Money and Output in Tanzania: A Test for Causality

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Abstract

This study has investigated empirically the causal relationship between money and output in Tanzania for the period 1986 to 2018. A VECM was estimated in log-difference and in log-level and Granger causality test undertaken by using annual time series data to test a null hypothesis that money does not Granger cause output either way. The log-difference results rejected the null that money Granger cause output in favour of the alternative hypothesis that output Granger cause money and the effect was unidirectional. The results in this case suggest money supply is endogenous such that monetary policy cannot directly be used in stabilizing the economy over the short-run. Instead the government should rely on fiscal policy rather than monetary policy to attain macroeconomic objectives in general and price stability in particular. Robustness test results from estimation the log-level results suggested the causality was unidirectional from money to output, implying money is exogenously determined and could be controlled by the monetary authority to achieve macroeconomic objectives, price stability in particular. The differing results demand for further empirical tests.

Keywords: Money, Output, Tanzania, VECM, Causality

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1. Introduction

Monetary policy is one of the policy options used in macroeconomic stabilization programmes in and outside the developing countries. Until very recent the practice in monetary policy in most economies has been to target monetary aggregates as an intermediate to an achievement of the desired macroeconomic objective, mainly price stability. Notable, the monetary policy regime based on monetary targeting presumes stability of money and, in relation, existence of a long run equilibrium between money and output in an economy. It is in this context that the nature of causality between money and output has been at the center of empirical studies in both developed market economies (DMEs) and underdeveloped market (UMEs), elsewhere referred to as developing countries mostly found in Asia, the Latin America and Africa.[1] At the center of investigation in such empirical studies has, by and large, being the null hypothesis that money does not Granger cause output. In theory, rejection of that hypothesis implies effectiveness of monetary policy in the effort to stimulate the economy or achieve macroeconomic stability.

The main purpose in this paper is to investigate the relevance to Tanzania of the mainstream hypothesis on money-output nexus. The analysis is motivated by two main factors. One is the use of monetary targeting as an anchor of monetary policy in Tanzania. Second is dearth of empirical studies on the money-output nexus in Tanzania. Hitherto, only study by Maganya (2006) exist and explicitly focused on but rejected the mainstream hypothesis on the money-output nexus in Tanzania but by using annual time series data for the period 1970-2004. Notable, however, empirical findings of a related study by Mkupete and Ndanshau (2017) confirmed the relevancy of the monetarist's money-output nexus in Tanzania. Noteworthy, however, results and statistical inferences from both studies are likely suspect because the samples covered was characterized by government-controlled prices of commodities and financial assets and direct rather that indirect monetary policy regime. This study updates the previous studies in two ways. First, the analysis only covers the economic reforms period; and, thus is based on annual time series data for the period1986-2018. The chosen period averts the structural break in data likely to have been occasioned by shift in macroeconomic policy regime in 1986 that transited the command economy regime (1967-1985) to the existing market economy regime. Second, analysis is carried out by using more robust econometric methods, in particular, test for cointegration by (bounds) autoregressive distributed lag (ARDL) technique and a test for Granger causality by using vector error correction model (VECM) which superior to the standard technique used by Maganya (2006).

The rest of the paper is organized as follows. Apart from this introductory section, Section 2 motivates the envisaged analysis by dwelling on the evolution of money and output in Tanzania during the sample period. The relevant literature is reviewed in Section 3; and, Section 4 carries the methodology of the study. The econometric results are presented, discussed, and compared with that of the previous studies in Section 5. Section 6 concludes with a presentation of the main findings, policy implications and areas of future research.

[1] This is evidenced in the literature survey here under.

2. Stylized Facts on Money and Output in Tanzania

Since the attainment of her political independence in 1961, Tanzania has been under three macroeconomic management regimes: liberal market economy over the period 1961-1967; regulated markets (planned) economy during the period 1967-1985; and a market economy over the period 1986-2020. The three types of economic regimes also became borne in the deployment of macroeconomic policies to achieve the fundamental macroeconomic objectives, particularly economic growth and price stability. The most recent market economy regime has been evolving since 1986 when the Government started to implement IMF (International Monetary Fund) and World Bank supported economic reforms designed to address severe macroeconomic crises that characterized the planned economy regime.

The plots in Figure 1 and 2 suggests the shift in policy regime, coupled with the reforms of the legal and institutional framework governing the financial system bear influence on the evolvement of output and money in Tanzania. It is notable in Figure 1 and Figure 2 that between 1986 and 1990 real output grew as growth in nominal narrow money supply (M1) decreased, albeit turbulently, and, the broad money supply (M2) growth almost trended with the output growth. Notable, following enactment of the Banking and Financial Institutions Act (BFIA) the M1 and M2 decreased to an unprecedented low in 1995when after Following enactment of the BFIA rose and fell to a low than the decrease in M2. In contrast, between 1991and 20060 real income rose sharply and virtually remained stable for the rest of the period. The real M1, however, decreased very rapidly to a low in 1995 when price stability was declared in Bank of Tanzania (BoT) Act of 1995 as the prime objective of monetary policy in Tanzania. Virtually, the real M1 appear to have increase and decreased and fell sporadically since 2000 as real income stabilized.

The plots of real income and the M2 in Figure 2 exhibit some salient difference to that of the M1 and income in Figure 1. Income rose but then fell to a low in 1992. Similarly, the M2 cyclically rose and fell to a low in 1990. It is notable that the M2 fell after the Government liberalized the financial sector by enactment of the BFIA in 1991; and, the growth in both M1 and M2 reach unprecedented low growth rates in 1996, that is after the Government enacted the BoT Act 1995 that shifted the country from direct to indirect monetary policy regime targeted to price stability. Apparently thereafter, the growth in M1 and M2 rose to a high in 2005 and thereafter decreased as the economy grew at relatively smooth cum stable rate.

Figure 1: Growth of M1 and Real GDP

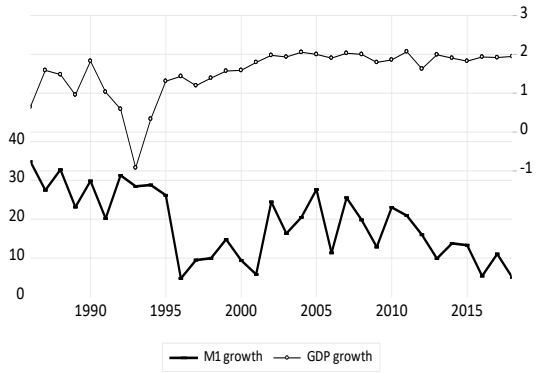
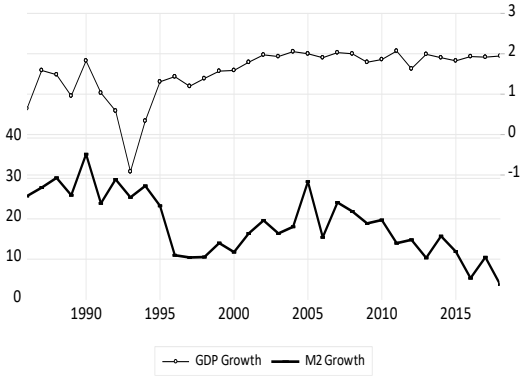


Figure 2: Growth of M2 and Real GDP



In general, the plots in Figure 1 and Figure 2 suggest three things. One is lack of a strong difference in the in the time trends of the M1 and M2, frequent swings (turbulent) in the former. Second, is lack of a close relationship between the growth rate of either M1 or M2 and the growth rate of real income. In sum, it is unlikely that either money, howsoever measured, bear influence on the evolvement of real output in Tanzania, at least during the sample period.

3. Review of related literature

3.1 Theoretical Literature

The theory on how monetary policy impact on output in an economy exist in two major camps, namely, the money business cycle (MBC) and real business-cycles (RBC) camps, respectively based on the monetarist's Quantity Theory of Money (QTM) and Keynesian's income expenditure macroeconomic theory. In the MBC view, the stock of money supply is exogenously determined by a central monetary authority, a central bank in particular (Biswas and Saunders, 1986). Accordingly, it is maintained that changes in money supply (monetary shocks) by prudent monetary policy actions impacts positively on real economic activity (and prices) over the short-run and only prices over the long-run. Simply stated, money is not neutral over the short run but over the long-run.

In contrast, money supply is endogenously determined in the RBC, that is, it is demand driven by output. Specifically, in the context of the theory of money supply determination, the RBC's view is that changes in the stock of money supply is primarily determined by the behavior of the commercial banks and the nonbank public responsible for the "production" of inside money but not the central bank that "produce" the outside money. The bottom-line argument is that monetary policy actions that increase (decrease) money supply ab ignition increase reserves available for lending to the private sector. Granted, banks bent on profit maximization lower the lending interest rate that increase inside money and thereof private investment that impact positively on output and consequently increase in demand for money and finally money supply. In this regard, it is in the RBC's view that changes in money supply (or monetary shocks) do not impact on output, rather, it is output that impact on money supply. Thus, monetary policy is inefficient and ineffective because "money has little or no effect on output and real variables" in an economy (Cagan, 1989:117).[2]

The neutrality of money over the long-run in the MBC view exists under three "channels". One is "real wage channel", given fixed nominal wage contracts; second, is channel of "misperception of an increase in relative demand" (Ahmed, 1993:15). In the real wage channel, changes in money supply cause inflation that depress real wages that, following forces of demand and supply, increase in employment, production that increase output (Ahmed, 1993). In the misperception channel, imperfect information about evolution of prices across sectors of an economy cause increase in demand for goods and services in one sector that toll-bell for an increase in output. To some monetarists the non-neutrality of money over the short-run result from a fall in price of money relative to other goods that increase profitability of investment and leading to a rise in output. Over the long-run the increase in prices chokes the demand for goods and services as production costs also increase such that nominal output rise but due to the rise in prices but not

[2] Accordingly, changes or monetary shocks has no effect on output in an economy over the short-run. In contrast, it is maintained in the RBC view that money supply is endogenously determined by output, not otherwise. Accordingly, monetary policy is inefficient in stabilizing the economy.

real output. Thus, over the short run changes in the quantity of money upsets the assets markets equilibrium "and sets off a chain of portfolio substitution that ultimately affect the real sector of the economy" (Friedman,1973). In the long run money is neutral to output: it only affects prices as classical economists maintained.

3.2 Empirical Literature

In theory, it is deducible in the MBC that effect of monetary policy actions on the real sector of an economy is direct: simply, changes in money supply has a direct and positive unidirectional impact on output (and prices) over the short-run and a positive unidirectional impact (proportional) on prices over the long-run. Thus, in the MBC view monetary policy action is a potent approach to macroeconomic stabilization. In contrast, it is deducible in the RBC that money does not cause output: hence monetary policy action is an impotent approach to macroeconomic stabilization. Nevertheless, evidence from empirical studies on both developed market economies and developing countries so far lacks strong support to either of the two camps in the money-output nexus.

Evidence from studies on the United States of America (USA) and other DMEs that dominates the literature, is mixed and even controversial. For example, evidence from a study by Friedman and Schwartz (1963) and Sims (1972) was in support of the MBC's view: the causality was from money to output. However, a subsequent study by Sims (1980) which estimated a trivariate VAR model found "interest rate accounted for the significant part of output variations previously attributed to money supply" (Maitra, 2011, p. 121). Empirical evidence from a subsequent study on the USA by Friedman and Kuttner (1992), which extended the sample period from post-ward to the 1980s, was not supportive to existence of a strong causal effect of money on output as established by Friedman and Schwartz (1963). Moreover, a survey of empirical studies by Ansari and Ahmed (2007) found the evidence in most previous studies on DMEs was "not clear cut": some studies had established causality was from money to output, but others had found the causality was bi-directional.

Noteworthy, empirical evidence from a few studies on UMEs in Asia, the Latin America and Africa also is not clear-cut on the nature of the relationship between money and output. In Asia, study on Singapore by Maitra (2011) found money and output were cointegrated but not anticipated money supply and output. Moreover, causality test based on a VECM established existence of unidirectional causal effect of money on output but not anticipated money supply and output. Instead, only unanticipated money supply had impact on output in Singapore during the sample period. In another study on Singapore Huat and Tai Wai (2000) used cointegration technique to investigate the nature of causality between money supply and income. The study found money supply and GDP were cointegrated. However, Granger causality test established existence bi-directional causality between M1 and GDP and unidirectional causality from GDP to both M2 and M3.

In Bangladesh, Hussain and Haque (2017) used VECM to investigate the impact of money supply on the growth rate of per capita income over the period 1972-2014. Findings of the study suggested steady growth of broad money to GDP was associated with the growth rate of per capital income; and, in relation, the results suggested money supply had important impact on the growth rate of output in Bangladeshi over the long run period. Also, Aslam (2016) investigated empirically the

causality between money and output in Sri Lanka using time series data for the period 1959 - 2013. The multivariate econometric suggested money supply had a statistically significant positive impact on the economic growth.

In a study on Malaysia, which was based on Geweke's approach and used Wiener-Granger causality test, Tan and Cheng (1995) found causality ran from nominal money supply to nominal output. In addition, however, the study established existence of a strong feedback from real output to both narrow and broad measures of money supply. In general, therefore, the findings suggested existence of bi-directional causality between money and output in Malaysia. Moreover, Momen (1992) investigated and compared the nature of causality between money and output by comparing using a sample of ten (10) developing agricultural economies and developed industrial economies. As expected the study found money Granger caused output in developed economies; and, in contrast, output caused money in developing countries.

In sub-Sahara Africa (SSA), there exist even fewer noteworthy studies on money-output nexus. Study by Kalulumia and Yourogou (1997) used quarterly data for the period 1964 to 1993 to investigate the nature of causality between money and output in five member countries of the West African Monetary Union. The analysis carried out by using cointegration and dynamic modelling techniques established output was over the long run determined by real exchange rate, price level and nominal money balances. Among others, the study established existence of causality between money and output and non-neutrality of money in the sample countries that were relatively more advanced in industrial development, particularly Ivory Coast and Senegal. In general, the findings of the study were consistent with findings of some previous studies on developing countries which found money was non-neutral.

In Tanzania there are two studies by Mkupete and Ndanshau (2017) and Maganya (2006) which are specific on the nature of the relationship between money and output. The study by Mkupete and Ndanshau (2017) used a standard VAR model to compared the relative importance of monetary and fiscal policy in Tanzania over the period 1966-2013. In contrast, Maganya (2006) used the standard VAR model to specifically investigate the causality between money and output in Tanzania for the 1970 to 2004. The empirical results of Mkupete and Ndanshau (2017) were consistent with the monetarist based MBC view: effect of monetary policy on output was effective over the short run; and, fiscal policy was dominant in the short-run. In contrast, the results of the study by Maganya (2006) were consistent with Keynesian based RBC view: causality was from output to money, not otherwise as maintained in the MBC view. Aside their methodological differences, both studies failed to account for structural break in the sample period, particularly shift in monetary (and fiscal) policy regime in the 1990s. Following the so-called "Lucas critique" presented by Lucas (1976), models estimated with such notable shift in policy regime will "have little forecasting value in the new regime" (Gujarati, 2003:837). The analysis hereafter up-dates the previous study on Tanzania and beyond by using a longer sample period (1986-2018) and investigating for structural breaks in the relationship between money and output.

Several issues arise from the review of theoretical and empirical literature. First, the Neo Monetarists, including Lucas (1976), Sargent and Wallace (1973), share a view that the causal effect of money stock on output is unidirectional as claimed by the monetarist but only if money supply is unanticipated. Otherwise, over the short-run anticipated monetary shocks have impact

on prices only but not on output and other real variables (Barro, 1977). Though appreciated the Neo-Monetarists' view is not nested in the analysis hereafter. Second, diverse methodological issues characterize previous empirical studies: wrong specification of the estimation model; use of wrong lag lengths in the test for cointegration and in estimation of the VAR system of equations.[3] The analysis in this paper takes into consideration the fore mentioned methodological issues that are considered responsible for the differing results, among others, wrong empirical results leading to rejection of the mainstream hypothesis on the money-output nexus. Third, whether money causes output or otherwise as presented in the MBC and RBC views remains an empirical question more so in developing countries where there is a dearth of empirical studies.

4. Methodology of the Study

4.1 The estimation model

The empirical investigation into the nature of the causality between money and output in Tanzania is investigated by using a structural Vector Autoregressive (VAR) model with constant terms that reads as:

$$\mathrm{y}_t = \delta + \sum_{i=1}^{k} \varphi_i \mathrm{m}_{t-i} + \sum_{j=0}^{p} \omega_j \, \mathrm{y}_{t-j} + u1_t \quad (1)$$

$$\mathrm{m}_t = \emptyset + \sum_{i=1}^{k} \alpha_j \mathrm{m}_{t-i} + \sum_{j=0}^{p} \beta_j \, \mathrm{y}_{t-j} + u2_t \quad (2)$$

where m is level of money stock, alternatively measured by its narrow and broad definitions in Tanzania;[4] y is level of real output, which is central in monetarism, and is measured by real Gross Domestic Product (GDP);[5] $ec1_{t-1}$and $ec2_{t-1}$ are one-period lagged error terms of the cointegrating equations, $u1$ and $u2$ are properly behaved stochastic error terms, t is time, and k and p are lag lengths chosen by using Schwarz Information Criterion (SIC).

The testable null hypotheses in (1) and (2) are thus: $H_0: \varphi_i = 0, \forall j$ and $\omega_j \neq 0$, that is, money does not Granger cause output or rather it is neutral over the short run. The second null hypothesis is: $H_0: \beta_j = 0, \ \forall j$ and $\alpha_i \neq 0$, that is, output Granger cause money over the short-run. Third is a hypothesis that: $H_0: \varphi_i = \beta_j = 0, \forall j$, that is, money does not Granger cause output and output does not Granger cause money.[6]

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[3] On these issues, among others, see Bernanke (1986), Christiano and Ljungqvist (1988) and Krol and Ohanian (1990).

[4] Three measures of money supply are reported and monitored by the central bank: the traditional narrow money ($M1$), which is an aggregate of currency in circulation and demand deposits denominated in domestic currency; broad money ($M2$), which is aggregate of $M1$ and both savings deposits and time deposits denominated in domestic currency; and, extended broad money which aggregates $M2$ and foreign currency deposits denominated in domestic currency. The M2 has historically been the basis of monetary policy programming in Tanzania (Bank of Tanzania, 2008).

[5] NCPI was rebased in September 2010 from December 2001 (=100) by using 2007 HHBS (based on all types of household consumption in 21 geographical regions in Tanzania whereof weights used were based on expenditure of both urban and rural households with groupings that followed internationally recommended classification of individual consumption by purpose (COICOP) which has 12 major groups. In groups in Tanzania included 4 other classification were included: a) food and non-alcoholic beverages; b) energy and fuels; c) all items less food; and d) all items less food and energy.

[6] According to Friedman (1992) the neutrality of money over the short run period could run for three to ten years; and, over decades the rate of monetary growth would primarily affect prices.

There features in the literature several techniques used to investigate causality between money and output. The first and most common are the Granger (1969) and Sims (1972) techniques based on a standard Vector Autoregression (VAR). According to Ansari and Ahmed (2007) economists harbour serious doubts about potency of unrestricted VAR approach in the study of the causality between money and output and even prices. Also, following Engle and Granger (1987) application of VAR causality test to variables in first difference rather than in levels is bound to produced misleading results. Hence, use of the Vector Error Correction Model (VECM), which is most recent, popular and estimated to investigate the short run dynamics and long run relationship between money and output in Tanzania. Given (1) and (2), the VECM for estimation reads as:

$$X_t = \alpha + \sum_{i=1}^{k} \varphi_i X_{t-i} + \gamma ec_{t-1} + e_t \qquad (3)$$

where X is a column vector $(m,\ y)_{2x1}$, α is intercepts vector, $\varphi_{i_{2x2}}$ is a matrix of short-run impact multipliers $(i = 1,2, \dots k)$, γ_j is a vector of adjustment coefficients $(j = 1,2)$ over the long run period, ec_{t-1} is a vector of one-period lagged error terms of the cointegrating vector, k is lag length, e_t is vector of white noise stochastic error terms. According to Kramers *et al*. (1992) statistical significance of the standard t-statistic estimated for vector γ_j is a powerful test of cointegration between money and output. Accordingly, irrespective of the nature of inference from short-run null hypotheses, money Granger causes output, and vice versa, over the long-run iff $\gamma_j < 0$ and its elements are statistically significant at the conventional test levels.

For VECM's sake, the estimation of equations (1) and (2) was preceded by fundamental tests: a) normality test; b) test of the order of integration of the variables by using Augmented Dickey Fuller (ADF) method; and, c) cointegration test by appealing to the Juselius-Johanson (1990) approach. Notable, existence of cointegration between money and output suggests existence of a stable long-run relationship but not causality between money and output. On this account the nature of the causality between money and output was investigated by estimating a bivariate conditional vector error correction model (VECM) in (1) and (2) by using E-view (Version 10).[7]

4.2 Data Type and Sources

This study is based on secondary annual time series data for the period 1986-2018.[8] While the end period is explained by data availability, the base period allows analysis of the relationship between money and output in a common macroeconomic policy and environment occasioned by implementation of the IMF (International Monetary Funds) and World Bank sponsored structural adjustment programmes since 1986. The data used in the analysis were from two sources: publications of the Bank of Tanzania (BoT) were the sources of data for monetary aggregates and consumer price index (CPI); and, data for Gross Domestic Product (GDP) were obtained from the publications of the National Bureau of Statistics (NBS). The GDP was deflated by the CPI.

[7] Fuller (1976) established that differencing of the variables does not lead to gains asymptotic efficiency in an autoregression even if it is appropriate. Moreover, Sims (1980) and Doan (2000) are against differencing even if the variables are non-stationary because the differencing will throw away important long-run properties in the data.

[8] To that effect, all the data for all variables were subjected to natural logarithm transformation, a technical approach that smoothen the data by reducing the its variance over time and also address likely multicollinearity problem in time series data.

4.3 Descriptive Statistics of the Data

The descriptive statistics presented in Table 1 show the measures of monetary aggregates (M1 and M2) were normally distributed at the 5% level of statistical significance test. The Kurtosis and Jarque-Bera probability statistic suggest all the variables were normally distributed in level and in their first difference.

It is appreciated that the descriptive statistics do not fully reveal the strength of the variables of the estimation model. Instead, more incisive quantitative analysis is required, for example correlation analysis, unit root test, and cointegration tests.

Table 1: Summary of Descriptive Statistics of the Variables

	$m1$	$m2$	y	$\Delta m1$	$\Delta m2$	Δy
Mean	13.80	14.27	16.20	0.19	0.19	0.05
Median	13.75	14.26	16.09	0.20	0.18	0.06
Maximum	16.28	16.76	17.15	0.35	0.36	0.08
Minimum	10.49	10.83	15.48	0.05	0.04	0.00
Std. Dev.	1.73	1.79	0.52	0.09	0.08	0.02
Skewness	-0.23	-0.26	0.36	0.06	0.15	-0.75
Kurtosis	1.97	1.96	1.77	1.79	2.24	2.46
Jarque-Bera	1.74	1.85	2.79	2.04	0.92	3.49
Probability	0.42	0.40	0.25	0.36	0.63	0.17
Observations	33	33	33	33	33	33

Notes: The variables are in natural logarithm, where $m1$ is narrow money, $m2$ is broad money, y is real national income, and Δ is a first difference operator.

Accordingly, the correlation matrix in Table 2 show real GDP is positively related to the M1 and M2.

Table 2: Correlation Matrix

	$m1$	$m2$	y	$\Delta m1$	$\Delta m2$	Δy
$m1$	1.00	1.00	0.97	-0.60	-0.68	0.70
$m2$	1.00	1.00	0.97	-0.60	-0.67	0.70
y	0.97	0.97	1.00	-0.54	-0.64	0.71
$\Delta m1$	-0.60	-0.60	-0.54	1.00	0.90	-0.38
$\Delta m2$	-0.68	-0.67	-0.64	0.90	1.00	-0.38
Δy	0.70	0.70	0.71	-0.38	-0.38	1.00

Notes: Calculated by authors.

The two measures of money stock are strong and equally correlated to real income. The almost unity (0.97) correlation coefficient suggests "a good match between nominal money balances and real income, that is, "what could buy" during the sample period. The very strong correlation may, *ceteris paribus*, also suggests existence of a stable relationship between the nominal money balances and output in Tanzania. Alternatively, it could be that both money stock and output are reacting to innovations in some third factor" (Freeman, 1992, p.).

5. Econometric Results

5.1 Unit Root Test

Table 3 present the ADF unit root test results in level and first difference, with intercept and intercept and trend scenarios. On the one hand, the ADF results with intercept shows the M1 and M2, respectively, are stationarity in level, suggesting both monetary aggregates in levels are I(2), that is, are second difference stationary. However, while only M1 in level is first difference stationary, both measures of money and output are I(2). On the other hand, the ADF test (with intercept and trend) show that income and narrow money are I(1) but not the broad money. Nonetheless, all the variables are I(2) (Table 3).

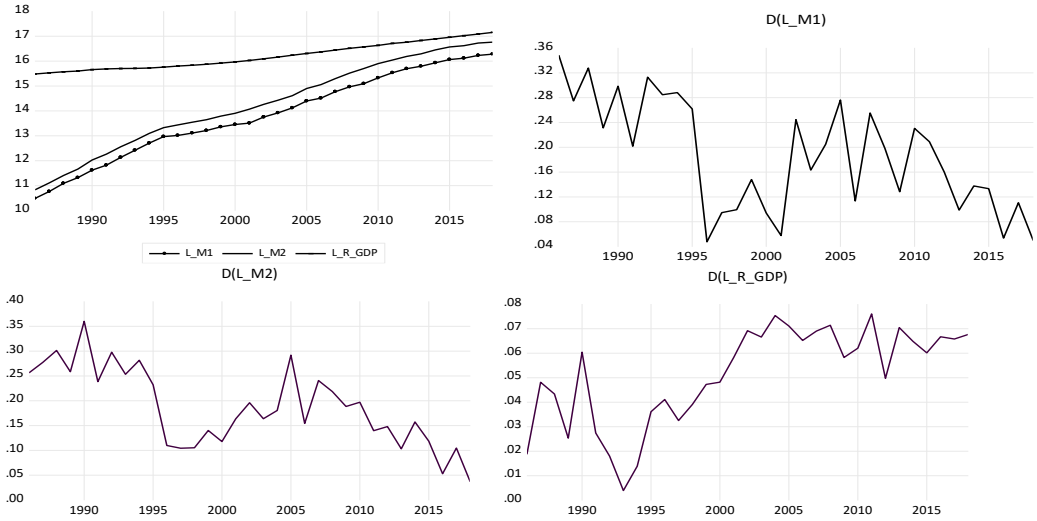
Table 3: Unit Root Test for Variables

Variable	ADF Test (with Intercept)			ADF Test (with Trend & Intercept)		
	Level	First Diff	Second	Level	First Diff	Second
y	2.274	-2.213	-7.972***	-1.624	-3.675**	-7.789***
$m1$	-4.490***	-3.036**	-5.648***	-2.127	-4.262***	-5.153***
$m2$	-2.726*	-1.030	-10.011***	-2.262	-2.396	-10.001***

Note: Critical values for ADF unit root test are: ***= 1% and **= 5%levels of significance, respectively.

Plots in Figure 2 suggests both measures of money experienced a structural break which was marked by a drastic fall in the growth rate of money supply between 1995 and 1996. Also notable, is a structural break in real income growth that fell from 6 percent in 1990 to about 0.4 percent in 1993. Granted, the two structural breaks seemingly explain the higher order stationarity of the variables of the estimation model. In the context of Peron (1989), they are I(2) because are "broken-trend stationary" (Gillman and Nakov, 2004:663).

Figure 2: Plots of the Variables



The ADF results reveals that dynamic specification of the estimation model in levels is bound to yield spurious regression results. On this account, following Bernanke (1986) and Cuddington (1981) two dummy variables and a time trend were included in estimation to attend to the structural

change detected in the sample in 1990 and 1995. Second, since all variables of the estimation model were not first difference stationary, the estimation model was estimated in level and first difference to establish the most efficient approach.[9]

Thus, cointegration test was carried out to ascertain appropriateness of the Vector Error Correction Model (VECM) which can only be used if variables not integrated of the same order are cointegrated.

5.2 Choice of Lag Length

Importance of choosing an optimal lag length for both cointegration test and estimation of a VAR model is emphasized and demonstrated by Hsiao (1981) and Braun and Mittnik (1993). Noteworthy is that a lag length of eight (8) and four (4) are, respectively, common in studies that fitted quarterly and annual time series data by using autoregressive (AR) approach. Given the use of annual time series data in the analysis the maximum lag length was initially set at four; and, by trial and error approach, the lag length was increased and decreased to validate or reject it as the optimal length for analysis. The trial and error approach was aided by use of conventional criterion in the literature that are used to choose optimal lag length for VAR models, namely AIC and SIC, and also the F-statistics that inform on the explanatory power of the model fitted per each selected lag length.[10]

Table 4: Choice of Lag Length

Lag Length	AIC	SIC	SER	F-stat.
1	3.580	3.852	1.336	2.745
2	3.518	3.881*	1.267	2.895*
3	3.504*	3.958	1.235	2.741
4	3.600	4.144	1.276	2.150
5	3.752	4.387	1.362	1.552

Note: * Preferred magnitude for the respective lag length.

According to the AIC criteria, the optimal lag length is three (3); and, according to the SIC criteria, the optimal lag length is two (2) (Table 4). Notable, however, a lag length of 2 was chosen for two main reasons: a) the SIC is considered superior and most preferred than AIC; and, b) the F-statistic in Table 4 suggested 2 lags were optimal for producing a relatively more powerful estimation model.

5.3 Johansen-Juselius Cointegration Test

The variables of the estimation were integrated of order one, that is, were I(1); and, this justified a test for cointegration, that is, test for the existence of equilibrium relationship between money and output. The test was based on Johansen's procedure that, by assumption, include an intercept and a deterministic trend.

[9] Some commentators are against estimation of the Grange causality equations in first difference. Instead, consider estimation in level is more robust. For details, see Christiano and Ljungqvist (1988).

[10] Even though the choice of optimal lag in some previous studies was based on Final Prediction Error (FPE), the criterion was not used because it is almost similar to the AIC and SIC. For this note, I am grateful to Dr. Eliab Luvanda, renown Econometrician in the East African region. Also see Lutkepohl (2005).

Table 5a: J-J Cointegration Test Results for M1 and GDP

	Likelihood	5 Percent	1 Percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CE(s)
0.504	27.739	25.32	30.45	None *
0.199	6.678	12.25	16.26	At most 1
*(**) denotes rejection of the hypothesis at 5%(1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Note: CE (s) standing for cointegrating equation(s).

Table 5b: J-J Results of Cointegration Test for M2 and GDP

	Likelihood	5 Percent	1 Percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CE(s)
0.533	31.568	25.32	30.45	None **
0.226	7.933	12.25	16.26	At most 1
*(**) denotes rejection of the hypothesis at 5%(1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Note**:** CE (s) standing for cointegrating equation(s).

The Johansen-Juselius cointegration test results presented in Table 5a and 5b reveal presence of a one cointegrating equation. This result implies there exist one unique long-run equilibrium relationships among the variables of the estimation model; and, following Granger (1988), the results suggest there is at least one unidirectional Granger causality between either money (M1 or M2) and output in Tanzania at least during the sample period.

5.4 Vector Error Correction Model (VECM)

Tables 6 presents results from the estimated VECM for both narrow and broad money stock in Tanzania. Notable, all estimated coefficients of M1 in Eq. 1 are statistically insignificant; and, while one has an unexpected negative sign, the other has the expected positive sign. In contrast, all estimated coefficients of M1 in Eq. 2 are unexpectedly negative signed and one of them is statistically significant at the 5 percent test level. The findings suggest only changes in M1 has significant effect on output in Tanzania over the short-run. The coefficient of the $ec1_{t-1}$ in Eq. 1 is statistically insignificant but negative signed as expected. In contrast, the coefficient of $ec2_{t-1}$ in Eq. 2 is statistically significant but positive signed. Following Kramers *et al*. (1992), the latter finding suggests lack of long-run relationship between the broad money and output in Tanzania during the economic reforms period.

It is also notable in Table 6 that all the coefficients of real income in Eq. 3 are statistically significant but negative signed. In contrast all the coefficients of M2 are statistically insignificant but positive as expected. In Eq.4, all the coefficients of real income are unexpectedly negative signed but are statistically significant at the conventional test levels. This finding, suggests output Granger cause an adverse effect on money over the short-run, is not consistent with that positive and significant effects obtained, among others, by Momen (1992) for Pakistan and Kalulumia and Yourougou (1997) for five West African countries. Notable, the estimated coefficient of $ec2_{t-1}$ in Eq. 3 is statistically insignificant but negative as expected. In contrast, the coefficient of $ec2_{t-1}$ in Eq. 4 is statistically significant but positive. The estimated coefficient of the of $ec2_{t-1}$ in Eq. 3 and Eq. 4 suggests that the M1 does not significantly Granger cause output over the long run. In contrast, the estimated coefficient of $ec2_{t-1}$ is statistically significant but unexpectedly positive.

This finding suggests the long-run effect of the M2 on output cause monetary reduction over the long run. Again, following Kremers *et al*. (1992) estimated coefficients of the $ec2_{t-1}$ in Eq. 3 suggests money and output are cointegrated; and, money does not Granger cause out over the long-run. Also the estimated coefficient of the $ec2_{t-1}$ in Eq. 4 suggests money and output are not cointegrated but the latter exert significant effect on the former over the long run. This finding, which is similar to that obtained for the United Kingdom (UK) by Williams, Goodhart, and Gowland (1976), could be attributed to one main factor, that is, the narrow financial system.

Table 6: Estimates of Vector Error Correction Model, 1986 - 2018

	Eq.1	Eq. 2		Eq.3	Eq. 4
Variables	y	$m1$	Variables	y	$m2$
$ec1_{t-1}$	-0.076	3.450***	$ec2_{t-1}$	-0.199	3.481***
	[-0.562]	[5.421]		[-0.955]	[4.994]
Δy_{t-1}	-0.594831***	-2.487**	Δy_{t-1}	-0.545**	-2.478***
	[-3.138]	[-2.780]		[-2.546]	[-3.451]
Δy_{t-2}	-0.334**	-1.363	Δy_{t-2}	-0.329**	-1.345**
	[-2.078]	[-1.799]*		[-2.012]	[-2.458]
$\Delta m1_{t-1}$	-0.004	-0.003	$\Delta m2_{t-1}$	0.015	-0.287**
	[-0.127]	[-0.012]		[0.369]	[-2.057]
$\Delta m1_{t-2}$	0.018	-0.035	$\Delta m2_{t-2}$	0.037	-0.109
	[0.647]	[-0.273]		[0.985]	[-0.872]
C	-0.054	-0.580**	C	-0.033	-0.709***
	[-1.133]	[-2.592]		[-0.600]	[-3.871]
DUM_BOT	-0.197	20.358***	DUM_BOT	-0.745	17.603***
	[-0.229]	[5.028]		[-0.691]	[4.870]
TIME_86	1.915*	-14.862***	TIME_86	2.188**	-7.992**
	[1.936]	[-3.184]		[2.160]	[-2.354]
R^2	0.432	0.638	R^2	0.448	0.618
$\bar{R}^2$	0.273	0.537	$\bar{R}^2$	0.293	0.511
S.E.E	1.284	6.060	S.E.E	1.267	4.247
F-stat.	2.721	6.307	F-stat.	2.895	5.774
L-likel.	-50.504	-101.700	L-likel.	-50.053	-89.973
AIC	3.546	6.648	AIC	3.518	5.938
SIC	3.908	7.011	SIC	3.881	6.300

Note: (i) Critical values for ADF unit root test are: ***= 1% and **= 5%levels of significance, respectively.

(ii) The number in the bracket refers to standard errors and t-statistics.

The results in Table 6 reveal the equations estimated for broad money (Eq. 2 and Eq. 4) rather than the M1 (Eq. 1 and Eq. 3) command a relatively higher explanatory power: their estimated coefficient of determination and the F-statistics are relatively higher. This imply the equations fitted for the broad money (M2) offers a better basis for statistical inference. More definitely, the results also suggest the M2, which is at the center of monetary policy programming in Tanzania, does not Granger cause output. Rather, output Granger cause money over the short run; and, over the long run the output exert a significant effect on money supply.

In general, the results do not support the mainstream thesis that money Granger cause output over the short-run and is neutral over the long run. With particular reference to the estimated results for the M2, the results are in favour of "output Granger cause" output over the short run. This finding is similar to that obtained by Maganya (2006) in a study on Tanzania for the period 1970-2004. Also notable, the finding is partially corroborated by some studies on developing countries that establish existence of bidirectional causality between money and output, for example, Abbas (1991) in a study on Pakistan, Malaysia and Thailand; Lee and Li (1983) in the case of Singapore; and, Joshi and Joshi (1985) in a study on India.

5.5 Pair-wise Granger-Causality Test

Table 7 present results from standard bivariate Granger causality tests. The results for M1 and M2 reveal that the null hypotheses that money does not Granger cause real output over the long run, and vice versa can be accepted.

Table 7: Pairwise Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
Δy does not Granger Cause $\Delta m1$	33	0.65072	0.5294
$\Delta m1$ does not Granger Cause Δy		0.66267	0.5234
Δy does not Granger Cause $\Delta m2$	33	0.38652	0.683
$\Delta m2$ does not Granger Cause Δy		1.57242	0.2253

The findings in Table 7 are somehow consistent with that obtained for the VECM. The implicit neutrality of money supply over the long run is consistent with theory.

5.6 Robustness Test

Some commentators share a view that "statistical importance of money" is reduced by Granger causality test based on log differences which, among others, engender a specification error (Eichenbaum, 1986; Christiano and Ljungqvist, 1988; quoted in Ambler, 1989). In this respect, the VECM in (2) was estimated in level.

Table 8: VECM Results (in Level)

Variable	Δy	$\Delta m1$	Variable	Δy	$\Delta m2$
$ec1_{t-1}$	-0.121	-0.211	$ec1_{t-1}$	-0.113	-0.077
	[-4.321]	[-1.194]		[-4.608]	[-0.656]
Δy_{t-1}	-0.071	0.464	Δy_{t-1}	-0.198	0.727
	[-0.445]	[0.462]		[-1.104]	[0.848]
Δy_{t-2}	-0.037	0.784	Δy_{t-2}	-0.097	0.882
	[-0.246]	[0.827]		[-0.631]	[1.196]
$\Delta m1_{t-1}$	0.064	-0.006	$\Delta m2_{t-1}$	0.122	0.068
	[2.098]	[-0.032]		[2.568]	[0.297]
$\Delta m1_{t-2}$	0.076	0.130	$\Delta m2_{t-2}$	0.098	0.326
	[2.937]	[0.796]		[2.817]	[1.957]
C	-0.343	-0.357	C	-0.405	-0.114
	[-4.221]	[-0.698]		[-4.465]	[-0.264]
TIME_86	0.021	0.033	TIME_86	0.024	0.012
	[4.373]	[1.090]		[4.660]	[0.486]
DUM_BOT	0.022	-0.148	DUM_BOT	0.037	-0.078
	[2.937]	[-3.093]		[4.089]	[-1.802]
R-squared	0.811	0.628	R-squared	0.818	0.735
Adj. R-squared	0.758	0.524	Adj. R-squared	0.767	0.660
Sum sq. Resid.	0.002	0.095	Sum sq. resids	0.002	0.053
S.E. equation	0.010	0.062	S.E. equation	0.010	0.046
F-statistic	15.283	6.039	F-statistic	16.016	9.883
Log likelihood	110.395	49.669	Log likelihood	111.024	59.431
Akaike AIC	-6.206	-2.525	Akaike AIC	-6.244	-3.117
Schwarz SC	-5.843	-2.163	Schwarz SC	-5.881	-2.754

The results in Table 8 shows the coefficient of the one period lagged error term ($ec1_{t-1}$) in the output equations (Eq. 1 and Eq. 3) are negative signed and very statistically significant. Also notable, the coefficients of lagged money in the output equations (Eq. 1 and Eq. 3) are positive signed and statistically significant. In contrast, the coefficient of $ec1_{t-1}$ in the money equations (Eq. 2 and Eq. 4) are negative signed but statistically insignificant; and, the coefficient of the lagged output in the same equations are positive signed but are statistically insignificant. In general, and following Kremers *et al*. (1992) suggests there is causality between money and output and, the causality is unidirectional, from money (M1 and M2) to output. This finding is consistent with the conventional monetarist's MBC view but is inconsistent with the results obtained by using log differenced variables to estimate the VECM. The finding appears to support the contention by Eichenbaum (1986) the log difference-based VAR approach undermines importance of money.

The pair-wise Granger causality results in Table 9 reveals in-existence of causality between money (M1 and M2) and real output (and vice versa) in Tanzania during the sample period.

Table 9: Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
L_M1 does not Granger Cause L_R_GDP	33	0.678	0.516
L_R_GDP does not Granger Cause L_M1		1.384	0.267
L_M2 does not Granger Cause L_R_GDP	33	0.965	0.393
L_R_GDP does not Granger Cause L_M2		0.270	0.765

The finding, therefore, suggests lack of monetary policy effect on real output over the long run.

6. Conclusion

This study has investigated empirically the causal relationship between money and output in Tanzania for the period 1986 to 2018. The analysis was carried out by using cointegration and bivariate error correction model (ECM) that was used to test for the causality between money and output.

The null hypothesis that money does not Granger cause output over the long run could not be rejected by the result from estimation of the VECM. Instead, the alternative null hypothesis that money Granger causes output was rejected in favour of output Granger cause money over the short run. Notable, however, opposite results obtained by estimating the VECM in level rather than in log-difference. Specifically, the log-level results revealed existence of unidirectional Granger causality from money to output. Even though, the log-difference and log-level results suggested broad money is a superior monetary aggregate for policy than the narrow money. Notable, therefore log-difference results suggest targeting monetary aggregates is an inferior policy strategy. Instead, as a matter of policy, the government should more use fiscal policy to attain the desired macroeconomic objectives, particularly growth in output. In contrast, the log-level emphasises importance of monetary policy in economic growth over the short-run and long run. Either of the policy implication is not definite, given the contradictory policy inferences. Thus, either of them could be confirmed or improved upon by some other studies. Such subsequent studies could also bring aboard nominal interest rate in the realm of analysis.

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