tanzania. Suffice it to note, however, that food group has historically carried relatively more weight in the construction of the CPI used to generate inflation

in Tanzania.[9] During the sample period the base of the CPI was changed four times---in 1970; 1977; 1994 and in 2001, to accommodate development in the markets.[10] Even though, over the sample period the weight of food in the CPI dominated. It ranged from 40 percent during the 1980s to 64.2 percent during the 1990s; and decreased to about 56 percent during 2001-2005 period. The noted dominant weight of food in the construction of the CPI in Tanzania is a common characteristic in most LDCs which suggests that the relationship between money growth and inflation in Tanzania may not strictly be consistent with the QTM proposition.[11]

Three measures of money are used: a) narrow money ($M1$) that sums currency in circulation and demand deposit; b) the broad money ($M2$), which sums the $M1$ and both savings and time deposits of the commercial banks; and, c) monetary base ($M0$).[12] As Lucas (1980) notes, the QTM does not provide "guidance as to the measurement of the quantity of money, or as to which (if any) of the aggregates corresponds to the variable theoretically termed "money" (p. 1006). Rather, the "question of which monetary aggregate one would theoretically *expect* to move in proportion to prices is much more open than has traditionally been recognized" (Lucas, 1980:106, emphasis in original document). On this account, the analysis in this paper is based on all the three measures of money stock in Tanzania.

Linear interpolation method was also used to generate quarterly data from the annual time series data of 91 days Treasury bill (TB). BoT's publications were the source of the nominal annual TB rates (R) data, which is used as a proxy measure of

[9] Over the sample period clothing and footwear, fuel, light and water are two of the other eleven group items that feature staunchly in the construction of the CPI in Tanzania.

[10]Splicing method was used to rebase the base years of the CPI into 2001 base year in vogue and used to generate the inflation rate.

[11] In Nigeria, for example, food prices account for 69.1 percent of the CPI. This, as Moser (1995) notes, implies that such factors as agro-climatic conditions, wages, domestic inputs, and import prices and rainfall influences greatly CPI.

[12] There exists in Tanzania another measure of money stock referred to as extended broad money M3) that sums M2 and foreign currency deposits. The measure is not used due to lack of adequate and consistent data.

short-term nominal interest rate. The R, rather than inflation rate, which is usually used as a measure of opportunity costs of money balances, was preferred because it is in theory one of the alternate intermediate targets of monetary policy. Moreover, R nests into the estimation model the liberalization of interest since the Government engaged the economic reforms programme in mid-1986. To some extent, the correlation (0.54) between the natural logarithm of the CPI (p) and that of the TB rate (r) tends to justify the modeling of the latter in the estimation model.

Expected inflation rate (π^e) was generated by a stationary autoregressive integrated moving average (ARMA) scheme. The preference of ARMA method over the adaptive expectation originally used by Cagan (1956), follows from its seemingly ease of use and superiority. For example, Kallon (1992), informs that the ARMA is a more appropriate ad hoc mechanism for modeling expectation; and that the process has desirable attributes of both adaptive and rational expectation hypotheses (AEH and REH). Moreover, use of adaptive expectation in studies on Tanzania has been found to yield poor results (Ndanshau, 2004; Naho, 1983).

Since the analysis is based on quarterly data, the estimation followed ARMA (8, 1, 0). The choice of the lag length of equation (3) was guided by plots of autocorrelation function (ACF) and partial autocorrelation function (PAF) of the difference stationary inflation rate. Lag 1 to 15 of the ACF was statistically different from zero in the 95 percent confidence limit (± 0.209). The PAC, however, had distinctive and significant negative spikes in the first 8 lags. The Q-statistic also rose dramatically after the eighth lag, implying insignificance relationship. The PAC therefore suggested AR (8) as the most appropriate approximation for the ARIMA model for estimation of expected inflation rate. However, first, Greene (2003) informs that ARMA models with relatively small values of p and q are more powerful.

Secondly, besides its cost in terms of substantial reduction in degrees of freedom and possible multicollinearity problem, the mean and the median expected value of π^e generated by ARIMA(8,1) was very big, more than 20 times! Granted, to circumvent the very erratic behavior of π^e and its consequences the long cut-off point of the ACF and PACF was reduced to an equivalently parsimonious ARMA (1, 1) model.[13] The equation estimated by OLS method reads as,

$$(3) \qquad \hat{\pi}_t^e = 0.0005 + 0.935\Delta\pi_{t-1} + 0.917\Delta e_t - 0.406\Delta e_{t-1}$$

The coefficient of the constant term is not statistically significant at the conventional test levels. However, the rest of the parameter estimates are statistically significant, at least at the 5 percent test level. The AIC (3.44) and a very high (890.76) and very statistically significant at the conventional test level (Prob. 0.000) suggest that the chosen ARIMA model was powerful. Moreover, the ACF and PACF of the residual obtained in equation (3), coupled with unit root test applied to π^e, suggested that the estimated model reasonably fitted the data. This and the preceding information justify the estimated ARMA model used to estimate π^e.

IV. ECONOMETRIC RESULTS

a) Long run Inflation model: The results

Econometric implementation was preceded by the exploratory data analysis (EDA) followed by unit root and cointegration tests. Graphical plots suggests that the narrow ($m1$) and broad money ($m2$) supply (in log-level) exhibited a stable behavior that

[13] I am indebted to Prof. Asmerom Kidane for this observation and some suggestions.

was characterized by a break in 1985: II. The behavior of the base money ($m0$) and inflation rate (π) is quite erratic but tending to stability (Appendix Figure 1). In contrast, both nominal interest rate (R) and the log-level real income (y) exhibited dramatic kinks, an outcome that suggests they may not be stationary. As a result of its long period of control by the Government, the nominal official exchange rate (ER) was stable over the period 1967: I – 1986: I and started to rise after the launch of economic reform programme in mid-1986 (Appendix Figure 1).

The mean and median of all key variables of the basic estimating equation are about equal, serve for the growth rate of real income (Δy), the rate of return on treasury bills (R) and the exchange rate (ER) (Table 1). This, and the very statistically significant Jarque-Bera statistics, suggests lack of strong skewness (to the right or left) of only two of the regressors of the basic equation (1); any of the three measures of money growth, and the expected rate of inflation (π^e) (Table 1).

Table 1: Common Sample Descriptive Statistics of the Key Variables Used, 1967: IV – 2005: IV

	p	π	π^e	Δm0	Δm1	Δm2	Δy	R	r	ER
Mean	1.91	4.25	0.92	5.38	5.03	5.05	0.94	9.97	1.97	316.37
Median	2.06	3.40	0.77	4.77	5.21	5.18	1.46	4.95	1.60	93.70
Maximum	4.76	20.47	10.11	32.83	62.41	40.27	20.18	50.92	3.93	1169.20
Minimum	-1.33	-3.78	-4.86	-14.55	-47.83	-28.06	-15.85	2.50	0.92	6.90
Std. Dev.	2.16	4.56	2.60	9.15	9.40	6.67	4.90	11.41	0.71	379.49
Skewness	-0.09	0.68	0.46	0.49	0.47	0.19	0.32	2.78	1.38	0.87
Kurtosis	1.47	3.34	3.48	3.19	18.18	12.02	5.83	9.83	4.22	2.28
Jarque-Bera	14.22	11.68	6.44	5.91	1378.97	486.08	50.11	462.40	54.29	20.97
Probability	0.00	0.00	0.04	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Obs.	143	143	143	143	143	143	143	143	143	143

The EDA, therefore, suggests that the variables in equation (1) are normally distributed. In this regard, they satisfy one of the assumptions for subjecting equation

(1) to regression analysis (Mukherjee, White and Wuyts, 1998:69).

The correlation matrix shows that inflation (π) is unexpectedly negatively correlated with the growth rates of all three measures of money stock ($\Delta m0, \Delta m1, \Delta m2$) in Tanzania (Table 2). Also π is negatively related to real income (Δy), an outcome that could be attributed to successful disinflation policy measures in economic reforms implemented in Tanzania since mid-1986. π is also negatively related to the official nominal exchange rate (ER).[14] This could be speculatively attributed to depressive effect of economic deregulations, among others, the liberalization of the foreign exchange market and lift of controls of imports that reduced uncertainty and its inflationary implications. The rest of the regressors are thus: unexpectedly, π is positively correlated with the nominal interest rate (R). This suggests possible inflation hedging in nominal interest rates formation in Tanzania. As would be expected, π is positively related to expected inflation (π^e). The correlation between π and its one-period lagged value is positive, suggesting existence of positive inflation inertia in Tanzania.

Table 2: Common Sample Correlation Matrix of the Key Variables in Levels

	π	π^e	Δm0	Δm1	Δm2	Δy	R	r	ER	p
π	1.00									
π^e	0.26	1.00								
Δm0	-0.01	0.13	1.00							
Δm1	-0.11	0.03	0.45	1.00						
Δm2	-0.06	0.07	0.49	0.95	1.00					
Δy	-0.77	-0.27	0.02	0.11	0.07	1.00				
R	0.17	0.03	0.17	0.04	0.07	0.00	1.00			
r	0.14	0.07	0.12	0.02	0.05	0.09	0.92	1.00		
ER	-0.27	0.07	-0.04	-0.03	-0.04	0.13	0.26	0.35	1.00	
p	-0.06	0.09	0.00	-0.02	0.00	0.12	0.39	0.54	0.88	1.00

[14] The growth rate of ER, that would suggest depreciation or appreciation of the official exchange rate, was also negatively related to π.

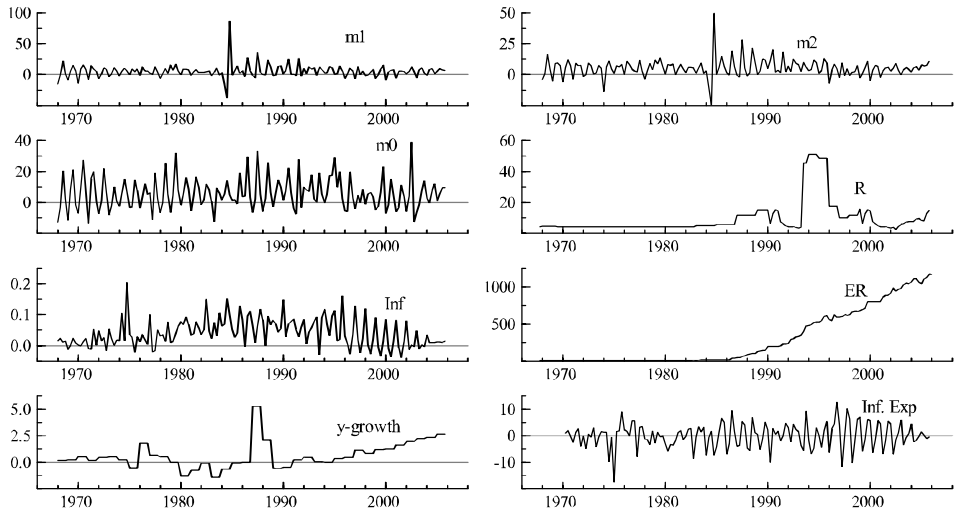
The correlation statistics suggests three things: a) lack of a positive and very strong relationship between growth in money supply (for all three measures) and inflation in Tanzania;[15] b) multicollinearity problem may characterize the estimation of the basic equation; and, this would arise from the very high correlation between the growth in real income, as well as exchange rate and the growth rates of money supply (Table 2). Since all variables are very important none is contemplated for dropping during regressions; c) growth in nominal money supply, howsoever measured, is strongly correlated with the growth of real income. Thus, there is no superneutrality in the relationship between money and output in Tanzania (de Grauwe and Polan, 2005).

Visual inspection of the plots in Figure 1 conveniently generated by GiveWin 2 suggests that the growth rates of money ($\Delta m0$, $\Delta m1$, $\Delta m2$), real income (Δy) and expected inflation (π^e) are very noisy and thus they could be stationary. All variables appear to exhibit unexplainable brake in 1984:I. The nominal exchange rate (ER) is characterized by an upward trend, mainly since mid-1980s when the country started to implement economic reforms. The plot of the nominal TB rate (91 days), which is used as a surrogate measure of the nominal interest rate (R), is characterized by major breaks in the period between 1992:IV and 1996:I, a period that includes two major events: total liberalization of interest rates in 1994 and shift of monetary policy regime to the use of traditional instruments of monetary policy in mid 1995. On account of EDA, first, the econometric analysis in this paper is based on data points for the 1970:I – 2005:IV period that also allows for the lag structure chosen to generate π^e and estimate the ECM. Second, log transformation was applied to eliminate outlier in the nominal interest (R).[16]

[15] De Grauwe and Polan (2005) failed to find existence of a correlation in cross-country regressions that covered a sample of 165 countries.

[16] Pre-test results showed that the explanatory power of the estimating equation was far much better when the log transformed interest rate (r), rather than R, was used as a regressor.

Figure 1: Behaviour of the Key Variables, 1967:IV – 2005:IV



The Augmented Dickey-Fuller (ADF) unit root test results presented in Table 3 indicate that all the variables, except the inflation rate (π), which is integrated of order one $I(1)$, are stationary, that is, are $I(0)$. This finding may suggest inexistence of the theorized long run equilibrium relationship between π and regressors of the basic estimating equation. In fact, Engle and Granger (1987) two-steps cointegration test (results not reported here) rejected existence of long run equilibrium between inflation and all the log-level measures of money supply in Tanzania.[17] However, further cointegration test also by using Engle and Granger (1987) methodology attested to an existence of a long run equilibrium relationship between inflation and the left-and right hand variables in equation (1).[18]

Granted, the long run OLS regression results in Table 4 generated by EViews (Version 5) are not spurious but robust (Enders, 1995). In content, they robustly show that the long run influence of growth in money supply on inflation, no matter how

[17] The approach is simply presented in Gujarati (2003) and also Johnston and Dinardo (1997) and Stock and Watson (2003).

[18] ADF test showed that the residuals of equation (1) for all measures of money were very stationary.

Table 3: Unit Root Test Results Based on Augmented Dickey-Fuller Approach

Variable	**p**	**$\Delta p=\pi$**	**$\Delta\pi$**	**$\Delta m1$**	**$\Delta^2 m1$**	**$\Delta m2$**	**$\Delta^2 m2$**	**$\Delta m0$**	**$\Delta^2 m0$**
Specification									
Lag	5	3	6	2	6	2	6	4	6
ADFτ	1.105	-2.846	-8.507	-13.848	-9.650	-12.850	-9.126	-5.391	-9.453
Critical values									
1%	-3.475	-3.475	-3.476	-3.474	-3.476	-3.474	-3.476	-3.474	-3.476
5%	-2.881	-2.881	-2.881	-2.881	-2.881	-2.881	-2.881	-2.881	-2.881

Variable	**Δy**	**r**	**Δr**	**π^e**	**$\Delta\pi^e$**	**ER**	**ΔER**
Lag	3	0	0	3	3	0	0
ADFτ	-3.704	-2.536	-12.907	-8.506	-8.995	-0.470	-11.629
Critical values							
1%	-4.020	-3.473	-3.473	-3.476	-3.478	-3.475	-3.475
5%	-3.440	-2.880	-2.880	-2.823	-2.883	-2.881	-2.881

measured, is unexpectedly negative and statistically significant at 5 percent statistical test level of significance (Table 4). Also, contrary to the QTM prediction, results in Table 4 show that the influence of money growth on inflation is very small and across all the trio measures of money stock (Table 4). Specifically, the evidence shows lack of the predicted positive and one-to-one long run influence of money growth on inflation in Tanzania. However, it is notable that the coefficient of the growth rate of $M2$ is slightly larger than that of the narrow and high powered money.

That the regression results are inconsistent with the major "laws" of the QTM suggest other factors are more important in explaining inflation in Tanzania. First, the long run income elasticity coefficients in all the three equations estimated are negative as expected (Table 4). However, at least in absolute terms, none of the magnitudes of the estimated income coefficients is close to zero in the context of the superneutrality of money thesis. Instead, (in absolute terms) each of the trio income elasticity coefficients approach unity and is very statistically significant. Contrary to the QTM the estimated coefficients of the growth rate of real income is larger than that of the

Table 4: Regression Results for the Long Run Model♣

Variable	1	2	3
C	3.906*	3.839*	3.884*
	(1.187)	(1.183)	(1.186)
Δm0			-0.025**
			(0.013)
Δm1		-0.021**	
		(0.011)	
Δm2	-0.033**		
	(0.016)		
Δy	-0.864*	-0.863*	-0.861*
	(0.032)	(0.032)	(0.032)
π^e	0.026	0.024	0.033
	(0.031)	(0.031)	(0.031)
r	1.216**	1.217**	1.217*
	(0.498)	(0.498)	(0.498)
ER	-0.003**	-0.003**	-0.003**
	(0.002)	(0.001)	(0.002)
R^2	0.86	0.86	0.86
s.e.e	1.74	1.74	1.74
AIC	3.99	4.00	4.00
F-stat.	138.80*	138.04*	138.61*
D.W.	2.15	2.15	2.16

Note: a, b, and c are statistical significances at 1percent, 5 percent and 10 percent, respectively.

♣ All equations in the table have been corrected for very significant first order serial correlation by using Cochrane-Orcutt method.

growth rates of the money stock (Table 4). Second, irrespective of how money is measured, the official exchange rate (ER) exerts an unexpected and unexplainable statistically significant negative influence on inflation (Table 4). Third, the influence of interest rate on inflation in Tanzania is positive and statistically significant at the 10 percent test level. Fourth, Table 4 shows that the influence of expected inflation (π^e) on inflation in Tanzania is positive as expected but is very statistically insignificant at the conventional test levels. Thus, following Dell (1982), it is incorrect to attribute the

inflation in Tanzania to a single factor, namely money growth. After-all the estimated coefficient of money growth are negative signed, an outcome that captures more influence on inflation of the contractionary monetary policy measures of the BoT since the 1986 and more so since mid-1995.

b) Short-run Inflation Dynamics: The results

Short run inflation dynamics in Tanzania were analyzed by using equation (2). The analysis proceeded as follows: First, one-period lagged error terms (ect_{t-1}) from the estimated long run cointegrating equations for the trio measures of money supply were used in equation (2). Second, following Charemza and Deadman (1997), a very general overparameterized ADL model was estimated. The choice of the lag structure of the ADL model was guided by two factors. One is the correlogram of the difference stationary inflation rate. Its PAC had distinctive positive and statistically significant spikes at lag 4 and 8. Empirical evidence from some of the previous studies was the second factor that was used to identify the lag structure of equation 2. Some of the previous studies suggest that adjustment of prices to changes in money supply may range from 4 quarters (Khan and Schimmelpfennig, 2006; de Grauwe and Polan, 2005; Saini, 1982) to up to 20 quarters (Carlsson, 1980). On this account, as a general setting 24 lags of money growth and 8 lags of the rest of regressors (excluding the error term) were included in the ECM.

The general ECM model was gradually trimmed by dropping overly insignificant lags each round of estimation on the basis of the individual *t-statistics* and both *F-statistic* test for the individual and joint regressors statistical significance. In addition, the adjusted coefficient of determination ($\bar{R}^2$), standard error of regression (SER), Shwartz Information Criterion (SIC) and Akaike Information

Criterion (*AIC*) were also used to monitor effect of the individual reductions on explanatory power of the targeted parsimonious model. As if led by the extreme QTM position that "money matters most" insignificant lags were dropped last.

Table 5: Statistical Results from the Reductions of the General Model to a Specific Parsimonious Model: Case of M2

Model	t-stat. Prob. Limit	Reductions	SER	SIC	AIC	R^2	F
0	None	None	1.33	5.18	3.71	0.98	40.38
1	$Pob. \geq 0.75$	**Δy** (-2, -7), **Δπ**^{e} (-2, -4, -8), **ΔR**(-4, -5, -8), **Δ**ER(-2, -4, -8), and **Δπ**(-1 to -5).	1.21	4.71	3.52	0.98	60.06
2	$Pob. \geq 0.30$	**Δy** (-3), **π**^{e} (-3, -7), **Δ**ER(-1, -6).	1.20	4.59	3.49	0.98	66.21
3	All lagged regressors, except money, with insignificant lags	**Δy** (-6), **Δπ**(-8), **ΔR**(-3), **Δ**ER(-3), and **Δπ**^{e} (-5).	1.20	4.43	3.47	0.97	75.70
4	Money with $Pob. \geq 0.50$	**Δm** (-3, -8, -15, -20).	1.18	4.29	3.41	0.97	86.95
5	All lagged regressors insignificant at $Pob. \geq 0.10$	**Δm** (-1, -2, -4, -12, -18, -19), **Δπ**^{e} (-3, **Δ**R(-7) **Δ**ER(-7, -8).	1.20	4.06	3.40	0.97	111.22

Notes: The F-statistics were used to choose the variables dropped in each regression. *F-stat. (p value) was used to check for joint significance before they were dropped from the regressions. The F stat suggested that the lags were jointly not statistically different from zero.

Table 5 shows the "five steps" taken from the overparameterised ADL model to the achievement of a very parsimonious inflation model.[19] As Table 5 shows the ultimate parsimonious model estimated for $M2$ and replicated for $M1$ and $M0$ is quite powerful. The standard error of regression (*s.e.r*) decreased from 1.33 to 1.20; the SIC decreased from 5.18 to 4.06 as AIC also fell from 3.71 to 3.40. More

significantly, the F-statistic rose sharply from a low of about 40.00 to as high as 111.22. Table 5 shows that the improvement in explanatory power of the model was achieved with little sacrifice on explanatory power of the repressors because R^2 decreased very marginally. The Durbin Watson (DW) statistics also suggests that serial correlation is not a problem.[20] Even more important, all parameter estimates of the equations estimated for the three measures of money in Tanzania have very small standard errors ($s.e$), and, therefore small variances. This implies that the estimators in each equation are very efficient.

According to the short run regression results in Table 6 growth in money stock (measured by $M2$) has a positive but a statistically insignificant contemporaneous influence on inflation in Tanzania. Instead, all interim multipliers are statistically significant at least at the 5 percent test level. However, it is notable that some of the interim multipliers are negative and others are positive. The change in signs is probably consequent from contractionary and expansionary monetary policy actions taken by BoT to achieve price stability. The results in Table 6 show that short run influence of the $M2$ growth lasts for up to 21 lags (21 quarters) that is more than five years. The coefficient estimated for the error correction term is, as expected, negative signed and very statistically significant at the 1 percent test level.

The results in Table 6 further show that structural factors also bear short run influence on inflation. The growth in real income has a negative and very statistically significant contemporaneous influence on inflation. In absolute terms the cotemporaneous influence of the real income growth is larger than that of the growth of $M2$. The estimated interim multiplier imbibes that the depressive and sometimes

[19] The results in Table 5 are only based on the broad measure of money stock, that is $M2$, which is used by BoT as the intermediate target of monetary policy.

[20] Lack of serial correlation was confirmed by first order Cochrane-Orcutt test.

Table 6: Short-Run Regression Results: Case of Broad Money (M2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.223	0.311	0.716	0.476
Δm 2	0.028	0.019	1.510	0.134
Δm 2(-5)	0.039	0.019	2.098	0.038
Δm 2(-6)	0.038	0.019	2.056	0.042
Δm 2(-7)	0.050	0.018	2.757	0.007
Δm 2(-9)	0.115	0.019	5.987	0.000
Δm 2(-10)	-0.120	0.021	-5.797	0.000
Δm 2(-11)	-0.067	0.018	-3.613	0.001
Δm 2(-13)	-0.038	0.022	-1.704	0.091
Δm 2(-14)	0.072	0.022	3.275	0.001
Δm 2(-16)	-0.069	0.018	-3.830	0.000
Δm 2(-17)	-0.078	0.021	-3.665	0.000
Δm2(-21)	0.036	0.018	1.971	0.051
Δy	-0.891	0.029	-30.534	0.000
Δy(-1)	0.736	0.055	13.291	0.000
Δy(-4)	0.194	0.076	2.531	0.013
Δy(-5)	-0.271	0.074	-3.686	0.000
Δy(-8)	0.156	0.047	3.354	0.001
$\Delta \pi^c$	-0.296	0.103	-2.862	0.005
$\Delta \pi^e(-1)$	0.285	0.147	1.944	0.055
$\Delta \pi^e(-6)$	-0.078	0.043	-1.787	0.077
ΔR	0.051	0.024	2.107	0.038
ΔR(-1)	-0.024	0.023	-1.044	0.299
ΔR(-6)	-0.016	0.023	-0.664	0.508
ΔER	-0.013	0.006	-2.148	0.034
$\Delta \pi(-2)$	0.598	0.253	2.364	0.020
$\Delta\pi(-3)$	0.226	0.104	2.176	0.032
$\Delta \pi(-4)$	0.406	0.109	3.738	0.000
$\Delta \pi(-8)$	0.205	0.061	3.337	0.001
ECM2(-1)	-0.633	0.121	-5.217	0.000
R^2	0.970	AIC		3.406
$\bar{R}^2$	0.961	SIC		4.064
s.e.r	1.203	F-statistic		111.217
D.W stat.	1.932	Prob(F-statistic)		0.000

Note: a, b, and c are statistical significances at 1percent, 5 percent and 10 percent, respectively.

inflationary influence of the short run real income growth lasts up to the 8th lag, that is 8 quarters that equal two years. Expected inflation exerts a statistically significant negative contemporaneous influence on inflation; and, its interim influence on

inflation is mixed but statistically significant up to the 6^{th} lag. Interest rate bears a statistically significant contemporaneous influence on inflation; and, the interim influence is negative but statistically significant. Table 6 further shows that the contemporaneous influence of change in exchange rate is negative and statistically significant. Lagged inflation up to the 8^{th} lag exerts statistically significant on inflation.

Table 7 shows that growth in narrow money ($M1$) lacks a statistically significant contemporaneous influence on inflation in Tanzania. Nevertheless, while the influence of the first 9 lags is positive and statistically significant at 1 percent test level, that of the remaining lags is also statistically significant but with variable signs. Since $M1$ account for the largest share of the $M2$ targeted by policy, the alternating signs of the interim multipliers could probably be an outcome from policy measures of BoT. As in the case of $M2$, the coefficient of the error correction term is negative, as expected, and is very statistically significant at the 1 percent test level.

According to Table 7, the contemporaneous influence of the real income growth is negative and larger than that of the growth in $M1$. The influence on inflation of the interim multipliers estimated for real income alternate in sign and generally decays over the lags but remains very statistically significant. The contemporaneous influence of expected inflation on inflation is negative and statistically significant at 1 percent test level; and, that of short run changes in nominal interest rate is positive and statistically significant at 5 percent test level.

Changes in exchange rate exert a negative and very statistically significant (about 1 percent test level) influence on inflation. The influence of lagged inflation that lasts to the 8^{th} quarter is positive and statistically significant at least, at 5 percent test level.

Table 7: Short-Run Regression Results: Case of Narrow Money (M1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.401	0.239	1.681	0.096
Δm1	0.014	0.012	1.180	0.241
Δm 1(-5)	0.031	0.013	2.493	0.014
Δm 1(-6)	0.027	0.013	2.008	0.047
Δm 1(-7)	0.029	0.012	2.376	0.019
Δm 1(-9)	0.076	0.013	5.764	0.000
Δm 1(-10)	-0.093	0.015	-6.346	0.000
Δm 1(-11)	-0.051	0.012	-4.220	0.000
Δm 1(-13)	-0.020	0.015	-1.358	0.178
Δm 1(-14)	0.048	0.015	3.211	0.002
Δm 1(-16)	-0.055	0.012	-4.598	0.000
Δm 1(-17)	-0.066	0.014	-4.546	0.000
Δm1(-21)	0.029	0.012	2.440	0.016
Δy	-0.906	0.028	-32.629	0.000
Δy(-1)	0.784	0.055	14.351	0.000
Δy(-4)	0.171	0.074	2.304	0.023
Δy(-5)	-0.283	0.071	-4.001	0.000
Δy(-8)	0.192	0.046	4.220	0.000
$\Delta \pi^e$	-0.342	0.095	-3.587	0.001
$\Delta \pi^e(-1)$	0.398	0.138	2.880	0.005
$\Delta \pi^e(-6)$	-0.091	0.041	-2.246	0.027
ΔR	0.047	0.023	2.056	0.042
ΔR(-1)	-0.038	0.022	-1.715	0.089
ΔR(-6)	-0.021	0.022	-0.944	0.348
ΔER	-0.015	0.006	-2.588	0.011
$\Delta \pi(-2)$	0.767	0.237	3.245	0.002
$\Delta\pi(-3)$	0.305	0.097	3.135	0.002
$\Delta \pi(-4)$	0.448	0.104	4.317	0.000
$\Delta \pi(-8)$	0.233	0.058	4.029	0.000
ECM1(-1)	-0.638	0.113	-5.665	0.000
R^2	0.973	AIC		3.273
$\bar{R}^2$	0.966	SIC		3.931
s.e.r	1.126	F-statistic		127.551
DW stat.	2.105	Prob(F-statistic)		0.000

Note: a, b, and c are statistical significances at 1percent, 5 percent and 10 percent, respectively.

Table 8: Short-Run Regression Results: Case of Base Money (M0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.507	0.428	1.184	0.239
Δm0	0.005	0.025	0.194	0.847
Δm0(-5)	0.031	0.025	1.247	0.215
Δm0(-6)	-0.058	0.024	-2.412	0.018
Δm0(-7)	-0.021	0.022	-0.952	0.343
Δm0(-9)	0.001	0.024	0.023	0.982
Δm0(-10)	0.033	0.024	1.375	0.172
Δm0(-11)	-0.008	0.022	-0.352	0.726
Δm0(-13)	-0.035	0.024	-1.465	0.146
Δm0(-14)	0.022	0.024	0.915	0.362
Δm0(-16)	-0.021	0.023	-0.902	0.369
Δm0(-17)	0.021	0.025	0.831	0.408
Δm0(-21)	-0.022	0.025	-0.906	0.367
Δy	-0.803	0.039	-20.402	0.000
Δy(-1)	0.610	0.067	9.111	0.000
Δy(-4)	0.092	0.088	1.038	0.302
Δy(-5)	-0.072	0.088	-0.816	0.417
Δy(-8)	0.076	0.059	1.289	0.201
$\Delta\ \pi^e$	-0.116	0.136	-0.850	0.397
$\Delta\ \pi^e(-1)$	0.163	0.203	0.801	0.425
$\Delta\ \pi^e(-6)$	-0.061	0.059	-1.030	0.306
ΔR	0.056	0.035	1.599	0.113
ΔR(-1)	0.032	0.034	0.929	0.355
ΔR(-6)	0.026	0.038	0.683	0.496
ΔER	-0.009	0.009	-1.004	0.318
$\Delta\ \pi(-2)$	0.298	0.340	0.876	0.383
Δπ(-3)	0.004	0.135	0.033	0.974
$\Delta\ \pi(-4)$	0.120	0.136	0.881	0.380
$\Delta\ \pi(-8)$	0.121	0.077	1.566	0.121
ECM0(-1)	-0.573	0.157	-3.655	0.000
R^2	0.939	AIC		4.098
$\bar{R}^2$	0.922	SIC		4.756
s.e.r	1.701	F-statistic		53.936
D.W.	2.078	Prob(F-statistic)		0.000

According to Table 8 growth in monetary base ($M0$) also lacks a statistically significant contemporaneous influence on inflation. As is also evident, only coefficient of the 6th lag is statistically significant at 5 percent test level. The results in Table 8 show, however, that contemporaneous influence of growth real income on

inflation is negative and very statistically significant at the 1 percent test level. The coefficient of the first interim multiplier is positive and statistically significant. It is notable that, in absolute terms, the contemporaneous influence of growth in real income is larger than that of growth in base money. Moreover, changes in the rest of structural factors lack statistically significant influence on inflation (Table 8). However, the estimated coefficient of the error correction term is negative as expected and very statistically significant at the conventional test level of 1 percent. Again, this suggests existence of a long run relationship between inflation and the growth rate of the base money in Tanzania.

V. DISCUSSION AND COMPARISON OF THE RESULTS

The empirical evidence is inconsistent with the fundamental law of the QTM that there exists a long run positive and proportionate relationship between changes in money supply and inflation. Other studies on Sub Saharan Africa (SSA) have established a positive long run relationship between changes in money supply and inflation, for example Kuijs (1998) in the case of Nigeria. In the short run, estimated elasticities suggest existence of positive but not a one-for-one relationship between monetary growth and inflation in Tanzania. With specific reference to each monetary aggregate, a unit change in the growth rate of M2 would only cause inflation to change by (positive) 0.01. This contrasts with the growth rate of M1 and M0 that would only cause inflation to change by (negative) 0.31 and about (positive) 0.23, respectively. As notable, therefore, the influence on inflation from changes in money supply is far less than unity and not quite predictable.

The positive but statistically insignificant contemporaneous influence of money growth on inflation obtained for Tanzania is inconsistent with that obtained by

some of the previous studies, for example Saini (1984) in a study on India, Blavy (2004) on Guinea, and Naho (1983) in the case of Tanzania. Implicitly, the negative influence on inflation associated with some of the interim multiplier is not unusual.[21] Furthermore, the long-lagged influence on inflation associated with the growth of money supply in Tanzania, howsoever measured, is also not unusual. In the United States of America (USA), a country with a more developed financial system, Kanorsky (1978) established that a change in money growth was fully reflected in inflation after five years (20 quarters)!

Moreover, the sign and the size of the short-run income elasticities estimated suggest that real income growth exert relatively larger depressing effects on inflation than money growth in Tanzania. The same result was obtained by Sowa and Kwakye (1993) and Sowa (1994, 1996) in Ghana.[22] It is worth noting, however, that the very statistical significance of changes in income in all estimated long and short run equations suggest that demand-side rather than supply side factors could be more important in explaining inflation in Tanzania.

The importance of other factors in explaining inflation in Tanzania is evidenced by very statistical significant influence of exchange rate, expected inflation and price inertia on the inflationary process that could probably be attributed to supply shocks and policy shifts and measures, for example, a series of devaluations in Tanzania since mid-1980s. It is worth noting that structural factors, other than real income, unexplainably lack both contemporaneous and interim short run influence on

[21]The inconsistency could be attributed to "noise" in the quarterly data used that have "a much higher variance than the systematic movements in the time-series in question and thus obscure the basic economic relationship" (Brillembourg and Khan, 1979:359). Also see Bromberger and Makinen (1979) for the view that data account for the "paradox negative sign." However, pre-test of this view by annual data did not lead to a positive short-run multiplier. Volatility in the relationship between money, prices, and output due to financial innovations could also be one reason for alternating signs of the interim multipliers. See Caprio and Honohan (1990) and Adam (1995).

[22] It is also worth noting that a very small (less than 10 percent) changes in money on inflation was obtained by de Grauwe and Polan (2000) but for a cross section of 165 countries with experiences of hyper inflation experiences.

inflation when changes in base money enter the inflation equation.

The estimated coefficients of one-period lagged error terms (ect_{t-1}) in the estimated ECM equations are negative as expected and very statistically significant at the 1 percent test level. This suggests existence of a long run reversion to equilibrium of the price adjustment process, irrespective of the measure of monetary aggregate used. The magnitude of coefficients of ec_{t-1} suggests that the adjustment of inflation to changes in money growth range from about 57 percent to 64 percent. In the case of M2, which is BoT's intermediate target of monetary policy, adjustment of inflation to its growth is about 63 percent complete in one year. The negative and slow long run adjustment coefficient implies that the period between decision to change money supply and its impact on inflation in Tanzania may not have been quite long.

It is worth noting that in the estimated long run inflation equations coefficients of the constant term is about 4 and is statistically significant. Ceteris paribus, this suggests that 4 percent is the optimal or rather threshold inflation rate at the long run equilibrium level output in Tanzania. In general, it is evident from the results that inflation in Tanzania is not wholly influenced by money. Rather, other factors are more significant, in this case inflation inertia, economic growth, and exchange rate. The less than proportionate influence of money on inflation has also been found to characterize low inflation countries (Frain, 2004). Mwase (2006) found perturbing non-conventional response of inflation to exchange rate movement in Tanzania—in particular, the decrease in inflation despite exchange rate depreciation (p. 24).[23]

[23] Mwase (2006) attributes the inconsistency to increase in competition, higher productivity, and tighter monetary policy implemented in Tanzania since the late 1990s.

VI. ROBUSTNESS TESTS

The estimated long run equation for each of the three measures of money in Tanzania was subjected to stability tests. Chow breakpoint tests, where the break was set on 1994:IV due to shift in monetary policy regime, fails to reject existence of structural break in the estimated long run equations (Table 9).

Table 9: Chow Test Statistics

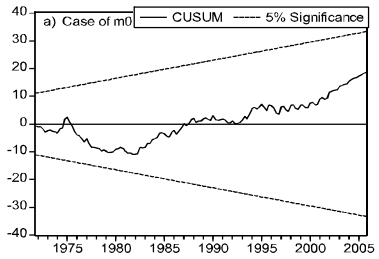
	Basic equation for	$F_{m,\infty}$	$\chi^2_{(m)}$
a)	$m0$	Prob. F (6, 131)=0.094	$\chi^2_{(6)} = 0.071$
b)	$m1$	Prob. F (6, 131)=0.095	$\chi^2_{(6)} = 0.072$
c)	$m2$	Prob. F (6, 131)=0.232	$\chi^2_{(6)} = 0.192$

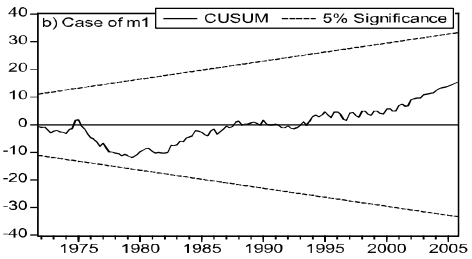
Furthermore, CUSUM and CUSUMQ tests for stability based on an assumption that equations estimated were linear in parameters and the error terms were $iid(0,\sigma^2)$, shows that the estimated long run equations for the three monetary aggregates in Tanzania lacked serious instability as the CASUM lies within the $\pm 2S.E$ band (Figure 2a).

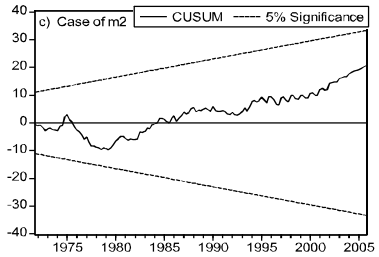
The CASUM test, however, shows that the estimated equation was particularly very stable during the period between the launch of economic reforms in 1986:II and the shift to the traditional monetary policy in macroeconomic management to achieve price stability in 1995:II. The plot of CASUM square test wiggles but remains within the 5% significance test level, suggesting that the estimated equation was somehow stable. That the estimated equations were particularly stable between 1986 and 1994 is evidenced by recursive plots in Figure 2c. The plots of recursive coefficients also suggest that the estimators were particularly stable since 1986.

Figure 2: Recursive Tests of the Long Run OLS Results

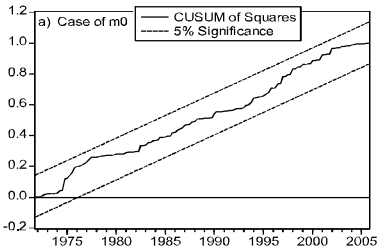
(a) CUSUM Test

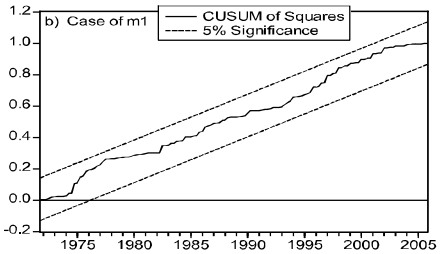


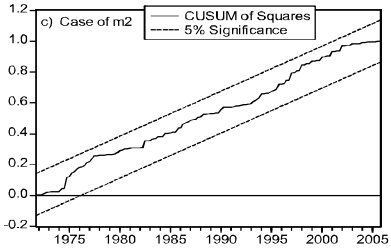




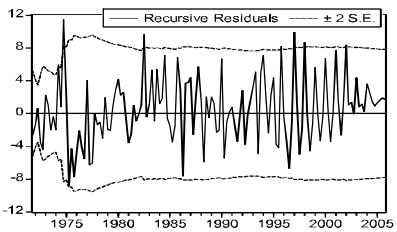
(b) CASUM of Square Test



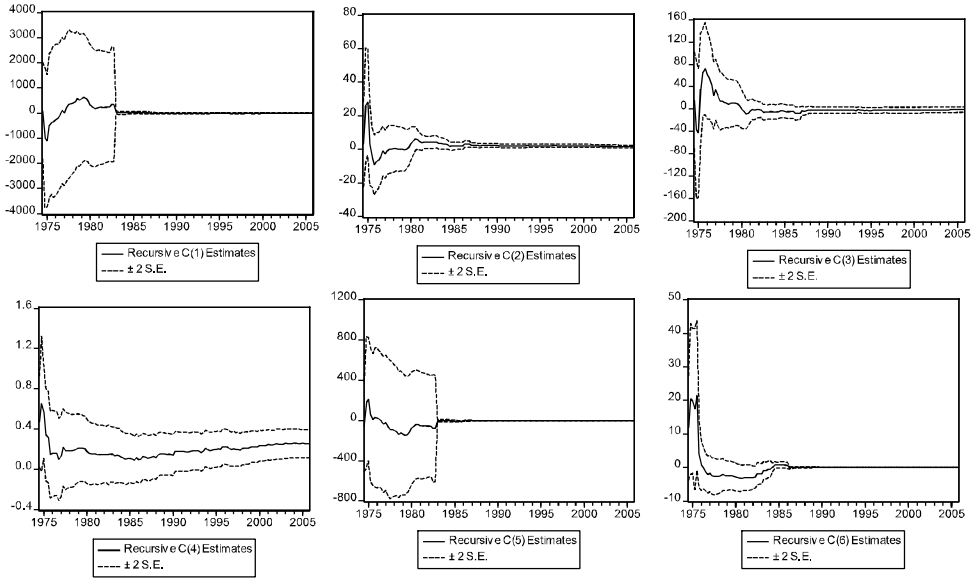




(c) Recursive residual test



(d) Recursive Coefficients Test



Regression results obtained from the use of dummy method failed to establish existence of structural breaks in the long run regressions for money-inflation equations caused by the supply shocks, particularly the oil price shocks.[24]

The stability tests generally suggest existence of a stable link between inflation and money growth, particularly measured by the broad money aggregate in Tanzania. However, contrary to the QTM prediction, the evidence fails to establish existence of a "one-to-one" correspondence relationship between changes in money growth and inflation in Tanzania. This could, probably be attributed partly to the limitation of the QTM in a developing country. Among others, Lucas (1980) notes that the quantity-theoretic laws are obtained as "characteristics of steady states, or limiting distributions, of theoretical models…" (p. 1006). Thus, the test of the law in a developing economy like Tanzania where all the basic "theory conditioning factors" are, by and large, absent could be construed as an expedition driven by curiosity to

build a basis for generalizing the theory with evidence from quite different macroeconomic environment, among others, different monetary policy environment and regime. It is in this case that the interest exists in establishing from the data available whether there is an emerging convergence of the economic behaviors of the developing countries, for example, the link between inflation and money, is converging to that in developed capitalist economies to contrast with inflationary process in developing countries where unemployment is a paramount political and economic issue (Modigliani and Papademos, 1976; Tobin, 1975). As noted elsewhere, "if output is below capacity levels, it is likely that an increase in money supply will be non-inflationary and that the effect will be a rise in output" (Dell, 1982:608). Besides, the "seemingly paradox" results could be attributed to monetization that may have endogenized the growth in money supply and/or increased the income velocity after the liberalization of the financial sector in Tanzania since mid-1980s. Moreover, it is maintained in literature that the coefficients of money, output, and interest rate in price equation can either be positive, negative or insignificant depending on the constellation of shocks hitting the economy. Implicitly, the negative sign established here should not be unexpected, given the series of internal and external shocks experienced by Tanzania during the sample period.

VII. CONCLUSION

This study sought to establish the relative importance of money growth and other factors in explaining inflation in Tanzania. The analysis, which was based on quarterly data for the period 1967:IV - 2005:IV, was motivated by reliance and

[24] The dummy variable was assigned a value of a unity during oil shock dates, including 1975, 1979, 2004, and zero otherwise.

importance attached by policy makers to the QTM in anti-inflation money monetary policy approach in Tanzania since the 1990s. The findings presented in this paper raise critical questions on the relevance of such mainstream based monetary policy approach in Tanzania.

According to the empirical results the changes in money supply is not positive and proportionately related to inflation as predicted in the QTM. This finding does not only apply to the broad money, which is used by BoT as an intermediate target of monetary policy, but also the narrow and the base money. The estimated dynamic autoregressive distributed lag error correction model also failed to produce evidence in favour of QTM. Instead, and contrary to QTM, findings of the study suggests that other factors, basically structural factors account more for the long run and short run inflation dynamics in Tanzania. Specifically, in the short and long run the depressive influence of real income was more important than money—both in terms of magnitude and statistical significance. Also contrary to the theory, the findings show that changes in interest rate and exchange rate were important determinants of inflation in Tanzania—both in the short run and long run. The finding thus far suggests that a "money only" monetary approach is improper or rather not properly anchored for the attainment of price stability, a legally defined prime objective of monetary policy entrusted to the central bank in Tanzania. Rather, structural factors should be accommodated to help demand management.

The results of this paper are not foolproof. More empirical investigation is required on monetary analysis, especially on causal test of the link between money and prices, measurement of money, and influence of specific shocks on inflation in Tanzania. Relative importance of excess money growth in explaining inflation could also be explored in future research works. Future research should be directed to a test

of a theory in vogue that only core inflation has a long run relationship with money; and further investigation of the relationship and causality between money growth, exchange rate and inflation in Tanzania. The influence of the openness of the economy since economic reforms were implemented, coupled with globalization syndrome, could also be of interest in future studies on inflation in Tanzania.

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