Money demand stability: A case study of Nigeria

Saten Kumar, Don J. Webber and **Scott Fargher**
Auckland University of Technology, Auckland, New Zealand

Abstract

This paper presents an empirical investigation into the level and stability of money demand (*M1*) in Nigeria between 1960 and 2008. In addition to estimating the canonical specification, alternative specifications are presented that include additional variables to proxy for the cost of holding money. Results suggest that the canonical specification is well-determined, the money demand relationship went through a regime shift in 1986 which slightly improved the scale economies of money demand, and money demand is stable. These findings imply that Nigeria could effectively use the supply of money as an instrument of monetary policy.

Keywords: Money demand; Structural breaks; Cointegration; Monetary policy

JEL Numbers: E41; C22

Acknowledgements: The authors thank Prof. B. Bhaskara Rao, Prof. Akinlo and Prof. Peter Howells for useful comments on earlier drafts. Any error remains the authors' responsibility.

Corresponding author: Don J. Webber, Department of Economics, Auckland University of Technology, Auckland, New Zealand. Email: don.webber@aut.ac.nz

1. Introduction

The level and stability of the demand for money has received enormous academic attention because an understanding of its causes and consequences can usefully inform the setting of monetary policy. It is vital to investigate and test the stability of money demand since its instability is a major determinant of liquidity preference. In a seminal paper, Poole (1970) argued that the rate of interest should be targeted if liquidity preference is unstable while the money supply should be targeted if the investment-savings relationship is unstable and the demand for money is stable. It is necessary to select the correct monetary policy instrument since selecting the wrong instrument may result in large fluctuations in output.

The implementation of financial reforms in many countries has raised doubts about the use of monetary aggregates to stabilize inflation rates. Since the 1980s and following countless deregulation and liberalization policies, central banks in many advanced economies switched between instruments of monetary policy by moving away from policies that influence the money supply towards those which influence the bank rate. A large number of developed country case studies show that the demand for money has become unstable due to financial reforms and hence support the targeting of the rate of interest by central banks (see, for instance, McPhail, 1991; Haug, 1999; Maki and Kitasaka, 2006; and Caporale and Gil-Alana, 2005; Haug, 2006).

Central banks in many developing economies have followed suit and switched towards monetary policies directed at the bank rate. A major part of this policy switching is grounded on the view that their own financial market reforms and liberalizations might have contributed to the instability in their own money demand functions. However, recent studies have raised doubts about the validity and strength of central bank interest rate targeting in developing economies (Bahmani-Oskooee and Rehman, 2005; Rao *et al*., 2009; Rao and Kumar, 2009a and 2009b).

Our case study focuses on the Nigerian economy, which arguably squandered her benefits from the oil boom of the 1970s and suffered various political coups in the 1980s, including one in 1985 that led to a bout of political and economic policies that were designed to stabilize the economy. Most notably, Nigeria instituted the IMF's Structural Adjustment Program in 1986 with an aim of putting the economy on the path towards a drastic reduction in international dept; sadly this program was abandoned in 1988. Such economic and political structural changes are likely to have a significant influence on a range of economic relationships.

Studies of the demand for money in African countries have presented results of applications of time series techniques that were based typically on small sample sizes, which may significantly distort the power of standard tests and lead to misguided conclusions. To the knowledge of the authors, there is no current study that tests for structural changes in the money demand relationships for any African economy. Recognizing the limitations of previous studies, the purpose of this paper is to contribute to the empirical literature on the stability of money demand by investigating and estimating money demand relationships using more up-to-date econometric techniques that allow for structural breaks in the cointegrating relationship for Nigeria. In addition to estimating the canonical specification, alternative specifications are estimated which include additional variables to proxy for the cost of holding money.

This paper has the following structure. The next section provides a brief review of the empirical literature that focuses on money demand in African countries. Section 3 gives details of data, specification and method. The empirical results are presented and discussed in Section 4. Section 5 offers conclusions.

2. Money demand

Keynes (1936) developed the liquidity preference theory which explicitly highlights the transaction, precautionary and speculative motives for holding money. Laidler (1977) points out that Keynes did not regard the demand for money arising from the transactions and precautionary motives as technically fixed in their relationships with the level of income and therefore emphasizes that the most important innovation in Keynes' analysis is his speculative demand for money. The primary result of the Keynesian speculative theory is that there is a negative relationship between money demand and the rate of interest.

Friedman (1956) opposed the Keynesian view that money does not matter and presented the quantity theory as a theory of money demand.[1] He modeled money as abstract purchasing power (meaning that people hold it with the intention of using it for upcoming purchases of goods and services) integrated in an asset and transactions theory of money demand set within the context of neoclassical consumer and producer behavior microeconomic theory. Friedman argued that the velocity of money is highly predictable and that the demand for money function is highly stable and insensitive to interest rates. This implies that the quantity of money demanded can be predicted accurately by the money demand function.

Money demand in Africa

Whether money demand is stable is an empirical question that provides important insight for theory and policy making. Empirical studies of money demand in African countries include Teriba (1974), Darrat (1986), Arize *et al*. (1990), Adam (1992), Kallon (1992), Simmons (1992), Fielding (1994), Ghartey (1998), Nachega (2001), Anoruo (2002), Nwaobi (2002), Nell (2003), Sterken (2004), Akinlo (2006), Nwafor *et al*. (2007), Owoye and Onafowora (2007), Bahmani-Oskooee and Gelan (2009) and Drama and Yao (2010). For convenience the major findings of single country empirical investigations are tabulated in Table 1.

{Insert Table 1 about here}

Adam (1992) successfully established a series of single equation demand for money functions (*M0*, *M1*, *M2* and *M3*) for the Kenyan economy from 1973 to 1989. Application of the Johansen technique suggested that income elasticities of money demand were around unity for *M0* and slightly lower at around 0.8 for the other monetary aggregates; therefore he found that the demand for *M1* is stable. Similar results surrounding Kenyan *M1* were obtained by Darrat (1986), although Darrat's income elasticity was unexpectedly high with a value of 1.8. With the exception of Drama and Yao (2010) and Nell (2003), all of these studies conclude that narrow and broad monetary aggregates are stable in respective African countries and hence support the perspective favoring monetary targeting by central banks.[2]

---

1 Friedman's theory of money demand is a reformulation of the classical quantity theory of money because it leads to the quantity theory conclusion that money is the primary determinant of aggregate nominal spending.

2 Ghartey (1998) and Kallon (1992) also find stable money demand function for Ghana. Ghartey (1998) estimated the demand for *M1* money using the Engel and Granger and JML techniques for the period 1970-2002. Kallon (1992) addressed whether the Ghanaian demand for real money balances was stable during the period 1966-

Many developing countries have underdeveloped, undiversified financial markets that lack financial sector instruments and payment technologies such that most transactions involve the use of narrow money. Therefore one should expect that the income elasticity of money demand should be around, or slightly above, unity. However studies of African economies have attained implausibly high or implausibly low income elasticities, as shown in Table 1.

Implausible estimates can be a result of omitted variable bias. Fielding (1994) extended the classical money demand function to include terms that reflect the variability of real rates of return. Specifically he applied the Johansen Maximum Likelihood (JML) technique to quarterly data for Cameroon, Ivory Coast, Nigeria and Kenya in order to estimate demand for *M2*. The obtained income elasticity estimates for Cameroon, Ivory Coast and Nigeria were 1.5, 1.58 and, 0.72, respectively. For Kenya, three cointegrating vectors were obtained with a statistically insignificant income elasticity estimate. Fielding's findings imply that given the degree of heterogeneity in the four countries selected, it would be difficult to formulate an efficient monetary policy which is invariant across these four countries; thus monetary policy in developing countries may need to be applied on a case-by-case basis.

The Nigerian case

As noted above, Nigeria went through a turbulent 1980s which included a period where the IMF Structural Adjustment Program (SAP) was instituted (1986-1988). Anorou (2002) tested for the stability of the demand for *M2* around the SAP period through application of the JML technique to quarterly data between 1986(Q2) and 2000(Q1); the principle result was an unreasonably high estimate of 5.70 for the elasticity of demand with respect to industrial production; his other results suggest that the *M2* money demand function was stable during this period and that the money supply is a viable monetary policy tool in Nigeria. A similar study conducted by Owoye and Onafowora (2007) applied the JML technique to *M2* quarterly data over a marginally longer time period (1986Q1-2001Q4) and also obtained an implausible income elasticity of approximately 2.1, which again suggests that *M2* demand is stable in Nigeria.[3]

Controversy remains in the literature with the estimates of income elasticities of money demand for Nigeria found to be above unity by Akinlo (2006; for *M2* and *M3*) and below unity by Nwaobi (2002; for *M1* and *M2*). If there is any consensus then there appears to be support for monetary targeting by the central bank because one or more monetary aggregate measure is found to be stable. The results of Bahmani-Oskooee and Gelan (2009) appear to corroborate this perspective, as they tested for the stability of *M2* money demand using quarterly data for 21 African countries (including Nigeria) between 1971Q1 and 2004Q3 using the Autoregressive Distributed Lag (ARDL) technique and obtained a long run relationship between *M2*, the

---

1986. Simmons (1992) estimated demand for *M1* for five African countries (Democratic Republic of the Congo, Cote d'Ivoire, Mauritius, Morocco and Tunisia) within an ECM framework. In the case of Cote d'Ivoire, Mauritius and Morocco, he found that the domestic interest rate played a significant role in explaining the demand for M1 in the long run. Sterken (2004) used quarterly data over 1966Q4-1994Q4 period to estimate *M1* demand for Ethiopia. Using JML, he identified a long run equilibrium condition relating real per capita money demand, real per capita GNP, shortage and the real export price of coffee. The income elasticity exceeds unity and there is some evidence of instability in *M1* demand during the period 1974–1975, perhaps due to changes in political regimes and natural disasters.

[3] Implausibly high income elasticities (around 5) have been identified for *M2* and *M1* for Nigeria and Cote d'Ivoire respectively by Nwafor *et al*. (2007) and Drama and Yao (2010).

inflation rate, income and the nominal effective exchange rate for all countries. Application of *CUSUM* and *CUSUMSQ* tests revealed that the estimated models were stable in all cases.

However, one drawback of all of these studies is that although they used standard time series techniques they failed to consider structural changes in the cointegrating vector. Given the economic and political turbulence that occurred in Nigeria during the 1980s, it would be prudent to allow and explicitly estimate for the presence of structural change that could have influenced the demand for money relationship.

3. Data, specification and method

The empirical work outlined below utilizes annual data for real money, real income, nominal rate of interest, real exchange rate and inflation rate over the period 1960-2008 for Nigeria. This sample period is constrained by the availability of data which is sourced from International Financial Statistics and the World Development Indicators. We first examine the time series properties of these variables with the Augmented Dicky-Fuller (ADF) and Elliot-Rothenberg-Stock (ERS) tests. The results of the ADF and ERS unit root tests are presented in Table 2.

{Insert Table 2 about here}

The null hypotheses of non-stationarity of each variable are tested against the alternative hypotheses of stationarity. ADF test results indicate that the unit root nulls for the level variables cannot be rejected at the 5% level (except for the inflation rate) and that the nulls that their first differences have unit roots are also rejected. Similarly, the computed ERS test statistics are more than the 5% critical values, implying that all the levels of the variables are non-stationary. However, the test statistics are lower than critical values for the first differences of these variables and reject the unit root null at the 5% level. It is worth noting that in the ERS test, the inflation rate is a non-stationary series. Since ERS is a stronger test than ADF, we argue that the level variables are non-stationary and that their first differences are stationary.

Many empirical studies have used canonical specification of the demand for money, however to capture the true cost of holding money we specify the demand for money in its canonical form and its extended versions, such that:

$$\ln m_t = \theta_0 + \theta_y \ln(y_t) + \theta_R R_t + \varepsilon_t \tag{1}$$

$$\ln m_t = \theta_0 + \theta_y \ln(y_t) + \theta_R R_t + \theta_E \ln E_t + \varepsilon_t \tag{2}$$

$$\ln m_t = \theta_0 + \theta_y \ln(y_t) + \theta_R R_t + \theta_E \ln E_t + \theta_\pi \pi_t + \varepsilon_t \tag{3}$$

where $\theta_0 =$ intercept, $m =$ real narrow money stock, $y =$ real output, $R =$ cost of holding money proxied with the nominal short term interest rate, $E =$ cost of holding money proxied with the real effective exchange rate, $\pi =$ cost of holding money proxied with the inflation rate and $\varepsilon \approx N(0,\sigma)$ Real money balances are defined as the narrow monetary aggregate, *M1*, deflated by the GDP deflator. Real output is constructed using nominal GDP deflated by GDP deflator and the 3 month deposit rate is our proxy for the nominal interest rate. Inflation rate is computed as the change in the GDP deflator.

The Gregory and Hansen (1996a and b) (henceforth GH) technique is the only time series based structural change test that estimates cointegrating vectors and considers break dates;[4] This gives it important advantages over other techniques if the purpose is to examine the change in slope parameters that are due to the impact of structural breaks. The null hypothesis of no cointegration with structural breaks is tested against the alternative of cointegration. Four models are proposed by GH that are based on alternative assumptions about structural breaks: i) level shift; ii) level shift with trend; iii) regime shift where both the intercept and the slope coefficients change and iv) regime shift where intercept, trend and slope coefficients change. Although this technique does not offer multiple break dates, the single break date is endogenously determined. We apply equation (3) to these four approaches, such that:

GH-1: Level shift

$$\ln m_t = \mu_1 + \mu_2\varphi_{tk} + \alpha_1 \ln(y_t) + \alpha_2 R_t + \alpha_3 \ln E_t + \alpha_4 \pi_t + \varepsilon_t \tag{4}$$

GH-2: Level shift (includes trend)

$$\ln m_t = \mu_1 + \mu_2\varphi_{tk} + \beta_1 t + \alpha_1 \ln(y_t) + \alpha_2 R_t + \alpha_3 \ln E_t + \alpha_4 \pi_t + \varepsilon_t \tag{5}$$

GH-3: Regime shift (intercept and slope coefficients change)

$$\begin{aligned}\ln m_t = {} & \mu_1 + \mu_2\varphi_{tk} + \beta_1 t + \alpha_1 \ln(y_t) + \alpha_{11} \ln(y_t)\ \varphi_{tk} + \alpha_2 R_t + \alpha_{22} R_t\ \varphi_{tk} \\ & + \alpha_3 \ln E_t + \alpha_{33} \ln E_t\ \varphi_{tk} + \alpha_4 \pi_t + \alpha_{44} \pi_t\ \varphi_{tk} + \varepsilon_t \end{aligned} \tag{6}$$

GH-4: Regime shift (intercept, trend and slope coefficients change)

$$\begin{aligned}\ln m_t = {} & \mu_1 + \mu_2\varphi_{tk} + \beta_1 t + \beta_2 t\varphi_{tk} + \alpha_1 \ln(y_t) + \alpha_{11} \ln(y_t)\ \varphi_{tk} + \alpha_2 R_t + \alpha_{22} R_t\ \varphi_{tk} \\ & + \alpha_3 \ln E_t + \alpha_{33} \ln E_t\ \varphi_{tk} + \alpha_4 \pi_t + \alpha_{44} \pi_t\ \varphi_{tk} + \varepsilon_t \end{aligned} \tag{7}$$

where φ is the shift in the slope, intercept or trend coefficient. The break dates are attained by estimating the cointegration equations for all possible break dates and a break date is selected where the absolute value of the ADF test statistic is at its maximum.[5]

4. Empirical results

[4] Bai and Perron (1998, 2003) tests are widely used but are specifically designed to determine breaks in the context of unit roots.

[5] Note that the critical values for cointegration in this procedure are different. Gregory and Hansen have tabulated the critical values for testing cointegration in the Engle-Granger (EG) method with unknown breaks. The well known EG method is a single equation time series technique and at first, the level variables are estimated to obtain long run elasticities. In the second stage the short run dynamic EG model is estimated. This technique also uses MacKinnon (1991) procedure to confirm cointegration between variables. Note that Gregory and Hansen have developed the critical values by modifying the MacKinnon (1991) procedure.

Break tests

Application of the GH cointegration technique to Nigerian money demand data for the period 1960-2008 reveals the results provided in Table 3. The null hypothesis of no cointegration is rejected for canonical specification (1) in models 1, 2 and 4, and the endogenously determined break dates are 1992 in model 1 and 1986 otherwise. For specifications (2) and (3), GH models 1 and 3 reject the null hypothesis of no cointegration and again offer the break date of 1986. These results imply that there exists a long run relationship between real money, real income, nominal rate of interest, real exchange rate and the inflation rate in Nigeria.

{Insert Table 3 about here}

The break dates are sensible. The Nigerian economy did introduce financial sector reforms in the mid-1980s. In particular, the 1986 reforms coincided with the instigation of the IMF's SAP and the introduction of e-money in Nigeria's banking lexicon. Prior to 1986, Nigeria had only 40 banks, but the number increased progressively thereafter to reach 120 in 1992. Between 1986 and 1993, the Central Bank of Nigeria made efforts to create a new environment for the introduction of an indirect approach to monetary management.[6]

Cointegrating equations

In the second stage we use the Engle-Granger technique to estimate the cointegrating equations for the models in which cointegration exists to enable us to select the optimal model. These results are reported in Table 4.

{Insert Table 4 about here}

The estimates of the canonical specification (1) imply that GH-4 is the most plausible model given that all the estimated coefficients are statistically significant with the expected signs and magnitudes. The income elasticity of demand for money estimate is around 0.9 and the Wald test could not reject at the 5% level that this estimate is unity.[7]

In specification (2) the GH model produces the incorrect sign for the income elasticity estimate while the exchange rate variable is insignificant at conventional levels. Further, specification (3) does support the perspective that the inflation rate seems to capture the cost of holding money, however, both the income elasticity and the estimate of inflation rate are only weakly statistically significant. Thus we shall disregard the estimates of specifications (2) and (3) because they appear potentially unreliable. To this end, we favor the canonical specification (1) and argue that the money demand function in Nigeria has undergone some regime shifts that led to changes in the intercept, trend and slope coefficients.

Our income elasticity for money demand estimate is slightly lower than that obtained by Akinlo (2006). One possible source of this difference is that the regime shifts may have contributed to some increased scale economies in the demand for money; nevertheless it is worth

[6] Further details on financial reforms in Nigeria could be obtained from the official website of the Central Bank of Nigeria. http://www.cenbank.org/monetaryPolicy/Reforms.asp

[7] The Wald test computed χ^2 (1) test statistic is 0.040 (p = 0.841) and statistically insignificant.

examining whether the money demand function has become unstable. To test the stability of the Nigerian money demand function we use the residuals from GH-4 of the canonical specification to estimate the short run dynamic equation for the demand for money with the error-correction adjustment model (ECM).

In developing the short run ECM model, we adopted Hendry's econometric methodology known as the General to Specific (GETS) technique[8] and regressed $\Delta\ln(m_t)$ on its lagged values, the current and lagged values of $\Delta\ln(y_t)$ and ΔR_t, and the one period lagged residuals from the cointegrating equation of GH-4. A maximum of 4 period lags is chosen given that the sample is comprised of 48 annual observations for each variable. Further application of variable deletion tests attains the following parsimonious equation:[9]

$$\begin{aligned}\Delta\ln m_t = \underset{(5.64)^*}{2.078} - \underset{(4.72)^*}{0.386}\, ECM_{t-1} + \underset{(2.34)^*}{1.876}\, \Delta\ln(y_{t-1}) + \underset{(2.01)^*}{0.449}\, \Delta\ln(y_{t-3}) \\ - \underset{(3.60)^*}{0.115}\, \Delta R_{t-3} + \underset{(1.99)^*}{0.207}\, \Delta\ln M_{t-2} \qquad (8)\end{aligned}$$

$$\bar{R}^2 = 0.709, \quad SER = 0.041, \quad \textit{Period}: 1965\text{-}2008$$

$$\chi^2_{sc} = 0.056\ (0.81),\ \chi^2_{ff} = 0.384\ (0.54),\ \chi^2_{n} = 0.569\ (0.75),\ \chi^2_{hs} = 2.209\ (0.14)$$

All the estimated coefficients are statistically significant at the 5% level. The lagged error correction term (ECM_{t-1}) has the expected negative sign; this implies a negative feedback mechanism which suggests that if there are departures from equilibrium in the previous period, this departure is reduced by about 39% in the current period. The χ^2 statistics indicate that there is no econometric specification problems associated with serial correlation (χ^2_{sc}), functional form misspecification (χ^2_{ff}), non-normality (χ^2_{n}) or heteroskedasticity (χ^2_{hs}) in the residuals; hence, the results presented for equation (8) are well-determined and robust. Having obtained the short run dynamic model it is prudent to proceed and test for the stability of the money demand function; when equation (8) is subjected to *TIMVAR* stability tests neither the *CUSUM* nor the *CUSUM SQUARES* indicate instability issues, as shown in Figures 1 and 2.

These tests imply that the money demand function is temporally stable in Nigeria and therefore money supply is the appropriate monetary policy instrument for the Central Bank of Nigeria. However, if the Central Bank of Nigeria chooses to follow the advanced countries example and target the rate of interest then this policy could cause more instability in income levels. There is evidence to support the view that there was some improvement in the economies of scale with respect to the demand for money around 1986 because our findings reveal an important regime shift in the money demand relationship. However, even if we allow for structural breaks in the cointegrating relationship, the demand for money function largely remains stable for this economy.

{Insert Figure 1 about here}

[8] For an overview and strengths of the GETS technique, see Rao *et al*. (2010).

[9] The absolute *t*- ratios are in the parentheses below the coefficients and * denotes significance at the 5% level.

{Insert Figure 2 about here}

5. Conclusion

This paper has presented estimates of the demand for real narrow money (*M1*) for Nigeria over the period 1960-2008. Two specifications were investigated: the canonical form and its extended forms through augmentations of real exchange and inflation rates to capture the costs of holding money. In all cases, we find that canonical specification of the money demand performs better for the Nigerian economy.

The results suggest that there is a cointegrating relationship between real narrow money, real income and the nominal rate of interest after allowing for a structural break. Out of a range of four possible models, the model including the regime shift (intercept, slope coefficients and trend changes) corresponding to 1986 yields the preferred model. Our findings imply that the demand for money was stable in Nigeria between 1960 and 2008 although there is evidence to suggest that it may have declined by a small amount around 1986.

The estimated income elasticity of money demand is around unity while the interest rate elasticity is negative and significant. Thus, there is no evidence that the money demand function for Nigeria has become unstable due to financial sector liberalization and reforms. Hence, and following Poole's analysis, we conclude that the money supply is the appropriate monetary policy instrument to be targeted by the Central Bank of Nigeria and failure to utilize the money supply as an instrument of monetary policy may result in fluctuations in the level of output.

References

Adam, C. (1992) ‘On the dynamic specification of money demand in Kenya’, *Journal of African Economies* **1**, 233-270

Akinlo, A. E. (2005) ‘The stability of money demand in Nigeria: An autoregressive distributed lag approach’, *Journal of Policy Modeling* **28**, 445-452.

Anoruo, E. (2002) ‘Stability of the Nigerian M2 money demand function in the SAP period,’ *Economics Bulletin* **14**, 1-9

Arize, A. C, Darrat, A. F. and Meyer, D. J. (1990) ‘Capital mobility, monetization and money demand: evidence from Africa’, *The American Economist* **XXXIV**, 69-75

Bahmani-Oskooee, M. and Gelan, A. (2009) ‘How stable is the demand for money in African countries’, *Journal of Economic Studies* **36**, 216-235

Bahmani-Oskooee, M. and Rehman, H. (2005) ‘Stability of the money demand function in Asian developing countries’, *Applied Economics* **37**, 773-792

Caporale, G. M. and Gil-Alana, L. A. (2005) ‘Fractional cointegration and aggregate money demand functions’, *The Manchester School* **73**, 737-753

Bai, J. and Perron, P. (1998) ‘Estimating and testing linear models with multiple structural changes’, *Econometrica* **66**, 47-78

Bai, J. and Perron, P. (2003) ‘Computation and analysis of multiple structural change models’, *Journal of Applied Econometrics* **18**, 1-22

Darrat, A. (1986) ‘The demand for money in some major OPEC members: Regression estimates and stability results’, *Applied Economics* **18**, 127-142

Drama, B. H. G. and Yao, S. (2010) ‘The demand for money in Cote d’Ivoire: evidence from the cointegration test’, *International Journal of Economics and Finance* **3**(1)

Fielding, D. (1994) ‘Money demand in four African countries’, *Journal of Economics Studies* 21, 17-51.

Friedman, M. (1956) ‘The quantity theory of money- a restatement’ in: *Studies in the quantity theory of money*, M. Friedman (Ed.), Chicago, IL: University of Chicago Press.

Ghartey, E. E. (1998) ‘Monetary dynamics in Ghana: evidence from cointegration, error correction modelling, and exogeneity’, *Journal of Development Economics* **57**, 473-86

Gregory, A. W. and Hansen, B. E. (1996a) ‘Residual-based tests for cointegration in models with regime shifts’, *Journal of Econometrics* **70**, 99-126

Gregory, A. W. and Hansen, B. E. (1996b) ‘Tests for cointegration in models with regime and trend shifts’, *Oxford Bulletin of Economics and Statistics* **58**, 555-559

Haug, A. A. (1999) ‘Money demand functions: Data span and tests,’ conference paper presented at the New Zealand Econometrics Study Group Meeting, Auckland July 1999, available at http://www.econ.canterbury.ac.nz/research/working_papers.shtml

Haug, A. A. (2006) ‘Canadian money demand functions: Cointegration-rank stability,’ *Manchester School* **74**, 214-230

Kallon, K. (1992) ‘An econometric analysis of money demand in Ghana’, *Journal of Developing Areas* 26, 475-488

Keynes, J. M. (1936) *The General Theory of Employment, interest and money,* Volume VII, Cambridge: MacMillan

Laidler, D. E. W. (1977) *The demand for money: theories and evidence* (2nd edition), New York: Harper and Row.

MacKinnon, J. G. (1991) ‘Critical values for cointegration tests’, in Engle, R. F. and Granger, C. W. J. (eds), *Long run Economic Relationships: Readings in Cointegration*, Oxford University Press, pp.267-276

McPhail, K. (1991) ‘The long-run demand for money, Canada savings bonds and treasury bills in Canada’, available at http://www.esri.go.jp/en/archive/dis/discussion-e.html

Maki, D. and Kitasaka, S. (2006) ‘The equilibrium relationship among money, income, prices, and interest rates: evidence from a threshold cointegration test’, *Applied Economics* **38**, 1585-1592

Nachega, J. (2001) ‘A cointegration analysis of broad money demand in Cameroon’, IMF Working Paper 01/26 (Washington DC: International Monetary Fund)

Nell, K. S. (2003) ‘The stability of M3 money demand and monetary growth targets: The case of South Africa’, *Journal of Development Studies* **39**, 151-180

Nwafor, F., Nwakanma, H., Nkansah, P. and Thompson, F. (2007) ‘The quantity theory of money in a developing economy: Empirical evidence from Nigeria’, *African Economic and Business Review* **5**, 1-9

Nwaobi, G. (2002) 'A vector error correction and non-nested modeling of money demand function in Nigeria', *Economics Bulletin* **3**, 1-8
Owoye, O. and Onafowora, O. A. (2007) 'M2 targeting, money demand, and real GDP growth in Nigeria: Do rules apply?', *Journal of Business and Public Affairs* **1**, 1-20
Poole, W. (1970) 'The optimal choice of monetary policy instruments in a simple macro model', *Quarterly Journal of Economics* 192-216
Rao, B. B. and Kumar, S. (2009a) 'A panel data approach to the demand for money and the effects of financial reforms in the Asian countries', *Economic Modeling* **26**, 1012-1017
Rao, B. B and Kumar, S. (2009b) 'Cointegration, structural breaks and demand for money in Bangladesh', *Applied Economics* **41**, 1277-1283
Rao, B. B., Singh, R. and Kumar, S. (2010) 'Do we need time series econometrics?' *Applied Economics Letters* **17**, 695-697
Rao, B. B., Tamazian, A. and Singh, P. (2009) 'Demand for money in the Asian countries: a systems GMM panel data approach and structural breaks', available at http://ideas.repec.org/p/pra/mprapa/15030.html.
Simmons, R. (1992) 'An error-correction approach to demand for money in five African developing countries', *Journal of Economic Studies* **19**, 29-48
Sterken, E. (2004) 'Demand for money and shortages in Ethiopia', *Applied Economics Letters* **11**, 759-769
Teriba, A. O. (1974) 'The demand for money in the Nigerian economy: some methodological issues and further evidence', *Nigeria Journal of Economic and Social Studies* **16**, 153-163

Table 1: Summary of studies on money demand in African economies

Country	Author	Period; Monetary aggregates	Estimation technique	Income elasticity	Interest Rate elasticity	Other Findings
Cameroon	Nachega (2001)	1964-1994; M2	JML	0.700 (2.00)*	0.900 (1.30)	M2 demand is stable.
Cote d'Ivoire	Drama and Yao (2010)	1980-2007; M1	JML	5.312 (6.16)*	-0.191 (0.243)	M2 demand is *not* stable.
Ghana	Kallon (1992)	1996Q1-1986Q4; M1	TSLS	0.667 (2.03)*	-0.005 (4.53)*	No significant effect of foreign interest rates on M1 demand.
Kenya	Darrat (1986)	1969Q1-1978Q4; M1	OLS	1.843 (8.91)*	-0.169 (3.40)*	M1 demand is stable.
Nigeria	Fielding (1994)	1976Q1-1989Q2; M2	JML	0.720	1.180	The income elasticity of M2 for Cameroon and Ivory Coast is 1.50 and 1.58, respectively.
Nigeria	Anoruo (2002)	1986Q2-2000Q1; M1	JML	5.700 (8.56)*	-5.440 (7.92)*	M1 demand is stable.
Nigeria	Nwaobi (2002)	1960 to 1995; M1	VAR	0.639 (4.33)*	-0.098 (0.889)	Income variable best captures the impact of wealth on M1 demand.
Nigeria	Akinlo (2006)	1970Q1-2004Q4; M2	ARDL	1.094 (43.8)*	-0.097 (1.91)**	M2 demand is stable.
Nigeria	Owoye and Onafowora (2007)	1986Q1-2001Q4; M2	JML	2.067 (5.33)*	0.306 (8.191)*	M2 demand is stable.
Nigeria	Nwafor *et al*. (2007)	1986Q3-2005Q4; M2	VAR	5.430 (1.64)**	0.480 (0.78)	M2 demand is stable.
South Africa	Nell (2003)	1965-1997; M1, M2 and M3	EG	1.480 (13.93)*	+0.940 (49.05)*	M3 demand is stable. However, M1 and M2 exhibits parameter instability.

Notes: The *t*-statistics are in parenthesis and * and ** denotes significance at 5% and 10% levels, respectively. OLS, ARDL, VAR, JML, TSLS indicates Ordinary Least Squares, Auto Regressive Distributed Lag, Vector Autoregression, Johansen Maximum Likelihood and Two-Stage Least Squares respectively. Fielding (1994) did not report the standard errors or *t*-statistics. Note for Nell that the value in the interest rate elasticity column corresponds to the price elasticity

Table 2: ADF and ERS unit root tests, 1960-2008

Variable	LAG	ADF	ERS
ln *m*	[1,0]	-1.482 (3.56)	8.112 (3.66)
Δln *m*	[0,1]	-5.734 (3.57)	6.042 (7.23)
ln *y*	[2,1]	-2.008 (3.56)	13.025 (2.85)
Δln *y*	[0,1]	-10.134 (3.57)	2.372 (12.87)
R	[1,1]	-0.725 (3.56)	14.927 (6.68)
Δ *R*	[0,1]	-3.672 (3.57)	7.051 (13.47)
ln*E*	[1,1]	-1.074 (3.56)	10.825 (2.85)
Δln *E*	[0,1]	-7.672 (3.57)	6.597 (12.87)
π	[1,2]	-4.230 (3.56)	13.927 (6.68)
Δ π	[0,1]	-5.185 (3.57)	7.074 (13.47)

Notes**:** LAG is the lag length of the first differences of the variables. For example [1,1] means that one lagged first difference is found to be adequate in the two test statistics, respectively. For both ADF and ERS, the absolute value 5% critical values are given below the test statistics in parentheses. A time trend is included because it is significant in levels and first differences of the variables. ADF and ERS tests were conducted in Microfit 4.1 and E-views, respectively.

Table 3: Cointegration tests with structural breaks, 1960-2008

Specification / GH model	Break date	GH test statistic	5% critical value	Existence of cointegration
$\ln m_t = \theta_0 + \theta_y \ln(y_t) + \theta_R R_t + \varepsilon_t$ (1)				
GH-1	1992	-4.187	-3.603	Yes
GH-2	1986	-5.775	-3.603	Yes
GH-3	1993	-0.159	-3.190	No
GH-4	1986	-3.892	-3.190	Yes
$\ln m_t = \theta_0 + \theta_y \ln(y_t) + \theta_R R_t + \theta_E \ln E_t + \varepsilon_t$ (2)				
GH-1	1986	-6.371	-3.603	Yes
GH-2	2002	-0.763	-3.603	No
GH-3	1986	-2.376	-3.190	No
GH-4	1992	-2.007	-3.190	No
$\ln m_t = \theta_0 + \theta_y \ln(y_t) + \theta_R R_t + \theta_E \ln E_t + \theta_\pi \pi_t + \varepsilon_t$ (3)				
GH-1	1992	-1.095	-3.603	No
GH-2	1994	-3.106	-3.603	No
GH-3	1986	-7.734	-3.190	Yes
GH-4	1986	-1.989	-3.190	No

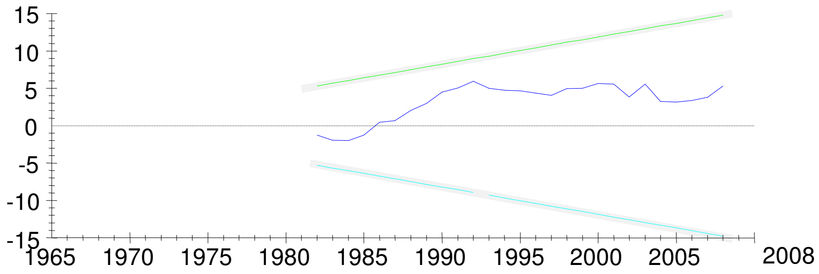
Table 4: Cointegrating equations 1960-2008

	Specification (1)			Specification (2)	Specification (3)
	GH-1 (1992)	GH-2 (1986)	GH-4 (1986)	GH-1 (1986)	GH-3 (1986)
Intercept	1.067 (2.35)*	3.461 (8.94)*	1.148 (3.45)*	2.065 (2.03)*	1.074 (7.94)*
Dum × Intercept	-0.568 (1.78)**	-1.250 (1.86)**	-1.355 (4.72)*	-1.246 (0.76)	-1.663 (6.56)*
Trend	–	0.007 (1.69)**	0.167 (2.01)*	–	–
Dum × Trend	–	–	-0.659 (3.11)*	–	–
ln (y_t)	1.634 (1.20)	2.350 (0.53)	0.904 (4.52)*	-0.076 (1.13)	1.241 (1.76)**
Dum × ln (y_t)	–	–	0.918 (5.62)*	–	1.309 (1.60)
R_t	-0.071 (2.35)*	-1.054 (1.70)**	-0.021 (1.98)*	-0.179 (1.80)**	-0.213 (0.64)
Dum × R_t	–	–	-0.019 (3.16)*	–	-0.196 (1.04)
ln E_t	–	–	–	-0.566 (1.54)	-1.763 (1.50)
Dum × ln E_t	–	–	–	–	-0.785 (0.88)
π_t	–	–	–	–	-0.127 (1.84)**
Dum × π_t	–	–	–	–	-0.094 (1.05)

Notes: Absolute t-ratios are in parentheses below the coefficients. Significance at 5% and 10% levels, respectively, is indicated with * and **. The year relevant for the dummy variable is indicated in the column header in parentheses. For example, DUM1992 means that the dummy is unity after that year and so on.

Figure 1: ***CUSUM*** **test for equation (8)**

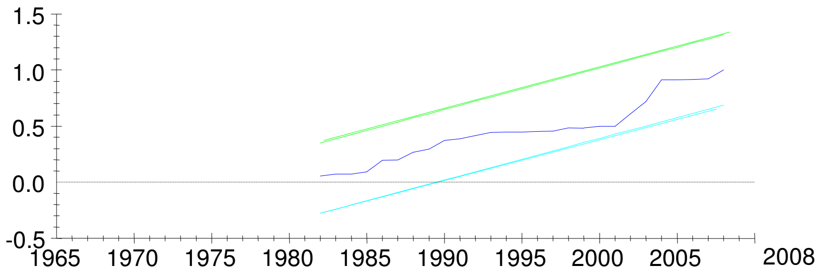
Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Figure 2: ***CUSUM SQUARES*** **test for equation (8)**

Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level