



# Capital Mobility, Monetization, and Money Demand: Evidence from Africa

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### **Abstract**

This paper provides empirical estimates of money demand functions for seven developing countries in Africa, taking into consideration the significance of the non-monetized sector. Countries included are: Egypt, The Gambia, Mauritania, Morocco, Niger, Nigeria, and Somalia. We find that money holdings are significantly related to monetized real income and external influences. Effective monetary policy thus should take into account the response of domestic money holdings to movements in foreign interest rates and exchange rates.

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## I. Introduction

Empirical research regarding money demand relationships has been directed towards the identification of a few key economic variables that determine desired money balances.<sup>1</sup> The typical money demand specification includes real income to represent the budget constraint, and the returns of one or more alternative assets to measure the opportunity cost of holding money. The demand function also includes a lagged dependent variable to approximate the short-run dynamic adjustments. In addition to identifying the key variables, important consideration has been given to the structural stability of the estimated money demand function since a stable money demand relation is necessary to implement appropriate monetary policy.

While much of the research has centered on money demand in developed countries, this paper focuses instead on money demand in developing countries.<sup>2</sup> In specifying money demand models for developing countries, two aspects require particular attention. First, most developing countries have a significant nonmonetized sector, a sector in which money is not used in market transactions. When approximating the budget constraint, care must then be taken to use the appropriate income measure: that is, income for the monetized sector only. Second, while the recent trend for all countries is towards a more open economy, it is especially important to consider the external influences of the world economy on developing countries. Many of these countries are relatively small in size and are closely tied to the larger, more developed countries.

The purpose of this paper is to empirically estimate money demand functions for seven developing countries in Africa. Incorporating both of the above considerations, the money demand equation uses an appropriate budget constraint approximated by monetized real income. To capture the potential effects of capital mobility, the model includes exchange and foreign interest rates.<sup>3</sup> Rational expectations are assumed in estimating the model. For each country, the appropriate adjustment mechanism is determined by Fair's (1987) recent procedure. A battery of other diagnostic tests are performed to check the appropriateness of the model specification. The remainder of the paper is organized as follows. Section II outlines the money demand model. Section III reports and analyzes the empirical results. Section IV concludes the paper.

## II. The Model

The money demand function estimated in the paper takes the form:

$$(M/P)^* = f \left[ Y^m, \epsilon, (r^f + E^e) \right] \quad (1)$$

where:

$(M/P)^*$	=	desired real money balances,
$Y^m$	=	monetized real income.
$e$	=	expected rate of inflation,
$r^f$	=	foreign interest rates.
$E^e$	=	expected exchange rate,
$r^f + E^e$	=	a measure of capital mobility.

Money demand is an increasing function of monetized real income. as the usual budget conditions dictates. Expected inflation. representing the expected return on physical assets, is inversely related to money demand. The variable  $(r^f + E^e)$  measures the opportunity cost of holding domestic money in an open economy with some degree of capital mobility. Domestic residents in such economies allocate their wealth among domestic money and physical assets, foreign financial assets as well as foreign currencies.<sup>4</sup> Since  $(r^f + E^e)$  measures the cost of holding domestic money, the theory predicts a negative effect of this variable on money demand. Of course. foreign financial assets and foreign currencies may have different effects on domestic money holdings. Therefore. in subsequent estimations, the two variables are also included separately in the model, letting diagnostic tests determine the appropriate specification for each country.

The seven African countries in our sample are Egypt, Gambia, Mauritania, Morocco, Niger, Nigeria, and Somalia. As Chandavarkar (1977) noted, these countries had significant nonmonetized sectors over the estimation period (1960-1987). A significant portion of nonmonetized income is usually found in the agricultural sector. The two main types of economic activities that do not use monetary transactions (i.e., subsistence and barter) are particularly characteristic of the agricultural sector. Many transactions in this sector involve payments in kind such as commodity loans, wages in kind, and sharecropping. Following the lead of other researchers such as Laumas (1978) and Driscoll and Lahiri (1983), nonmonetized income is approximated here by agricultural output and then subtracted from total income to obtain a measure of monetized income. Expectations are assumed to be formed rationally.<sup>5</sup> In so doing, we used Maddala's (1988) approach and replaced  $r^f$  and  $E^e$  with appropriate lagged instruments and then estimating the money demand equations across countries by means of the Two-Stage Least Squares (TSLS) technique.<sup>6</sup>

Assuming the common logarithmic functional form, equation (1) can be rewritten as:<sup>7</sup>

$$\log(M/P)^*_t = \alpha_0 + \alpha_1 \log Y^m_t + \alpha_2 \epsilon_t + \alpha_3 \log(r^f_t + E^e_t) + u_t \quad (2)$$

$$\log(M/P)^*_t = \alpha_0 + \alpha_1 \log Y^m_t + \alpha_2 \epsilon_t + \alpha_3 \log r^f_t + \alpha_4 \log E^e_t + u_t \quad (3)$$

where  $\alpha_3$ ,  $\alpha_4$  and  $u_t$  are the disturbance terms. If a nominal partial adjustment scheme is used, then the adjustment of nominal money demand to the desired level is some fraction of the gap between the desired nominal level in the current period and the actual nominal level in the previous period. This scheme serves to replace the unobservable  $\log(M/P)^*_t$  with the observable measure of real money balances,  $\log(M/P)_t$ . Combining this nominal partial adjustment procedure with equations (2.) and (3). the final forms of the money demand equations are obtained:

$$\log(M/P)_t = \alpha_0 + \alpha_1 \log Y^m_t + \alpha_2 \epsilon_t + \alpha_3 \log(r^f_t + E^e_t) + \alpha_4 \log M_{t-1} / P_t + u_t \quad (2)'$$

$$\log(M/P)_t = \beta_0 + \beta_1 \log Y^m_t + \beta_2 \epsilon_t + \beta_3 \log r^f_t + \beta_4 \log E^e_t + \beta_5 \log M_{t-1} / P_{t-1} + u_t \quad (3)'$$

where theory predicts for equation (2)' that  $\alpha_1, \alpha_4 > 0$  and  $\alpha_2, \alpha_3 < 0$ ; and in equation (3)' that  $\beta_1, \beta_5 > 0$  and  $\beta_2, \beta_3, \beta_4 < 0$ . If real partial adjustment is instead found to be the more appropriate scheme according to the Fair (1987) criterion, then the last term in equations (2)' and (3)' will be replaced by  $[\log M_{t-1} / P_{t-1}]$ .

$\epsilon_t$  and  $E^e_t$  are expected inflation and exchange rates, where the expected values were generated from the errors-in-variables' formulation of rational expectations. Foreign interest rates ( $r^f$ ) are measured by the average of short-term interest rates in five main OECD countries (USA, UK, France, Germany, and Japan). Exchange rates for each country are the domestic currency per U.S. dollar.  $M/P$  is real money balances where  $M$  is nominal money stock defined narrowly as currency plus demand deposits, and  $P$  is the consumer price index (1975 = 100). The narrow definition of money is chosen for consistency and comparability across the seven countries in our sample.  $Y^m$  is monetized aggregate real income defined as non-agricultural real GDP. All annual data series used in this study over the 1960-1987 period were taken from the *1988-89 World Tables*, published by the World Bank, and the *International Financial Statistics*, various issues.

### III. Empirical Results

The empirical results are reported for each country in Table 1. As can be seen from the table, the overall goodness of fit of the money demand equation for each country is adequate as the proposed model explains at least 90 percent of the variation in desired domestic money holdings. The Durbin-Watson statistics are not reported here since they are biased in the presence of a lagged dependent variable among the regressors. As alternative, the Durbin-h and the Breusch-Godfrey statistics are displayed and they both evidenced no significant autocorrelation. As Johnston (1984) noted, the virtue of the Breusch-Godfrey procedure is that it is a robust test of autoregressive and moving-average processes.

As discussed earlier, the Fair criterion was applied to select the appropriate partial adjustment scheme (nominal or real) for each equation in Table 1. Two additional specification tests were also employed. The Plosser-Schwert-White (1982) test was used to determine whether  $rf$  and  $E^e$  should be included jointly or separately in the equations as well as to test for serious omission of variables. On the other hand, Ramsey's (1969) RESET test was applied to test for incorrect functional forms (e.g., level versus first-differences).<sup>8</sup> The F-statistics of the two tests are reported in Table 2. As these results show, none of the F-values proves significant for either test. This indicates that the equations (in level forms) displayed in Table 1 are appropriately specified.

**Table 1**  
**Regression Results of Money Demand Functions**  
(TSLs Estimations) Annual Data, 1960-1987

Parameters	Country						
	Egypt	Gambia	Mauritania	Morocco	Niger	Nigeria	Somalia
Constant	<b>-0.62</b> (1.47)*	<b>-0.35</b> -1.22	<b>-1.43</b> (2.67)**	<b>-1.37</b> (6.12)**	<b>-1.01</b> (2.12)**	<b>-0.48</b> (2.31)**	<b>-0.71</b> (2.45)**
Monetized Real GDP	<b>0.44</b> (2.27)**	<b>0.33</b> (1.74)**	<b>0.42</b> (3.38)**	<b>0.3</b> (2.01)**	<b>0.32</b> (1.61)*	<b>0.2</b> (3.11)**	<b>0.49</b> (3.68)**
Expected Inflation	<b>0.85</b> -1.12	<b>-0.43</b> -0.53	<b>2.06</b> (20.60)**	<b>0.44</b> -0.59	<b>-0.19</b> -0.34	<b>0.09</b> -0.15	<b>-0.31</b> (1.46)*
Expected Exchange Rate	-	-	<b>-0.01</b> (1.89)**	<b>0.0004</b> -0.43	<b>-0.004</b> (1.55)*	-	-
Foreign Interest Rate	-	-	<b>-0.001</b> -0.04	<b>-0.019</b> (2.44)**	<b>-0.04</b> (2.02)**	-	-
Foreign Interest Rate plus Expected Exchange Rate	<b>-0.14</b> (1.51)*	<b>-0.001</b> -0.83	-	-	-	<b>-0.001</b> (1.43)*	<b>-0.002</b> (1.48)*
Lagged Partial Adjustment	<b>0.75b</b> (4.48)**	<b>0.70a</b> (3.37)**	<b>0.76b</b> (15.29)**	<b>0.96b</b> (6.58)**	<b>0.44a</b> (1.69)*	<b>0.87a</b> (18.16)**	<b>0.63a</b> (5.18)**
R <sup>2</sup>	0.98	0.92	0.98	0.99	0.9	0.97	0.93
S.E.	0.08	0.16	0.12	0.04	0.1	0.12	0.16
h	1.47	-	-0.59	-0.03	-	0.14	-0.21
B.G.	3.6	0.11	3.64	0.18	0.62	1.08	0.08

\* = significance at the 10 percent level  
\*\* = significance at the 5 percent level

h = the Durbin-h statistic  
B.G. = The Breusch-Godfrey statistic

a = real lagged adjustment  
b = nominal lagged adjustment

**Table 2**  
**F-Statistics of the Specification Tests**

Country	The Plosser	
	Schwert-White Test	The Ramsey RESET Test
Egypt	1.43	0.20
Gambia	0.20	0.76
Mauritania	1.06	1.61
Morocco	2.44	0.48
Niger	0.58	1.37
Nigeria	0.79	0.61
Somalia	1.18	0.63

**Notes:** For the Plosser-Schwert-White test, the 5 percent critical F-value is 2.93 for Egypt, Gambia, Nigeria and Somalia, and it is 2.74 for the remaining countries. For the Ramsey RESET test, the critical F-values at the 5 percent level are 3.55 and 3.59 for the two groups, respectively.

Having provided some evidence for the adequacy of the model specifications in Table 1, we now proceed with a discussion of the obtained estimates. The signs of the estimated coefficients are generally consistent with the underlying theory for the seven African countries. The coefficient of monetized real income is positive as predicted and is statistically significant at the 5 percent level across countries (except for Niger where the coefficient is significant at the 10 percent level). The coefficient of the lagged dependent variable is correctly signed and is statistically significant for all seven countries. This implies that the adjustment of actual balances to the desired level is not completed within a year. The fraction of the gap between desired and actual money balances that is made up in the first year (the speed of adjustment) ranges from 4 percent in Morocco to 56 percent in Niger.

For four out of the seven countries (Egypt, Gambia, Nigeria, and Somalia), the Plosser-Schwert-White test dictated combining foreign interest rates and expected exchange rates as the measure of capital mobility. As predicted, the coefficient on the capital mobility variable in these four countries appear with the correct negative signs and are statistically significant at least at the 10 percent level across the four countries (except for Gambia). On the other hand, separate inclusion of foreign interest rates and expected exchange rates (unequal effects) was found empirically superior for Mauritania, Morocco, and Niger. In these countries, too, the coefficients on both foreign interest rates

and expected exchange rates variables display the correct negative signs and are generally significant at the 10 percent level. Thus, whether jointly or separately, capital mobility variables do exert an important effect on domestic money demand in all countries studied.

As to the effect of expected inflation, the variable is correctly signed (negative) in only three countries and then proved statistically significant in only one of the three regressions (that of Somalia). Two explanations may be offered for such results. Policano and Choi (1978) have developed a theoretical model based on utility maximization in which expected inflation could have a positive impact upon the demand for assets (including money). Another explanation for the surprising results regarding the effect of expected inflation may lie in Chow's (1989) recent evidence that incorrectly imposing the assumption of rational expectations could lead to unreliable estimates. This seems more likely in the case of Morocco where imposing the rationality assumption yielded insignificant and incorrectly signed coefficients on both expected inflation and expected exchange rates.<sup>9</sup> Therefore, although the hypothesis of rational expectations is more consistent with economic theorizing than rival hypotheses (e.g., adaptive expectations), the assumption of rational expectations should nevertheless be used with caution particularly in the context of developing economies.

**Table 3**  
**Short-Run and Long-Run Real-Monetized**  
**Income Elasticities**

Country	Short-Run	Long-Run
Egypt	0.44	1.76
Gambia	0.33	1.10
Mauritania	0.42	1.75
Morocco	0.30	7.50
Niger	0.32	0.57
Nigeria	0.20	1.49
Somalia	0.49	1.32

Short-and long-run real income elasticities for the seven African countries are reported in Table 3. Given the logarithmic form of the estimated equations, short-run income elasticities are directly estimated by the coefficients of monetized real income. Long-run income elasticities can be calculated as the ratio of the coefficient of monetized real income to the speed of adjustment. The estimates of long-run real income elasticities reveal some evidence of economies of scale in cash management only for Niger; whereas money appears to be a luxury good in the remaining countries.<sup>10</sup>



It should be noted that our income elasticity estimates do not suffer from any possible bias due to the use of an improper measure of the budget constraint. As emphasized earlier, our budget constraint is measured only with the monetized sector in each of the countries under study. Of course, it may be useful to obtain some evidence that the distinction made here between monetized and total real income is important. Thus, another round of TSLS estimations were performed with total real income replacing monetized real income as our measure of the budget constraint. Table 4 reports the estimates obtained for short- and long-run elasticities. As is clear from the table, these elasticity estimates for total income are upwardly biased for five out of the seven countries.

Taken together, the proposed money demand model appears to fit the time series data from each of the seven African countries quite well with sensible coefficient estimates. When estimating regressions for developing countries, a typical problem has been the lack of sufficiently long time series data. One solution is to pool the time series data from the countries and to run cross-sectional regressions. It is of course encouraging to obtain estimates from the cross-sectional analysis [by means of the Fuller Battese (1974) method] that are similar to those reported above for the individual countries. The details of these additional estimates are not reported here to conserve on space, but are available from the authors upon request.

**Table 4**  
**Short-Run and Long-Run Real-Total .**  
**Income Elasticities**

Country	Short-Run	Long-Run
Egypt	0.47	1.97
Gambia	0.45	1.17
Mauritania	0.43	1.64
Morocco	0.42	1.81
Niger	0.18	1.31
Nigeria	0.28	2.03
Somalia	0.30	1.77

For implementing appropriate monetary policy, the structural stability of money demand equations assumes particular importance. The standard test used to check for structural stability is the Chow (1960) test. The results of the Chow test are given in

Table 5. In applying the test, we followed the suggestion of Farley, Hinich, and McGuire (1975) and split the sample at the mid-point to maximize the empirical power of the test.

**Table 5**  
**F-Statistics of Structural Stability Tests**

Country	The Chow Test	The Farley-Hinich Test
Egypt	1.42	1.62
Gambia	0.45	1.16
Mauritania	1.14	1.39
Morocco	0.42	1.23
Niger	1.28	0.76
Nigeria	1.66	0.35
Somalia	1.31	0.43

**Notes :** The critical F-test value at the 5 percent level for both tests is 2.74 for Nigeria, Gambia, Somalia, and Egypt. For the remaining countries, the critical F-value is 2.96.

The Chow test could not reject the stability hypothesis for any of the seven African countries. Given the sensitivity of the Chow test to the particular choice of the breaking date, applying an alternative test seems prudent. A test that does not require splitting the sample into two parts is the Farley and Hinich (1970) procedure. The calculated F-statistics of this are also reported in Table 5. The Farley-Hinich test corroborates the Chow test in not rejecting the stability hypothesis for any of the countries examined at the 5 percent level of significance. One can thus argue that the money demand equations estimated in this paper could be useful for policy analysis.

#### **IV. Concluding Remarks**

The central focus of this paper has been on the estimation of appropriate money demand functions for a group of seven African developing countries. In regards to this estimation, two key features are emphasized. First, a developing economy is likely to have a significant nonmonetized sector. Since money is not used as a medium of exchange in this sector, the effect of income on money demand is due only to the monetized sector. Second, a developing economy is also small in size and has close ties with the rest of the world. Thus, the demand for money depends, in part, on capital mobility measured here by movements in foreign interest rates and expected exchange rates (either jointly or separately). For the seven developing countries, money demand equations are estimated taking into account the impact of monetized realincome and

capital mobility. Expectations are assumed rational and incorporated by means of the "errors in variables" method using TSLS estimates.

The empirical results from the time series analysis indicate that money holdings in these seven African countries are significantly related to monetized real income and external influences. Consequently, money demand equations that fail to distinguish between monetized and monetized real income or fail to take account of the openness of the African economies could lead to biased results. In particular, effective monetary policies in these African countries should incorporate the response of domestic money holdings to movements in foreign interest rates and exchange rates. It is also worth emphasizing that the money demand equations estimated in this paper proved structurally stable across all African countries. Stability evidence obtained for the money demand functions suggests that such estimates could be utilized by the African authorities to design appropriate monetary policies.

### End Notes

1. See, for example, Goldfeld (1973), Boughton (1981), Sweeney (1985), and Koskela and Viren (1987).
2. Several researchers have investigated money demand functions in developing economies. Among others, see Wong (1977), Ghatak (1981), Cardoso (1983), Darrat (1986) and the references cited therein.
3. It should be pointed out that lack of adequate data necessitated the exclusion of domestic interest rates from the estimated money demand equations. Moreover, to the extent that such data exists, it may not be reliable due to tight government controls. For more on this, see Crockett and Evans (1980), Darrat (1981), and Driscoll and Lahiri (1983).
4. See Cuddington (1983) for an elaborate discussion.
5. It should, however, be noted that if expectations are not in fact formed rationally, then the estimates from the otherwise correct model could be biased. For more on this, see Chow (1989).
6. The instruments are one- and two-lagged values of  $n$ ,  $M$ ,  $Y^o$ ,  $r_f$ , and  $E$ . We are especially indebted to an anonymous referee for pointing out this and many other aspects of our estimations.
7. Note that the inflation variable enters linearly as inflation rates for some years assume zero or negative values in which case the logarithms become undefined.
8. For a lucid description of these tests, see Maddala (1988). Note that, although considered tests for general misspecifications, Thursby (1989) has recently reported an extensive Monte Carlo evidence that the power of such tests is confined to the specific alternative stated in the text above.
9. Interestingly, when the rationality assumption was relaxed, both variables achieved significance and were correctly signed. Details of these results are available from the authors upon request.
10. For Morocco, the unreasonable estimate of the long-run income elasticity is the outcome of her extremely slow speed of adjustment.

### References

- Boughton, J. M.. "Recent Instability of the Demand for Money: An International Perspective." *Southern Economic Journal* 47. January 1981, pp. 579-597.
- Cardoso, E. A.. "A Money Demand Equation for Brazil," *Journal of Development Economics* 12, February/April 1983, pp. 183-193.
- Chandavarkar. A. G.. "Monetization of Developing Countries," International Monetary Fund, *Staff Papers* 24. November 1977, pp. 665-721.
- Chow, G. C., "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," *Econometrica* 25, July 1960, pp. 591-605.
- \_\_\_\_ "Rational Versus Adaptive Expectations in Present Value Model." *Review of Economics and Statistics* 71. August 1989, pp. 376-384.
- Crockett. A. D.. and O. J. Evans. "Demand for Money in Middle Eastern Countries." International Monetary Fund. *Staff Papers* 18. February 1980, pp. 543-577.
- Cuddington. J T. "Currency Substitution. Capital Mobility, and Money Demand." *Journal of International, Money and Finance* 2. 1983, pp. 111-133.
- Darrat. A. F., "A Monetarist Approach to Inflation for Saudi Arabia." Unpublished Ph.D. Dissertation, Indiana University, 1981.
- "The Demand of Money in Some Major OPEC Members: Regression Estimates and Stability Results." *Applied Economics* 18. February 1986, pp. 127-142.
- Driscoll, M. J., and A. K. Lahiri, "Income Velocity of Money in Agricultural Developing Economies, *Review of Economics and Statistics* 65. August 1983, pp. 393-401.
- Fair, R. C., "International Evidence on the Demand for Money." *Review of Economics and Statistics* 69, August 1987, pp. 473-480.
- Farley, J. U., and M. I. Hinich. "A Test for a Shifting Slope Coefficient in a Linear Model." *Journal of American Statistical Association* 65. September 1970. pp. 1320-13, 19.
- \_\_\_\_ and T. W. McGuire. "Some Comparisons of Tests for a Shift in the Slope of a Multivariate Linear Time Series Model." *Journal of Econometrics* 3, August 1975. pp. 297-318.
- Fuller. W. A.. and G. E. Battese. "Estimation of Linear Models With Cross-Error Structure," *Journal of Econometrics* 2. 1974. pp. 67-78.
- Ghatak. S.. *Monetary Economics in Developing Countries*. New York: St. Martin Press. 1981.
- Goldfeld, S. M.. "The Demand for Money Revisited." *Brookings Papers in Economic Activity* 3. 1973, pp. 577-646.
- Johnston, J., *Econometric Methods*. Third Edition. New York: McGraw-Hill Book Co.. 1984.

- Koskela, E., and M. Viren. "Inflation, Hedging and the Demand for Money: Some Empirical Evidence." *Economic Inquiry* 5, April 1987, pp. 251-265.
- Laumas, P. S., "Monetization, Economic Development and the Demand for Money," *Review of Economics and Statistics* 60, November 1978, pp. 614-618.
- Maddala, G. S.. *Introduction to Econometrics*. New York: Macmillan Publishing Company, 1988.
- Plosser, C. L, G. W. Schwert, and H. White. "Differencing as a Test of Specification," *International Economic Review* 23, October 1982, pp. 535-552.
- Policano, A., and E. Choi. "The Effects of Relative Price Changes on the Household's Demand for Money," *Journal of Monetary Economics* 4, 1978. pp. 743-753.
- Ramsey. 1. B., "Tests for Specification Errors in Classical Linear Least-Squares Regression Analysis," *Journal of Royal Statistical Society* 31. Series B, 1969, pp. 350-371.
- Sweeney, R. J., "Short-run Money Demand Functions: Estimated Speeds of Adjustment and Serial Correlation." *Journal of Macroeconomics* 7, Spring 1985. pp. 247-256.
- Thursby, J. G., "A Comparison of Several Specification Error Tests for a General Alternative." *International Economic Review* 30, February 1989, pp. 217-230.
- Wong, C. H.. "Demand for Money in Developing Countries: Some Theoretical and Empirical Results," *Journal of Monetary Economics* 3. January 1977, pp. 59-86.