“Money demand function for malawi- implications for monetary policy conduct”

AUTHORS	Mark Lungu Kisu Simwaka Austin Chiumia Arnold Palamuleni Wytone Jombo

ARTICLE INFO	Mark Lungu, Kisu Simwaka, Austin Chiumia, Arnold Palamuleni and Wytone Jombo (2012). Money demand function for malawi- implications for monetary policy conduct. *Banks and Bank Systems*, *7*(1)
RELEASED ON	Thursday, 12 April 2012
JOURNAL	"Banks and Bank Systems"
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

Mark Lungu (Malawi), Kisu Simwaka (Malawi), Austin Chiumia (Malawi),
Arnold Palamuleni (Malawi), Wytone Jombo (Malawi)

Money demand function for Malawi – implications for monetary policy conduct

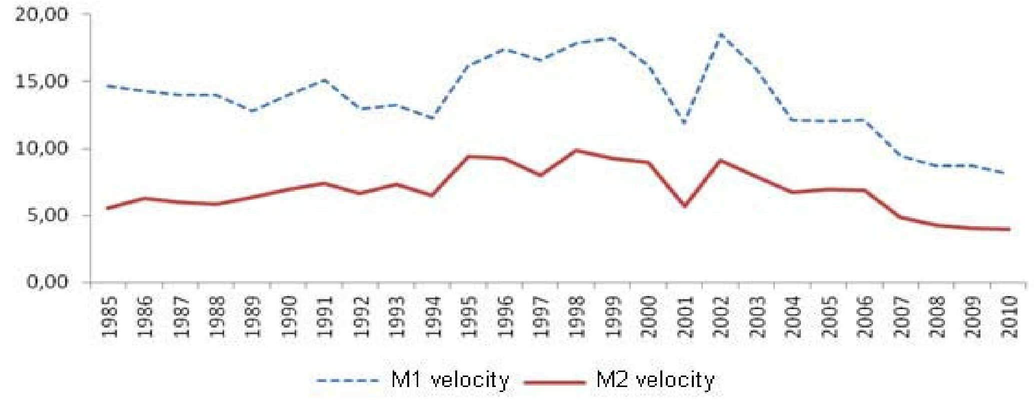
Abstract

This paper analyzes the money demand function for Malawi during the period of 1985-2010 using monthly data. During the sample period, several structural changes occurred in the economy. Most of these changes were ignited by the structural adjustment programs that started in the late 1980s, then came the move to plural politics in the early 1990s. This was followed by structural reforms in the financial sector. In the very recent past, there has been an increase in real economic activity as measured by strong growth in real GDP in the years after 2002 and the financial innovations within the banking system after the year 2000. These factors do not seem to have affected the stability of the demand for money and hence increasing the probability of success for the conduct of monetary policy. Cointegration test results indicate a long-run relationship amongst real money balances, prices, income, exchange rate, Treasury bill rate and financial innovation. While all variables significantly influence money demand in the long-run, short-run policy must be directed at increasing financial innovation, open market activities and improving the productivity of the economy to provide higher return on alternative investments.

Keywords: cointegration, money demand, monetary policy.
JEL Classification: E41, E43, E44.

Introduction

Despite the consensus that money demand function has little role under an interest rate-based (Taylor-rule-type) monetary policy, it is still believed that money demand is important for both macroeconomic modelling and monetary policy. This is especially important for countries like Malawi where monetary authorities continue to emphasize the role of money demand function on their monetary policy operations. Duca and VanHoose (2003), argue that monetary policy does not work only through the interest rate channel, but the money demand function does also provide useful information about portfolio allocations. Theoretical research and empirical analysis using primary data on developing countries have shown that the money demand function can become unstable as a result of financial innovations and financial sector reforms. Partly, because of the instability in the money demand functions, most central banks in recent years have switched from money supply targeting which focused on monetary aggregates as the intermediate target to inflation targeting which seeks to stabilize prices by adjusting interest rates based on inflation forecasts. Malawi targets money supply by focusing on monetary aggregates as intermediate targets. With the presence of structural changes in the economy and innovations in the financial sector, it remains an empirical question whether targeting money supply remains relevant in the conduct of monetary policy.

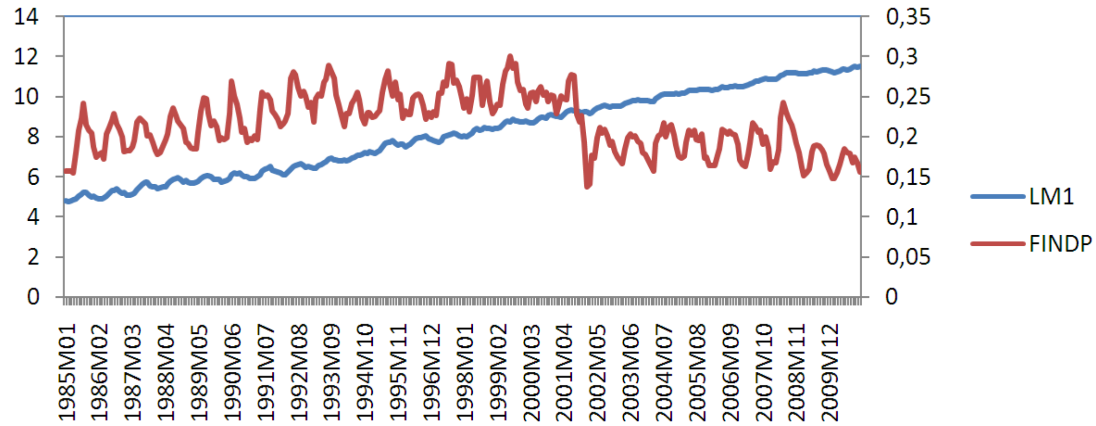


Source: Reserve Bank of Malawi.

Fig. 1. Velocity of money

Consequently, examining the characteristics of money demand function in Malawi should bear significant meaning for present and future conduct of monetary policy. Broad money velocity has fluctuated a lot moving from an average of 6.2 in 1985 to 9.8 in 1998 before declining to an average of 4.1 in 2010. These fluctuations have often been attributed to unexplained shifts in money demand. Considering the fact that a stable money demand function is considered essential for the formulation and conduct of efficient monetary policy, considerable effort has been made in the empirical literature for both industrialized and developing countries to determine factors that affect the long-run demand for money and assess the stability of the relationship between these factors and various monetary aggregates. In Malawi, to our knowledge, no attempt has been made to study the money demand function, particularly on the stability of the estimated coefficients.

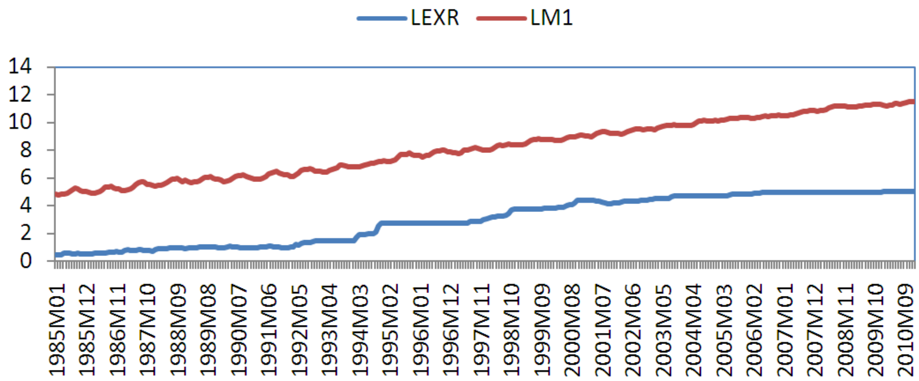
There are a number of studies on money demand in other sub-Saharan African countries, but most of them have used traditional estimating methods, by applying the partial adjustment model like Goldfeld (1973) when analyzing the money demand. The focus of the money demand studies has been to analyze stability of demand functions, especially when major structural changes have taken place.



Source: Reserve Bank of Malawi.

Fig. 2. Narrow money and financial depth

Money demand is an important element of monetary policy analysis. This follows the monetarists' view that inflation is in the long run, everywhere and always, a monetary phenomenon. If the money demand function is stable over the long run, money supply changes are closely related to prices and income, and it should be possible therefore for policy makers to control inflation through appropriate adjustments to the money supply. If, on the other hand, the money demand function is unstable over the long run, changes in money supply are not closely related to prices and income and it is not possible for authorities to appropriately control inflation through adjustments to money supply.



Source: Reserve Bank of Malawi.

Fig. 3. Narrow money and exchange rate developments

This study therefore examines the behavior of the demand for money in Malawi for the period of 1985-2010. The hypothesis is that there exists a stable relationship among narrow money, income and a vector of return rates over this sample period. The first objective is to estimate a demand for money function for Malawi using cointegration and error correction modelling. The second objective is to identify relevant factors in demand for money for Malawi. The third objective is to test for the stability of demand for money, in view of its importance in the conduct of monetary policy. Owing to non-availability of high frequency GDP data, annual data has been transformed into monthly data using a quadratic formula.

The rest of the paper is organized as follows. Section 1 reviews literature on demand for money. Section 2 outlines the econometric methodology used in the study. Section 3 discusses results. The final section provides conclusion and recommendations for the conduct of monetary policy.

1. Literature review

1.1. Theoretical review. There is a diverse spectrum of money demand theories. The theoretical underpinnings of the demand for money have been well established in the economic literature with widespread agreement that the demand for money is primarily determined by real cash balances. Keynes postulated three motives for holding real money balances: transactions, precautionary and speculative motives. Following the emergence of liquidity preference theory, several authors have questioned Keynes's rationale for a speculative demand for money and have contributed to the theoretical literature by distinguishing broadly between the transactions demand (Baumol, 1952; Tobin, 1956) and the asset motive (Tobin, 1958; Friedman, 1956). Empirical studies of money demand have however tended to converge to a specification where demand for real money balances is a function of scale variable e.g., income or expenditure, own rate of return on money, the opportunity cost of holding money (notably the domestic interest rate and/or expected rate of inflation). The domestic interest rate and expected inflation are proxies for the rates of return on alternative financial and physical assets, respectively. The inclusion of expected rate of inflation has been emphasized especially for developing countries where, given the existence of underdeveloped monetary and financial systems and non-market determined interest rates, physical assets represent one of the major hedges against inflation and an alternative asset in the portfolio of the non-bank public. In addition, with increasing financial globalization and empirical evidence on portfolio balance models in open economies, the expected rate of return on foreign securities has often been added as an explanatory variable.

Theory portrays that money demand depends positively on real GDP and the price level due to the demand for transactions. Money demand depends negatively on interest rates due to speculative concerns. This relationship can be depicted as follows:

$$M^D = f(P^{(+)}, Y^{(+)}, i^{(-)}), \qquad (1)$$

where M^D is the aggregate, economy-wide money demand, P is the current price level, Y is the scale variable (real GDP, wealth, or expenditure in real terms) and i is the average interest rate. The positive sign indicates a positive relationship while the negative sign indicates negative relationship between the dependent variable and the explanatory variable. The money demand function is often reported in real terms as follows:

$$M^D / P = L(Y, i). \qquad (2)$$

Equation (2) can be viewed as a liquidity preference function. This specification represents the "desired" or long-run real money demand function and assumes a long-run unitary elasticity of the nominal cash balances with respect to the price level.

Many commentators have argued that inflation is a monetary phenomenon in the long run and the empirical relation between money and prices is usually discussed in the money demand framework. Monetary policy is arguably effective as a means of controlling inflation. If the money demand function is stable over the long run, money supply changes are closely related to prices and income, and it is possible for policy authorities to control inflation through appropriate adjustments to the money supply. If, on the other hand, the money demand function is unstable over the long run, changes in money supply are not closely related to prices and income and it becomes difficult for policy makers to appropriately control inflation through adjusting the money supply. Thus, another fundamental issue in studying the money demand function is to examine whether there exists the equilibrium relation of money demand.

1.2. Empirical review. In a study covering 35 Sub-Sahara Africa countries, Hamori (2008) finds a stable money demand function after finding a co-integrating relationship of money demand in individual countries. Using Johansen's maximum likelihood and dynamic modeling procedure, Randa, (1999) finds equilibrium in the long run and stable money demand function for Tanzania. Nell (1999) investigates money demand function for South Africa and finds a stable long run demand for money function for M3, while the demand for M1 and M2 display parameter instability following financial reforms since 1980. In Ghana, results by Andoh (1999) shows no evidence of instability of both narrow and broad money demand suggesting that reforms did not affect the financial sector deeply or long enough to destabilize the demand for M1 and M2.

Evidence gathered by Kumar, Webber & Fargher (2010) through their empirical investigation into the level and stability of money demand (M1) in Nigeria between 1960 and 2008, suggest that money demand is stable effectively implying that Nigeria could effectively use the supply of money as an instrument of monetary policy.

Using an error correction model to examine the stability of demand for money for the traditional monetary policy, evidence from Uganda as reported by Kararach (2001) suggests that money demand function is unstable. From this finding, he draws recommendations that there is a need for monetary policy to be used in conjunction with other policies to achieve the goal of price stabilization and adjustment.

Although various methods have been used in modeling demand for money, an error correction model becomes particularly appealing because of its ability to uncover short- and long-run dynamics. Suppose variables in this study include real money balances, real income, interest rate, inflation have a unit root and a linear combination of these non-stationary variables is stationary, then any deviation from the relation is temporary and the relation holds in the long-run. If such a linear combination exists, the variables are said to be cointegrated. If the money demand is well identified and the money supply is an integrated process, the money demand function can be estimated by the cointegration method. This study therefore applies the multivariate error correction model.

2. Data description and model specification

2.1. Data description. This study applies cointegration analysis and derives an error correction model to examine the behavior of the demand for money in Malawi. The variables in the model are real money demand, real gross domestic product, inflation, Treasury bill rate, exchange rate and financial depth (money supply/GDP). The data source for prices and gross domestic product (GDP) are the National Statistics Office and the International Monetary Fund, respectively. All other variables have been sourced from the Reserve Bank of Malawi Research and Statistics Database. Except for interest rates, inflation and financial depth, other variables have been expressed in logarithm form. We use both inflation and interest rate as measures of opportunity cost.

2.2. Model specification. The choice of money demand definition is empirically determined by the problem to be modelled. Particularly, policy makers are increasingly interested in understanding not only what happens to a particular variable when its determinants change but also whether the relationship amongst the variables is stable and whether it means reverting and how soon the stability will be achieved. Most studies on demand for money have used an error correction model. The basis of this choice is the fact that this technique is capable of revealing more information on the long- and short-run behavior of economic variables. This study therefore employs the Johansen Cointegration technique to uncover the long-run and short-run behavior of M1.

To analyze the relationship between money demand and its causative factors various models have been tested and the most appropriate in the context of this study is presented below:

$$\ln M_t = b_0 + b_t \ln Y_t + b_2 INF_t + b_3 \ln E_t + b_4 FINDP_t + b_5 TB_t + \varepsilon_t, \tag{3}$$

where ε_t represents white noise error process M_t is the real money demand (defined as currency outside banks plus demand deposits), Y_t is the real GDP, INF_t is the annualized inflation rate, Et is the US dollar Nominal Exchange Rate, $FINDP_t$ is the financial depth, TB_t is the average treasury bill rate.

2.3. Expected results. Based on the conventional economic theory, the income elasticity coefficient, b_1 is expected to be positive implying that higher income leads to an increase in money demand; the coefficient of inflation b_2 is expected to be positive, higher inflation may lead to high demand for money because of the time value of money. Arango and Nadiri (1981) argue that for the elasticity coefficient on the exchange rate variable, b_3, it can either be positive or negative. If the increase in exchange rate (depreciation) is perceived as the increase in wealth and leads to a rise in domestic money, the coefficient on exchange rate is positive. But if the increase in exchange rate leads to a decrease in domestic money demand (currency substitution), then the coefficient of exchange rate is negative. Improved technology/financial products entails reduced demand for cash balances. Demand for money by economic agents decreases as they shift from consumption to investment in which case the elasticity of money demand with respect to return on invested funds is expected to be negative. Hence, b_4 and b_5 are expected to be negative.

2.4. Econometric methodology. *2.4.1. Unit root tests.* Stationarity tests are a prerequisite before conducting most econometric works. The Augmented Dickey Fuller (ADF) test is used to determine the order of integration of the data. It is however well established in literature that the ADF test has very low power in the presence of structural breaks as under such circumstances, it is biased towards non-rejection of a unit root. This test is, therefore, augmented by the Phillip Perron (PP) unit root test. While the former uses augmentation to whiten residuals, the latter uses non-parametric correction. Besides, the sample in this study is large enough to warrant the use of the two and they remain the most widely used in literature. They both use the null of stationarity with the following test equations and null hypothesis:

$$\Delta Y_t = \beta_1 + \beta_{2t} + \delta Y_t - 1 + \sum_{t=1}^{m} \alpha_i \Delta Y_t - 1 + \varepsilon_t, \tag{4}$$

$$H_0 : \delta = 0.$$

2.4.2. Co-integration tests. The concept of cointegration has been widely used to test long-run relationships. Supposing real money balances, real income and interest rate are non-stationary variables with a unit root and a linear combination of these non-stationary variables is stationary, then any deviation from the relation is temporary and the relation holds in the long run. If such a linear combination exists, the variables are said to be cointegrated. The Johansen and Juselius approach of cointegration is based on a VAR model which can be written in different form as follows:

$$\Delta W_t = \alpha + \sum_{i=1}^{9} \Gamma_k \Delta W_{t-k} + \Pi W_{t-1} + vt, \tag{5}$$

where W_t represents a vector of the six variables and vt is a multivariate Gaussian error term i.e. (free from autocorrelation, heteroskedasticity and multivariate normal). k is the lag length. Π is the 6x6 impact matrix which provides information relating to long-run relationship. The rank r of the impact matrix is the number of co-integrating vectors. Johansen (1995) introduced two likelihood ratio methods in order to investigate co-integrating vectors as illustrated below.

1. Trace statistic.

$$\lambda_{trace}(r) = -N \sum_{k=1}^{m=1} \ln(1-\lambda_l), \tag{6}$$

where N is the number of observations, r is the number of cointegrating vectors, j is the number of variables and the lambdas are the Eigen values. The null hypothesis of the trace statistics is as follows:

H_0: number of $C.I \leq r$ against H_1: of $C.I > r$ where $C.I$ implies co-integrating equations

2. Maximal eigenvalue test statistics.

This statistic is given as follows with the variables defined as in the trace statistics

$$\lambda_m(r, r+1) = -N\ln(1-\lambda_{r+1}). \tag{7}$$

The null and alternative hypotheses of maximal Eigen values are as follows:

H_0: number of $C.I = r$ against H_1: no of $C.I = r + 1$, where $C.I$ implies co-integrating equations.

2.4.3. Vector error correction model (VECM). According to Engle and Granger (1987), if two series are co-integrated of order one i.e. $I(1)$, then there must exist a VECM representation in order to govern joint behavior of the series of the dynamic system. In VECM specification, short-run as well as long-run adjustments are made. VECM also provide information about instantaneous adjustment of the actual stock of real money balances to its desired level. The equilibrium state between real money supply and the real money demand is unlikely to be achieved given the existence of transaction costs, uncertainty and other factors. In addition, the desired level of real money balances is unobservable. A distinction has therefore to be made between long and short-run behavior in the money market by specifying an error-correction mechanism (ECM) of the actual real cash balances towards the desired (long-run) level.

The VECM specification related to the determinants of money demand is as follows:

$$\begin{aligned}
\Delta \ln M1_{1t} &= \alpha_{10} + \sum_{i=1}^{p}\alpha_{11,i}\Delta\ln GDP_{1,t-1} + \sum_{i=1}^{p}\alpha_{12,i}\Delta\ln INF_{2,t-1} + \sum_{i=1}^{p}\alpha_{13,i}\Delta\ln EXP_{3,t-1} + \sum_{i=1}^{p}\alpha_{14,i}\Delta\ln TRB_{4,t-1} + \sum_{i=1}^{p}\alpha_{15,i}\Delta\ln FININ_{5,t-1} + \lambda_1 ECT_{t-1} + \varepsilon_{1t},\\
\Delta \ln GDP_{2t} &= \alpha_{20} + \sum_{i=1}^{p}\alpha_{21,i}\Delta\ln M1_{1,t-1} + \sum_{i=1}^{p}\alpha_{22,i}\Delta\ln INF_{2,t-1} + \sum_{i=1}^{p}\alpha_{23,i}\Delta\ln EXP_{3,t-1} + \sum_{i=1}^{p}\alpha_{24,i}\Delta\ln TRB_{4,t-1} + \sum_{i=1}^{p}\alpha_{25,i}\Delta\ln FININ_{5,t-1} + \lambda_2 ECT_{t-1} + \varepsilon_{2t}\\
\Delta \ln INF_{3t} &= \alpha_{30} + \sum_{i=1}^{p}\alpha_{31,i}\Delta\ln GPD_{1,t-1} + \sum_{i=1}^{p}\alpha_{32,i}\Delta\ln M1_{2,t-1} + \sum_{i=1}^{p}\alpha_{33,i}\Delta\ln EXP_{3,t-1} + \sum_{i=1}^{p}\alpha_{34,i}\Delta\ln TRB_{4,t-1} + \sum_{i=1}^{p}\alpha_{35,i}\Delta\ln FININ_{5,t-1} + \lambda_3 ECT_{t-1} + \varepsilon_{3t},\\
\Delta \ln EXP_{4t} &= \alpha_{40} + \sum_{i=1}^{p}\alpha_{41,i}\Delta\ln GPD_{1,t-1} + \sum_{i=1}^{p}\alpha_{42,i}\Delta\ln INF_{2,t-1} + \sum_{i=1}^{p}\alpha_{43,i}\Delta\ln M1_{3,t-1} + \sum_{i=1}^{p}\alpha_{44,i}\Delta\ln TRB_{4,t-1} + \sum_{i=1}^{p}\alpha_{45,i}\Delta\ln FININ_{5,t-1} + \lambda_4 ECT_{t-1} + \varepsilon_{4t},\\
\Delta \ln TBR_{5t} &= \alpha_{50} + \sum_{i=1}^{p}\alpha_{51,i}\Delta\ln GPD_{1,t-1} + \sum_{i=1}^{p}\alpha_{52,i}\Delta\ln INF_{2,t-1} + \sum_{i=1}^{p}\alpha_{53,i}\Delta\ln EXP_{3,t-1} + \sum_{i=1}^{p}\alpha_{54,i}\Delta\ln M1_{4,t-1} + \sum_{i=1}^{p}\alpha_{55,i}\Delta\ln FININ_{5,t-1} + \lambda_5 ECT_{t-1} + \varepsilon_{5t},\\
\Delta \ln FININ_{6t} &= \alpha_{60} + \sum_{i=1}^{p}\alpha_{61,i}\Delta\ln GPD_{1,t-1} + \sum_{i=1}^{p}\alpha_{62,i}\Delta\ln INF_{2,t-1} + \sum_{i=1}^{p}\alpha_{63,i}\Delta\ln EXP_{3,t-1} + \sum_{i=1}^{p}\alpha_{64,i}\Delta\ln M1_{4,t-1} + \sum_{i=1}^{p}\alpha_{65,i}\Delta\ln TBR_{5,t-1} + \lambda_6 ECT_{t-1} + \varepsilon_{6t}.
\end{aligned} \tag{8}$$

This model can be expressed in compact form as defined in equation (3) above. The starting point is to model changes in real money balances as a response to the departures from one or two or all of the stationary linear combinations of the $I(1)$ variables, augmented by short-term dynamics from the current and lagged first differences of the variables included in the cointegrating vector.

2.4.4. VECM based causality. Granger (1998), states that in Granger representation theorem, if two variables are stationary of order (1) and cointegrated, then either the first variable causes the second or vice-versa. In this study, multivariate granger causality test based on VECM is utilized. It provides an additional channel for long-run causality which is ignored by Sims and Granger causality tests. Long-run causality is confirmed using the joint significance of the coefficients of lagged variables. Chi-squared test is employed to check the joint significance of the coefficients of the lagged variables and t-tests is used to check significance of the error term.

2.4.5. Diagnostic tests. Diagonostic tests are utilized to check the validity of the fitted model. In this study, VECM based diagnostic tests are reported. VEC residual serial correlation Langragian multiplier test is used for investigating possible serial correlation in the error term. The null hypothesis for this test is reported below:

H_0: $E(\mu, \mu t\text{-}q) = 0$ for $t \neq q$, $q = 1,2,...,p$ (9)

The residual normality test is carried out in order to investigate whether residuals are normally distributed or not. We use the Jarque-Bera normality test with the following null hypothesis.

H_0: Residuals are multivariate normal.

Finally, the VEC residual heteroskedasticity test is applied to check whether there is heteroskedasticity or not. The Chi-squared test will use the following null hypothesis.

H_0: Variance of residuals is homoscedastic.

2.4.6. Stability tests. We use the inverse characteristic roots to determine the stability of the VEC. If the characteristic roots of the variables lie within the circle, the parameters estimated are deemed to be stable.

3. Empirical results and discussion

3.1. Unit root tests. Table 1 presents ADF test results for the period of 1985-2010.

Table 1. ADF test results (1985-2010)

Variable	Without constant	With trend & constant
In levels		
Ln*M*1	-0.3574	-2.4405
LGDP	-0.86013	-0.9486
INF	-2.9195	-2.994
LEXR	-0.9825	-0.7870
LROC	-0.9924	-1.0775
LFININ	-1.0601	-1.7596
TBR	-2.3064	-2.2021
First differences		
∆Ln*M*1	-4.1487**	-4.1307**
∆*LGDP*	-4.1211**	-4.1700*
∆*INF*	-6.9753*	-6.994*
∆*LEXR*	-11.039*	-11.064*
∆*LFININ*	-6.0173*	-6.2125*
∆*TBR*	-18.4488*	-18.46374*
MacKinnon critical values		
1%	-3.4521	-3.98915
5%	-2.8710	-3.424

Notes: Null hypothesis: series have unit roots. *Significant at 1% level. **Significant at 5% level.

Table 2. PP test results (1985-2010)

Variable	Without constant	With trend & constant
In levels		
Ln*M*1	-0.1618	-3.409
LGDP	-0.49633	-1.2160
INF	-1.4247	-0.3322
LEXR	-0.9327	-0.875
LFININ	-3.599	-3.979
TBR	-1.265	-0.999
First differences		
∆Ln*M*1	-14.349	-14.266
∆*LGDP*	-13.933	-13.922
∆*INF*	-12.047	-12.129
∆*LEXR*	-10.652	-10.655
∆*LFININ*	-15.952	-16.663
∆*TBR*	-16.271	-16.4123
MacKinnon critical values		
1%	-3.451	-3.987
5%	-2.870	-3.4243

Notes: Null: series have unit roots. *Significant at 1% level. **Significant at 5% level.

The ADF results presented in Table 1 revealed that all the variables were nonstationary in levels. However stationarity was achieved after first differencing implying that all variables were $I(1)$. In light of the fact the ADF is weak in times of structural breaks, for further confirmation, results from the PP unit root test are reported alongside. Both tests indicate that all series are $I(1)$ processes. This finding triggers the search for a long-run relationship amongst the series which is done using the cointegration technique.

3.2. Cointegration results. Since stationarity results confirmed that all variables were integrated of order 1, before identifying the number of co-integrating vectors, we first applied VAR test in order to determine optimal lag length. The Schwartz Bayesian Criterion statistic indicated the optimal lag length of 2 for the Johansen Co-integration Test.

Table 3. Johansen and Juselius test (1985-2010)

Trace statistic				
Null hypothesis	Alternative hypothesis	Test statistics	Critical value	P-value**
H_0: $r \leq 0$	Ha: $r > 0$	171.0336*	83.93712	0.0000
H_0: $r \leq 1$	Ha: $r > 1$	98.09214*	60.06141	0.0000
H_0: $r \leq 2$	Ha: $r > 2$	37.10418	24.27596	0.0986
H_0: $r \leq 3$	Ha: $r > 3$	18.52154	12.32090	0.2234
Maximum eigenvalue statistics				
H_0: $r = 0$	Ha: $r = 1$	72.94148*	36.63019	0.0000
H_0: $r = 1$	Ha: $r = 2$	60.98796*	30.43961	0.0000
H_0: $r = 2$	Ha: $r = 3$	18.57664	24.15921	0.2381
H_0: $r = 3$	Ha: $r = 4$	13.52757	17.79730	0.1958

Notes: The tests indicate at least 2 cointegrating eqn(s) at the 0.01 level. * Denotes rejection of the hypothesis at the 0.01 level of significance. **MacKinnon-Haug-Michelis (1999) *p*-values.

The maximal and trace eigenvalue statistics strongly reject the null hypothesis of both the "none" and "at most one" cointegrating vectors in favor of at least two cointegrating vectors at the 1.0 percent significance level. Although we find at least two co-integrating relationships, the interest in this study is to examine the response of money demand to changes in real income, inflation, financial depth and Treasury bill rate. Therefore the co-integrating vector identified is given as follows.

Table 4. Normalized cointegrating vector

LM1	*C*	*LGDP*	*INFL*	*LEXR*	*LTBR*	*LFININ*
1.00	5.4988	-1.2662	-0.0072	0.3060	0.006	0.7346
-	-	[-10.80]*	[-4.10]*	[2.10]*	[2.54]	[4.58]*

Note: [] denote t-statistics. *Significant at 1%. The P-values are taken from MacKinnon-Haug-Michelis (1999).

With the evidence from the cointegration test, it can be interpreted that Malawi's demand for money, gross domestic product, inflation, exchange rate, interest rates and financial innovation move together. The cointegrating vectors were, therefore, normalized by the dependent variable. From the long-run equation it can be concluded that money demand largely depends on all the variables in the model. The demand for money with respect to income changes is highly elastic with 1.0 percentage change in GDP leading to a more than proportionate increase in demand for money. The positive association supports theory and other findings from similar constant elasticity models. Individuals are inclined to increase their holdings of money balances as their incomes rise. With regard to inflation, it is found that the semi-elasticity of money supply with respect to inflation is 0.7 percent, i.e. a 1.0 percent increase in inflation leads to an increase of 0.7 percent in demand for money. This again conforms to economic theory; according to the time value of money theory, under inflationary pressures the real purchasing power of the currency is eroded and a penny today is worth less than a penny tomorrow. A 100 percent rise in Treasury bill yield will only reduce demand for money by 1.0 percent where as the elasticity of money demand with respect to financial depth is 0.7. These findings conform to economic theory. Technological advances in the financial market will reduce demand for money. Similarly, if the financial market provides better return of cash balances, the demand for cash balances will decrease. A 1.0 percent rise in financial depth leads to a 0.7 percent decline in demand for money balances. An appreciation of the currency is found to have a negative relationship with money demand.

3.3. Vector error correction model. The model estimates that the short run dynamics are mainly driven by lagged money balances, prices, and financial innovation. The exchange rate, Treasury bill rate and income are not significant in correcting the disequilibrium. However, the concern is on the response of money demand to changes in GDP, INFL, EXR, TBR and FINDP. We therefore begin by analyzing short-run dynamics contained in equation (1) in Table 5. In the short run, demand for money in the current period is quite sensitive to what it was in the previous period. A 10 percent increase in demand for money in the current period leads to a further increase of 2.8 percent in demand in the next period. Financial depth is the most important factor in determining the short-run behavior of demand for money. The error correction term (ECT) is significant and negative indicating the existence of long-run relationship amongst the variables. The coefficient of the error term is -0.08 which showed low speed of adjustment towards long-run equilibrium. This indicates that whenever there was a disturbance in the system, in every short period, only 8% correction to the disequilibrium would take place.

Table 5. VECM results

	Eq 1. *D*(*LM*1)	Eq 2. *D*(*LGDP*)	Eq 3. *D*(*INFL*)	Eq 4. *D*(*LEXR*)	Eq 5. *D*(*LTBR*)	Eq 6. *D*(*LFININ*)
C	0.013829	0.012430	-0.156575	0.013307	-0.137916	-0.008476
	[3.08478]	[7.54123]	[-0.62506]	[4.03483]	[-0.49767]	[-1.78308]
$D(LM1_{t-1})$	0.288979	0.016254	0.616566	0.017204	-3.160695	0.359759
	[5.52869]	[0.84573]	[0.21110]	[0.44740]	[-0.97818]	[6.49087]
$D(LGDP_{t-1})$	-0.029545	0.335838	-4.307210	-0.276198	3.331313	-0.105535
	[-0.19996]	[6.18147]	[-0.52168]	[-2.54076]	[0.36470]	[-0.67356]
$D(INFL_{t-1})$	0.000704	0.000523	0.212964	0.000974	0.117541	0.001003
	[0.72375]	[1.46048]	[3.91699]	[1.36010]	[1.95414]	[0.97195]
$D(LEXR_{t-1})$	0.140979	0.021291	14.34460	0.441140	8.619506	0.181531
	[1.96777]	[0.80823]	[3.58319]	[8.36943]	[1.94619]	[2.38951]
$D(LTB_{t-1})$	0.000206	0.000284	0.136720	0.000400	-0.081365	0.000245
	[0.22084]	[0.82812]	[2.62007]	[0.58201]	[-1.40941]	[0.24711]
$D(LFINDP_{t-1})$	0.422912	-0.009433	-2.089567	-0.064351	0.099502	0.109243
	[8.33147]	[-0.50542]	[-0.73669]	[-1.72315]	[0.03171]	[2.02956]
(ECT_{t-1})	-0.077463	0.008609	3.185252	-0.002933	-0.446782	-0.127525
	[-4.79493*]	[1.44926]	[3.52851]*	[-0.24674]	[-0.44737]	[-7.44425]*
Summary statistics for the VECM						
R-squared	0.346558	0.156757	0.194875	0.220705	0.038321	0.242127
Adj. R-squared	0.331361	0.137146	0.176151	0.202582	0.015956	0.224502
Sum sq. resids	0.947916	0.128155	2959.733	0.513070	3622.523	1.065855
S.E. equation	0.056118	0.020634	3.135761	0.041286	3.469144	0.059507
F-statistic	22.80535	7.993588	10.40783	12.17811	1.713454	13.73775
Mean dep. var.	0.021690	0.019697	-0.023097	0.014689	-0.001855	-4.07E-05
S.D dep. var.	0.068629	0.022213	3.454770	0.046234	0.105337	0.067573

Table 6. VECM based block exogeneity tests

	Independent variable						Joint $\sum\chi^2$(5df)	*P*-values 1	$(ECT_{t-1})_{1t}$
	*D*Ln*M*1	*D*Ln*GDP*	*DINF*	*D*Ln*EXR*	*DTBR*	*D*Ln*FININ*			
Dep. var	χ^2(1df)								
*D*Ln*M*1	-	0.0399	0.5238	3.8721**	0.0487	69.4133*	76.36192*	0.0000*	-4.795*
*D*Ln*GDP*	0.7152	-	2.1330	0.6532	0.68579	0.2554	4.839	0.4357	1.449
DINF	0.04456	0.27214	-	12.8392*	6.8647	0.5427	22.7951	0.0004*	3.528*
*D*Ln*EXR*	0.20001	6.4554**	1.8498	-	0.33873	2.9692	10.4309	0.0639	-0.2467
DTBR	0.9568	0.1330	3.818**	3.7876**	-	0.0010	11.1220	0.0490**	-0.4475
*D*Ln*FININ*	42.131*	0.4536	0.9446	5.7097**	0.06106	-	48.3863	0.0000*	-7.444259*

Source: Authors calculation using E-views.
Notes: *Significant at 1% level. **Significant at 5% level.

The results show that in case of the first dependent variable, the $DLnM1_t$ lagged residual was statistically significant indicating the presence of long-run relationship amongst dependent and independent variables which was confirmed by the significance of $(ECT_{t-1})_{1t}$. The significance of the $\sum\chi^2$ is an indication of the presence of short-run causality.

3.4. The pair-wise Granger causality test. Appendix C shows the pair-wise Granger causality test results. The pair-wise Granger causality test confirms the cointegration findings. Results show that money supply does not Granger cause inflation. We also find that income Granger cause demand for money. The other channel supported here is that the rise in demand for money has an impact on the exchange rate. Furthermore, we fail to accept the null that exchange rate does not Granger cause inflation. One of the channels supported by this study therefore is that a rise in the level of income has had an impact on money demand which has affected the exchange rate which eventually has impacted inflation.

3.5. Impulse response functions. Appendix B presents impulse response functions. The study uses impulse response function as an additional check of the cointegration test's findings. The Cholesk-type of contemporaneous identifying restrictions are employed to draw a meaningful interpretation. The recursive structure assumes that variables appearing first contemporaneously influence the latter variables but not vice versa. In Appendix B, there are two salient outcomes pertinent to monetary policy operations. First that an increase in income raises demand for money from an initial period of the shock up to 9 months after which demand for money stabilizes at a new higher level. Secondly, a positive shock to exchange rate temporarily raises de-mand for money until the 5th month beyond which demand stabilizes towards pre-shock levels. Two ways of permanently reducing the demand for money are to increase the level of financial innovation and increasing Treasury bill rate which is a proxy to investment returns. A one standard deviation shock to inflation however is found to raise demand for transaction money balances until a 5th month beyond which demand stabilizes at a higher level.

3.6. Diagnostic checks. Table 7 presents model fitness.

Table 7. Model fitness

Test	Test statistics	P-value	Conclusion
LM serial correlation statistics	38.06	0.37	No serial correlation
Jarque-Bera statistic	2.29	0.31	Residuals are multivariate normal
Chi-squared	42.53	0.17	Residuals are homoscadastic

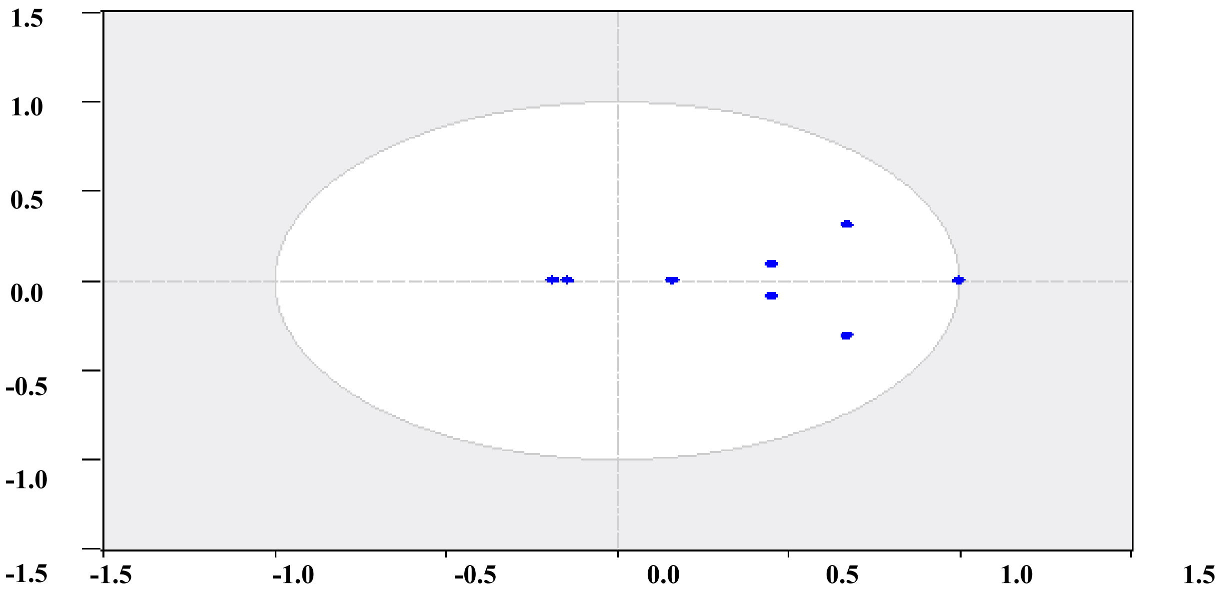


Fig. 4. VECM characteristic roots

Conclusion and recommendation

This paper investigates the real demand for money in Malawi using a cointegration analysis. Tests show that the model is stable and adequate. The stability of coefficients implies that the probability of the effectiveness of monetary policy is high in the long run. While in the long run, real GDP, inflation, exchange rate, Treasury bill rate and financial depth all have significant impact on the demand for money, in the short run, it is financial innovation, exchange rate movements and lagged money supply that display causality in money demand.

While in the long run demand for money is responsive to changes in interest rate, pursuits of policies in the short run aimed at altering level of interest rate to contain money demand are unlikely to bear fruit. The results obtained point to problems in implementing monetary policy using the bank rate in the short run. The insensitivity of demand for money to changes in interest rate in the short run is manifested in a sticky and wide spreads between the lending and savings rates. This development points to the underdeveloped nature of the money market and lack of financial deepening.

The long-run significant and negative relationship between real demand for money and exchange rate suggests that depreciation leads to increased demand for money balances for transaction purposes. In the short run however, an appreciation (overvalued currency) of the currency contributes to an increase in real money balances which may raise domestic absorption through imports and leading to persistent balance of payment problems. Another salient outcome of the model is that a depreciation of the Malawi kwacha leads to inflation. When the currency depreciates by 1 percent, prices in Malawi overreact, rising by around 1.4 percent immediately.

From the foregoing discussion, it can be concluded that the conduct of monetary policy must clearly distinguish between short-run and long-run objectives. The recent developments where money supply has been increasing at a faster rate while inflation has been somewhat stable or indeed trending downwards support the finding that targeting money supply could be ineffective in the short run. Although monetarists argue that inflation is always a monetary phenomenon, in Malawi inflation has most often been observed to go down when money supply is expanding. This finding points to the need for monetarist to rethink the monetary policy options in countries where inflation basket is largely skewed towards supply side like Malawi.

Acknowledgements

Special thanks should go to Dr. Grant P. Kabango, Acting General Manager, Mr. Efford Goneka, and all members of the Monetary Policy Implementation Committee of the Reserve Bank of Malawi for their comments on the paper. The views in this paper are those of the authors and do not necessarily represent the views of the Reserve Bank of Malawi. Any comments on this working paper are welcome.

References

1. Andoh, S.K. and Chappell, D. (2002). ‘Stability of the money demand function: evidence from Ghana’, *Applied Economics Letters*, Vol. 9, No. 13, pp. 875-878.
2. Arango, S. and Nadiri, M. (1981). Demand for money in open economies, *Journal of Monetary Economics*, 7, pp. 69-83.
3. Dickey, D. and Fuller, W. (1981). Likelihood ratio tests for autoregressive time series with a unit root, *Econometrica*, 49, pp. 1057-1072.
4. Engle, R.F. and Granger, C.W. (1987). Cointegration and error correction: representation, estimation and testing, *Econometrica*, 55, pp. 251-276.
5. Fuller, W. (1976). *Introduction to Statistical Time Series*, New York: John Wiley and Sons.
6. Goldfeld, S.M. (1973). The demand for money: revisited, *Brookings Papers on Economic Activity*, 3, pp. 577-646.
7. Duca, John V. (2000). “Financial Technology Shocks and the Case of the Missing M2”, *Journal of Money, Credit, and Banking*, 32, pp. 4.
8. Friedman, Benjamin M. (1988). “Lessons on Monetary Policy from the 1980s”, *Journal of Economic Perspectives*, 2, pp. 51-72.
9. Goldfeld, Stephen M. (1973). “The Demand for Money Revisited”, *Brookings Papers on Economic Activity*, 3, pp. 577-638.
10. Goldfeld, Stephen M. and Daniel E. Sichel (1990). “The Demand for Money”, in B. Friedman and F. Hahn (eds.), Handbook of Monetary Economics, Elsevier, pp. 300-356.
11. Kararach, George (2001). ‘Evidence on the Demand for Money function in Uganda’, UNICEF, WP No. 2002-01.
12. Kevin S. Nell (1999). “The Stability of *Money Demand* in *South Africa*, *1965-1997*”, Studies in Economics 9905, Department of Economics, University of Kent.
13. Kumar, Saten & Webber, Don J. & Fargher, Scott (2010). “Money demand stability: A case study of Nigeria”, MPRA Paper 26074, University Library of Munich, Germany.
14. Randa, John (1999). “Economic Reform and the Stability of the Demand for Money in Tanzania”, *Journal of African Economies*, 8 (3), pp. 307-344.

Appendix A

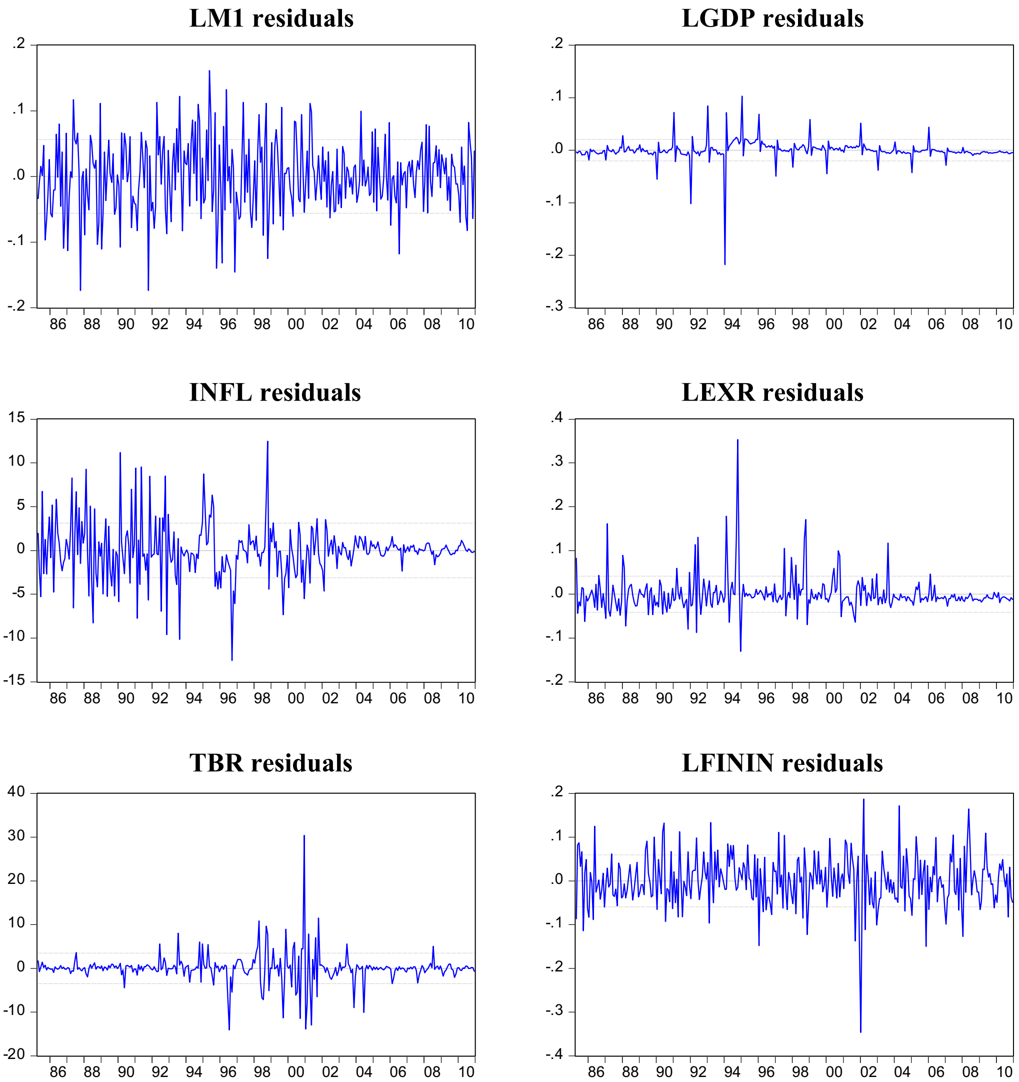


Fig. 1. Distribution of residuals

Appendix B

Response to nonfactorized one S.D. innovations

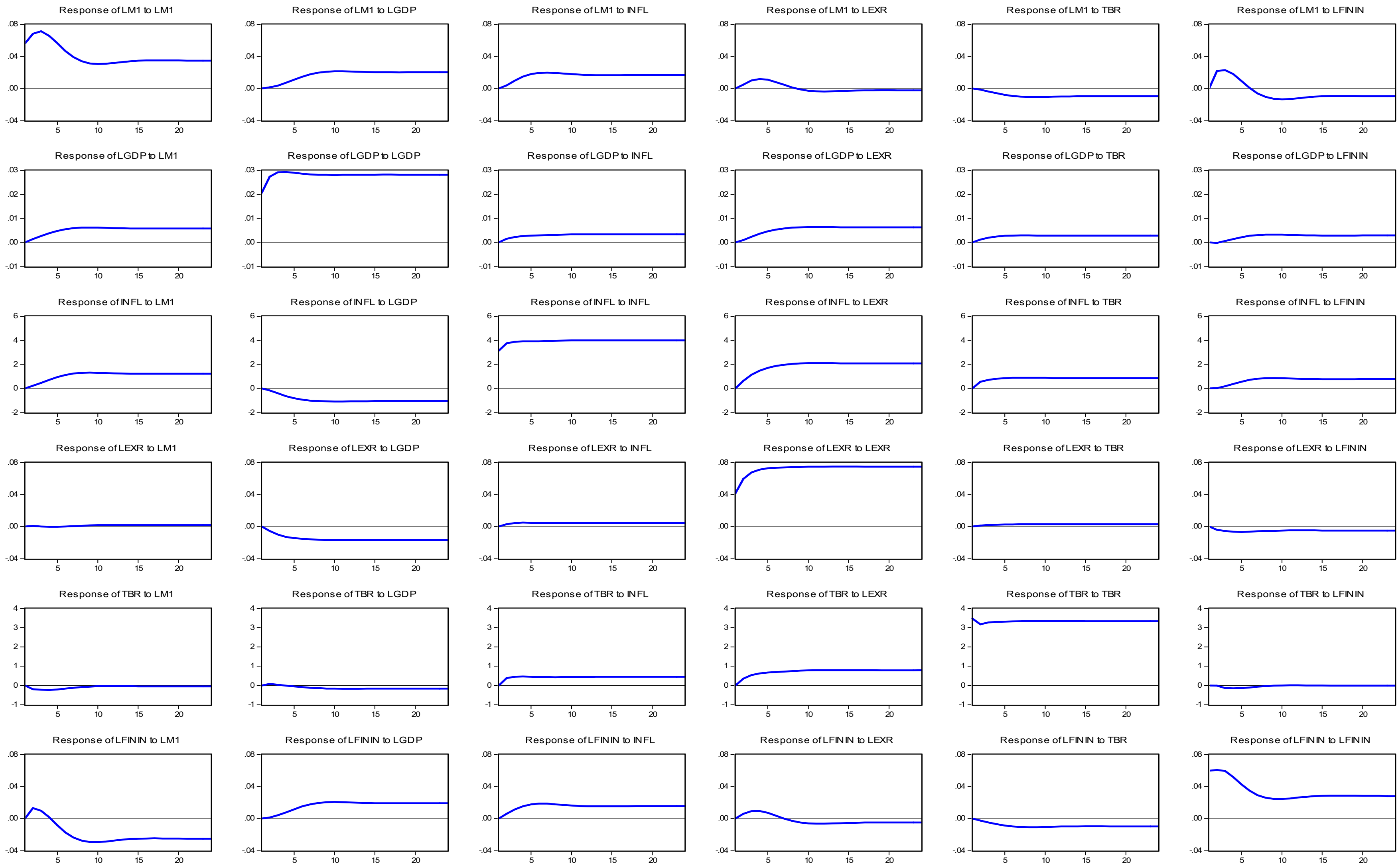


Fig. 2. Impulse response functions

Appendix C

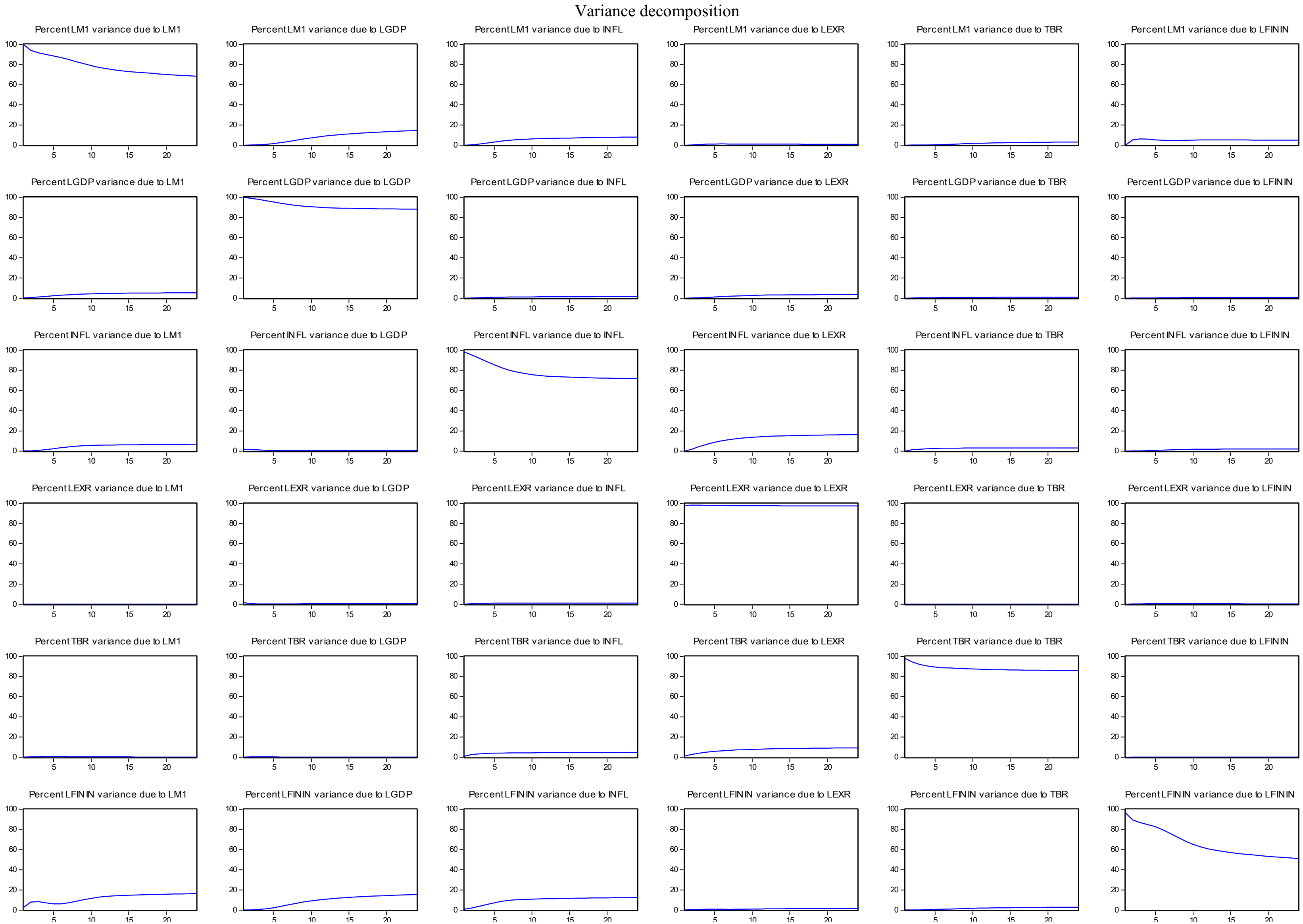


Fig. 3. Variance decomposition

Appendix D

Table 1A. Pairwise Granger causality test

Pairwise Granger Causality Tests Sample: 1980M01 2020M01 Lags: 1			
Null hypothesis	Obs	F-statistic	Prob.
INFL does not Granger cause LM1	311	0.79340	0.3738
LM1 does not Granger cause INFL	311	1.38739	0.2398
LGDP does not Granger cause LM1	311	9.75871	0.0020
LM1 does not Granger cause LGDP	311	0.01504	0.9025
LEXR does not Granger cause LM1	311	7.43392	0.0068
LM1 does not Granger cause LEXR	311	1.61325	0.2050
TB does not Granger cause LM1	311	2.17257	0.1415
LM1 does not Granger cause TB	311	0.36264	0.5475
LFININ does not Granger cause LM1	311	0.90101	0.3433
LM1 does not Granger cause LFININ	311	5.31844	0.0218
LGDP does not Granger cause INFL	311	2.09341	0.1490
INFL does not Granger cause LGDP	311	76.8609	1.E-16
LEXR does not Granger cause INFL	311	0.71859	0.3973
INFL does not Granger cause LEXR	311	0.02103	0.8848
TB does not Granger cause INFL	311	0.85180	0.3568
INFL does not Granger cause TB	311	2.41477	0.1212
LFININ does not Granger cause INFL	311	0.49518	0.4822
INFL does not Granger cause LFININ	311	2.97365	0.0856
LEXR does not Granger cause LGDP	311	59.2375	2.E-13
LGDP does not Granger cause LEXR	311	2.30594	0.1299
TB does not Granger cause LGDP	311	39.9594	9.E-10
LGDP does not Granger cause TB	311	0.25440	0.6144
LFININ does not Granger cause LGDP	311	9.62149	0.0021
LGDP does not Granger cause LFININ	311	4.13539	0.0429
TB does not Granger cause LEXR	311	1.66048	0.1985
LEXR does not Granger cause TB	311	0.01707	0.8961
LFININ does not Granger cause LEXR	311	0.26464	0.6073
LEXR does not Granger cause LFININ	311	3.22441	0.0735
LFININ does not Granger cause TB	311	1.26051	0.2624
TB does not Granger cause LFININ	311	1.14198	0.2861

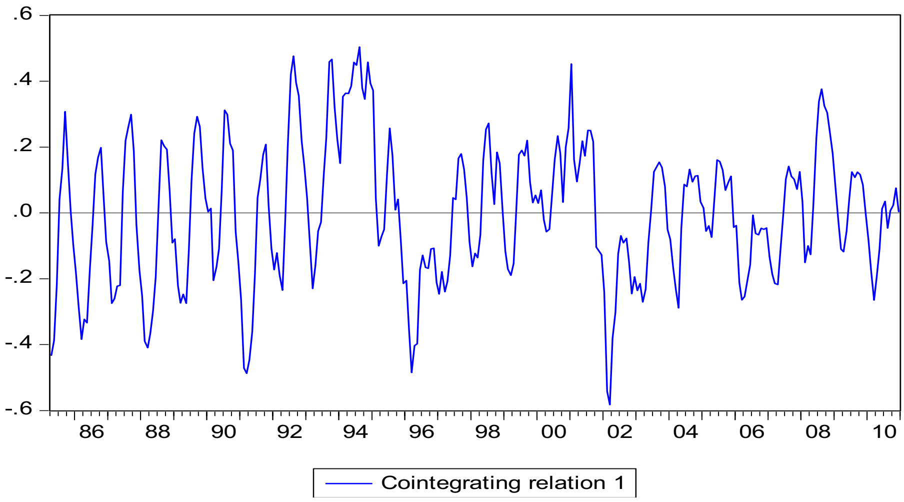


Fig.4. Cointegrating graph for the demand for money