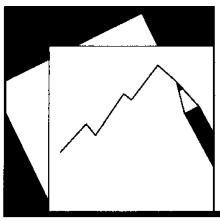
WP/11/273



IMF Working Paper

On the Stability of Money Demand in Ghana: A Bounds Testing Approach

Jihad Dagher and Arto Kovanen

INTERNATIONAL MONETARY FUND

 WP/11/273

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African Department

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Prepared by Jihad Dagher and Arto Kovanen

Authorized for distribution by Christina Daseking

November 2011

Abstract

This paper adopts the bounds testing procedure developed by Pesaran et al. (2001) to test the stability of the long-run money demand for Ghana. The results provide strong evidence for the presence of a stable, well-identified long-run money demand during a period of substantial changes in the financial markets. The empirical evidence points to complex dynamics between money demand and its determinants while suggesting that deviations from the equilibrium are rather short-lived.[1]

JEL Classification Numbers: E41, C2

Keywords: money demand, bounds testing, stability, Ghana.
Author's E-Mail Addresses: akovanen@imf.org and jdagher@imf.org

[1] The authors like to thank Peter Allum and the Bank of Ghana staff for their helpful comments. All remaining errors are authors' responsibility.

I. INTRODUCTION

Ghana's financial landscape has changed substantially over the last three decades. This reflects determined efforts by Ghanaian authorities to move forward with financial market reforms and allow prices and resources to be determined through market forces. Interest rate and credit controls were eliminated during the 1980s. The external current account was liberalized in early 1990s. Since then the authorities have been promoting financial innovation and cross-border financial transactions have been partially liberalized, in line with the observed trend towards increasing globalization of Sub-Saharan African countries. This has allowed foreign investors to participate in the longer-end of the domestic bond market while Ghanaian residents may hold foreign currency bank accounts. The exchange rate is largely determined by market forces, and monetary policy implementation is focuses on the direct control of inflation in the context of an inflation-targeting arrangement, which the Bank of Ghana formally introduced in 2007. Domestic capital markets have also started to develop, although still remaining nascent, and this has brought new investment options to the Ghanaians (such as stocks, treasury bills and bonds). Furthermore, new payment instruments, such as credit and debit cards, have making inroads in the Ghanaian economy and are expected to reduce the demand for cash in daily transactions, while modern payment technology and electronic banking will help to expand banking services to the rural communities often deprived of such options.

It is often suggested that financial market reforms could lead to an unstable demand for money and changes in money velocity[2], which could have consequences for monetary policy implementation. In countries where the central bank targets a money aggregate, for instance using reserve money to implement monetary policy, the effectiveness of monetary policy rests on the stability of the monetary transmission mechanism and money velocity. When this relationship is subject to unexpected shifts, monetary targets lose their transparency and are less able to accurately signal the appropriate stance of monetary policy. This argument has been used as a reason for moving to inflation targeting, which does not rely on the stability of money demand but instead uses a broad range of information to assess the monetary policy stance (for instance, Mishkin, 1999).

The objective of this paper is to analyze the stability of the demand for money in Ghana. Given the inconclusiveness of the empirical evidence on money demand estimates for emerging and developing countries, including for Ghana, the re-examination of the question whether money demand has remained stable during financial sector reforms is warranted. This study also benefits from the more recent data compared to earlier studies on Ghana, and uses the rebased national accounts which increased Ghana's per capita incomes on average by about 65 percent.[3].

[2] Financial deepening has affected money velocity in Ghana (Appendix Table 1).

[3] The Ghana Statistical Services published rebased national accounts in 2010, which comprised a new base year (to 2006 from 1993) and expansion of data coverage, in particularly for services.

We adopt the bounds testing procedure developed by Pesaran et al. (2001) to assess if there is a stable money demand function in Ghana, which has not been done before. The rest of the paper is organized as follows. Section II reviews recent empirical money demand studies for emerging market and developing countries. Section III describes the data used in this study and reports the results of the bounds testing approach. Section IV concludes.

II. RECENT LITERATURE

There is a vast empirical literature that studies the characteristics of money demand across various counties. Knell and Stix (2006) provide a useful and comprehensive summary of some of the main findings of this literature as to the empirical properties of money demand functions since the 1970s, including comparison between industrial and developing countries (see also Sriram, 2001). A key observation of this paper is that despite the fact that the empirical money demand studies cover a wide range of countries and time periods, they share many common features. The estimated average income elasticity is usually close to one subject to some variation between countries. Typically, the estimated income elasticities are sensitive to the choice of the monetary aggregate (the estimated elasticities are typically larger when broader money aggregates are used), and tend to be smaller when other explanatory factors, such as proxies for wealth and financial innovation, are also included in the estimation. When the interest rate is included in the estimation as a measure the opportunity cost of holding money, the estimated elasticity is always negative irrespectively of the precise type of interest rate used.

The empirical literature offers mixed evidence as to the impact of financial and economic liberalization on money demand stability. For instance, in the case of China, Lee and Chien (2008) find that economic and financial deregulation affected the stability of money demand, while Baharumshah et al. (2009) and Wu (2009) show that a stable money demand function would continue to exist when proper accounting for other financial assets is made. Bahmani-Oskooees and Rehman (2005), examine the stability of money demand for a group of Asian emerging market countries (India, Indonesia, Malaysia, Pakistan, the Philippines, Singapore, and Thailand), and their results suggest that in many of these countries money demand could be unstable, based on recursive CUSUM and CUSUMSQ residual tests, even when monetary aggregates are cointegrated with their determinants. Buch (2001) finds some evidence of parameter instability in the money demand for Hungary and Poland during the transition period. Pradhan and Subramanian (2003) suggest that financial deregulation and innovation in India affected the stability of the demand for money.

Several recent studies have focused on the money demand among African countries where financial market reforms are more recent and financial deepening is at its early stages. A comparative study by Bahmani-Oskooee and Gelan (2009), covering 21 African countries and using quarterly data for the period 1971Q1-2004Q3, conclude that in most African countries, including in Ghana, a stable cointegrating money demand relation can be established between

broad money, income, inflation, and nominal exchange rate. Two studies, by Nell (2003) and Todani (2007), examine the stability of money demand in South Africa, which has the most developed financial markets in Sub-Saharan Africa and is an inflation-targeter. These studies reach similar conclusions and find that money demand has remained relatively stable in South Africa despite the rapid development of the country's financial markets. They note, however, that the linkage between money and inflation is weak and that money provides little information about future movements in prices.

There are few empirical money demand studies specific to Ghana. These studies differ by the time period, monetary aggregate, data frequency, and model specification chosen for estimation. Furthermore, they provide mixed evidence as to the stability of money demand. An early study by Ghartey (1998) covers the period from 1970Q4 through 1992Q4 and finds a stable demand function for nominal narrow money in Ghana. The estimated equation exhibits long-run homogeneity of income and prices (that is, demand is for real money) and prices and income are super exogenous to money. There are two studies conducted by the Bank of Ghana staff which examine the stability of the demand for money in Ghana. Bawumia and Abradu-Otoo (2003), using monthly data for the period 1983-1999, conclude that there is a stable long-run relationship between inflation and broad money in Ghana. Amoah and Mumuni (2008), on the other hand, using quarterly data from 1980Q1 through 2007Q1, arrive at the conclusion that structural reforms and the deregulation of the financial sector have resulted in parameter instability in the demand for broad money in late 1990s and that money no longer provide useful information for predicting future inflation and output.

III. EMPIRICAL ANALYSIS

We choose to focus our analysis on the period 1990Q1—2009Q4, which comprises 80 data points.[4] Earlier years were excluded for two reasons. First, data from the 1980s exhibit excessive volatility and noise. Second, financial and foreign exchange markets in Ghana were highly regulated before the 1990s; in the absence of market-based interest and exchange rates financial variables for these years offered only limited information value for determining money demand. All variables are quarterly except for the national accounts data which in Ghana are available only annually. In the absence of quarterly national accounts data for the estimation period, we have converted for the purpose of this study the nominal gross domestic product data into quarterly series by a direct and smooth decomposition of the annual data.[5]

[4] See Figure 1 and Appendix Tables 1 and 2.

[5] The decomposition implies that there are no seasonal variations in the quarterly gross domestic product data, which is a neutral assumption in the absence of better information about seasonal variations. Ghana Statistics Services started publishing quarterly GDP data in early 2011, backdating the quarterly time series to 2006.

We begin by testing for the presence of unit roots in both the level and the first difference. The statistical results of the Augmented Dickey-Fuller (ADF) test are reported in Table 1. The lag length used for the ADF test is determined using a model selection procedure based on the Schwarz information criterion. We include a constant and show the results with and without a trend. The p-values indicate that we cannot reject the presence of a unit root in all level variables. They also indicate that most variables are stationary in first difference, except for broad money (both nominal and real). We cannot reject the presence of a unit root in the first difference of nominal broad money (M2+) and the test suggest the existence of a linear time trend in real broad money. This last finding might be the result of the ongoing financial reforms in Ghana, which have led to rising money demand (monetization) as a result of financial deepening. All interest rate variables are stationary in first difference but the results also suggest that the U.S. treasury bill rate might be trend stationary in levels.[6]

Table 1. Unit Roots

	Levels		First difference	
		With trend		With trend
Log(M2)	0.75	0.22	0.01	0.05
Log(M2+)	0.54	0.11	0.10	0.20
Log(P)	0.34	0.88	0.07	0.02
Log(M2/P)	0.94	0.62	0.02	0.09
Log(M2+/P)	1.00	0.78	0.15	0.00
Log(Y)	0.90	0.43	0.00	0.01
Log(NEER)	0.74	0.77	0.00	0.00
Log(1 + i_dep)	0.34	0.36	0.00	0.00
Log(1 + i_tbill)	0.61	0.11	0.00	0.00
Log(1 + i_us_tbill)	0.13	0.00	0.00	0.00
Log(1 + i_usd_libor)	0.19	0.28	0.00	0.00
Log(GHc/USD)	0.47	0.86	0.00	0.00

Source: authors' estimates.

Pesaran et al. (2001) approach provides a single equation alternative to the often-used Johansen's procedure for estimating long-run demand for money. In particular, unlike the Johansen's procedure, it does not require that all variables are stationary of the order I(1) as variables may be either I(0) or I(1). Pesaran et al. (2001) provides critical upper and lower values for an F-test related to the joint significance of the long-run relationship imbedded in the first-order difference equation.

[6] Studies on stationarity of U.S. interest rates commonly find that nominal interest rates are mean-reverting and a shock could therefore last a long period (see, for instance, Rose (1988)). Gil-Alana (2004) provides a more recent estimates for U.S. short-term interest rates.

We begin by presenting the estimated equation as a autoregressive distributed lag (ARDL) model, which includes changes in broad money as the dependent variable, its own lags, current and lagged values of explanatory variables (in difference form), and a linear combination of lagged levels of dependent and explanatory variables.

$$\Delta(m_t - p_t) = c_0 + c_1 t + \alpha(m_{t-1} - p_{t-1}) + \delta' X_{t-1} + \Phi' \Delta X_t + \sum_{i=1}^{p-1} \Psi_i' \, \Delta Z_{t-i} + u_t$$

where $m_t = \log (M)_t$ is broad money; p_t= log (P_t) is the consumer price index; X_t is a vector of explanatory variables relevant for explaining movements in money demand (such as a scale variable, usually real income, and interest and exchange rates); Z_t is a vector that contains both $m_t - p_t$ and X_t; and t denotes time trend. The disturbances, denoted by u_t, are assumed to be serially uncorrelated and distributed normally. For this to hold, it is important that the lag order of the underlying VAR is selected appropriately. As noted by Peseran et al. (2001), in such an exercise one needs to be aware of the tradeoff that exists between including a sufficient number of lags to mitigate residual serial correlation and the risk of over-parameterization of the ADL.

The estimation proceeds in stages. In the first stage, we specify the optimal lag length for the model (in this stage, we impose the same number of lags on all variables as in Pesaran et al. (2001)). We employ the Akaike's and Schwarz's Baysian information criteria to guide our choice of the lag length. For the test of serial correlation in the residual, we use the maximum likelihood statistics for the first and fourth autocorrelation.

In addition to the income (or scale) variable, we included in the money demand model the nominal effective exchange rate and several opportunity costs variables. The opportunity cost variables comprise the domestic deposit interest rate, which measures the return to bank deposits, the cedi treasury bill interest rate, which measures the return to an alternative financial investment in Ghana, the U.S. treasury bill interest rate, and the U.S. dollar Libor interest rate, which measure the return to foreign currency investments. The financial variables failed to produce statistically significant parameter estimates in the money demand model. Moreover, the nominal effective exchange rate performed better than the U.S. dollar exchange rate of Ghana cedi. The empirical fit for the broad money aggregate inclusive of foreign currency deposits was better than the fit of a monetary aggregate that did not include these deposit liabilities. In what follows, we only report the results for a model comprising broad money aggregate inclusive of foreign currency deposits, income and nominal effective exchange rate variables.

The results that will guide us in selecting the lag order are reported in Table 2.[7] The results from the Akaike's and Schwarz's Baysian information criteria are relatively similar

[7] The marginal significance levels are as follows: "***" refers to 1 percent significance level, "**" refers to 5 percent significance level, and "*" refers to 10 percent significance level.

between models with and without a deterministic trend. They strongly suggest that including four lags would best minimize significant serial correlations in residuals.

Table 2. Statistics for Selecting Lag Order

	No deterministic trend						Deterministic trend					
Lags	AIC	SBC	LM(1)		LM(4)		AIC	SBC	LM(1)		LM(4)	
1	-2.1	-1.8	11.5	***	35.4	***	-2.1	-1.8	0.8		26.3	***
2	-2.2	-1.8	41.0	***	24.6	***	-2.2	-1.8	29.5	***	23.8	***
3	-2.7	-2.2	14.6	***	8.4	***	-2.7	-2.2	15.4	***	8.4	***
4	-3.8	-3.2	0.0		1.1		-3.8	-3.2	0.1		1.2	
5	-3.7	-3.1	1.7	*	1.9	**	-3.7	-3.0	1.3		1.9	**

Source: authors' estimates.

Next we test for the existence of a long-run relation between money and its components. These test results are reported in Table 3 for models with four or five lags. The critical values for the bounds tests depend on whether an intercept and/or trend is included in the estimations. The F-test is for the null hypothesis that all the parameter estimates of the level equation are jointly statistically not different from zero, that is, no long-run money demand equation exist. The t-test is for the null hypothesis that the parameter estimate of the level real money variable is statistically not different from zero. The tests were conducted for models with or without a trend (an intercept was always included). The results for F-tests are similar for all models and reject the null hypothesis at 1 percent significance level. When testing for the significance of the parameter estimate of the real money variable, the results point in favor of a model with four lags and no trend. Furthermore, we may conclude that the null hypothesis of no long-run equation for money demand is conclusively rejected at lag length of four or five in a model where there is no trend. Critical values of these statistics are provided in Peseran et al. (2001).

Table 3. F- and t-Statistics for Testing the Existence of the Long-Run Model

	No deterministic trend Unrestricted intercept		Deterministic trend Unrestricted intercept	
Lags	F-test	t-test	F-test	t-test
4	7.05 ***	-4.53 **	7.58 ***	-3.87
5	5.38 ***	-4.00 *	5.78 ***	-3.33

Source: authors' estimates.

As indicated by Peseran et al. (2001), the lag length for each variable need not be identical except for the identification purposes above. We therefore select a more parsimonious model for the long-run money demand, using the Akaike information criterion as a guide. This results in ARDL(6, 8, 4) where the corresponding lags for real money, income, and nominal exchange rate are shown in the bracket, respectively. The parameter estimates are reported in Table 4. This model shows that the income elasticity in the long-run money demand equation is equal to 1.75, which is in line with the results for other countries (see, for instance, Nell (2003) for South Africa). The parameter estimate with respect to nominal effective exchange rate is equal to - 2.6 and confirms that movements in the exchange rate have a significant impact on the demand for broad money in Ghana.[8] That is, currency depreciation increases the demand for money as foreign currency deposit liabilities increase in value in units of domestic currency (Ghanaian cedi). This valuation effect is likely to be compounded by the substitution effect, as local residents shift from cedi-denominated deposits to foreign currency denominated deposits with a weakening currency (the opposite would be true when the local currency is stronger).

[8] Please note that an increase (a decrease) in the nominal effective exchange rate points to an appreciation (depreciation).

Table 4. The Estimated Long-Run Money Demand

	Parameter	Error	t-Stat.	Probab.
Log(M2+/P)	-0.14	0.04	-3.17	0.00
Log(y)	0.25	0.08	3.17	0.00
D_Log(NEER)	-0.37	0.18	-2.04	0.05
Constant	-0.64	0.20	-3.13	0.00

Source: authors' estimates.

In order to examine short-term dynamics of the model, we estimate an error-correction model associated with the above long-run money demand function. These results are reported in Table 5. The test statistics do not point to any problems with the empirical fit. The estimation results provide evidence of the complex dynamics and relatively long effects that seem to exist between money demand and its determinants. The estimated coefficient of the mean-reversion term is -0.47, which suggests that any disequilibrium would be substantially reduced within one-year time frame, which is relatively fast. Notice that the short-run income elasticity is close to one, which may suggest that individuals prefer to hold money balances as a store of value. This parameter estimate is somewhat larger than reported in Bahmani-Oskooee and Gelan (2009) for a group of African countries (their sample also includes Ghana), but Nell (2003) reports for South Africa estimates of income elasticity that exceed one. The outcome also suggests that there is an initial overshooting to money demand from changes in real income as the estimated short-run parameters sum up to 0.39. Regarding the exchange rate, the initial short-run effect is quite small[9] (estimated at -0.14), but the compounded effect over five quarters totals -0.76.

[9] Bahmani-Oskooee and Gelan (2009) also report small parameter estimates for exchange rate in African countries. See also Akinlo (2005) for Nigeria.

Table 5. Equilibrium Error-Correction Form of the ARDL(6, 8, 4)

Variable	Lags	Coefficient	Error	t-Stat.	Prob.
D_Log(m2+/p)	1	0.29	0.22	1.36	0.18
	2	0.08	0.11	0.67	0.51
	3	-0.08	0.08	-1.02	0.31
	4	0.79	0.08	10.27	0.00
	5	-0.39	0.18	-2.14	0.04
	6	-0.22	0.12	-1.76	0.08
D_Log(y)	0	0.97	0.17	5.66	0.00
	1	-0.32	0.29	-1.10	0.28
	2	0.07	0.22	0.31	0.76
	3	0.09	0.19	0.45	0.66
	4	-1.07	0.18	-5.78	0.00
	5	0.54	0.27	2.03	0.05
	6	-0.28	0.22	-1.29	0.20
	7	0.85	0.20	4.17	0.00
	8	-0.46	0.19	-2.44	0.02
D2_Log(NEER)	0	-0.14	0.08	-1.71	0.09
	1	-0.34	0.09	-3.76	0.00
	2	-0.07	0.10	-0.68	0.50
	3	-0.12	0.10	-1.18	0.24
	4	0.11	0.11	1.05	0.30
	5	-0.21	0.10	-2.18	0.03
EC_term	1	-0.47	0.26	-1.78	0.08
Constant		0.01	0.01	1.03	0.31

R-squared	0.91	Mean dependent var	0.03
Adjusted R-squared	0.87	S.D. dependent var	0.08
S.E. of regression	0.03	Akaike info criterion	-3.88
Sum squared resid	0.04	Schwarz criterion	-3.14
Log likelihood	158.72	Hannan-Quinn criter.	-3.58
F-statistic	21.68	Durbin-Watson stat	1.87
Prob(F-statistic)	0.00		

Source: authors' estimates.

Finally, we wish to examine the stability of long-run coefficients using the CUSUM and CUSUM squares tests (Figures 2 and 3). These tests are applied recursively to the residuals of the error-correction model shown in Table 5. Since the test statistics remain within their critical values (at 5 percent marginal significance level), we are able to confirm the stability of the estimated money demand equation.

IV. CONCLUSIONS

The purpose of this study was to re-examine the stability of Ghana's money demand for the period 1990Q1 through 2009Q4. During this period, Ghana's financial markets went through substantial changes as the authorities took determined steps to implement market-based financial reforms. Furthermore, the monetary operating framework was shifted from reserve money targeting to inflation targeting (effectively starting in 2004 and officially as of 2007). Ghana also became increasingly open for capital inflows as non-residents investors have actively participated in the country's treasury bond market. These changes have led to substantial volatility in the data. Thus an important question, that is addressed in this paper, is whether money demand remained stable during these changes. The evidence in earlier studies has been inconclusive on the effects of financial sector reforms on money demand, both for Ghana and for emerging and developing countries.

We conclude that despite considerable volatility in the data, we find a stable money demand function in Ghana for this period as estimated using the Peseran et al. (2001) bounds testing approach.[10] Key determinants of money demand are real income and exchange rate, while other financial variables were found insignificant in the estimation. The importance of the exchange rate for money demand in Ghana is consistent with other studies for developing countries and points to the importance of currency substitution and valuation effects. The failure to establish a statistically significant effect from interest rates to money demand is worth pointing out since this may suggest that financial markets are yet to play an important role in the public's financial decisions. This is clearly an avenue worth pursuing further in the future.

Do our findings suggest that broad money should play a more prominent role in the conduct of monetary policy? In Ghana monetary policy is implemented in the context of an inflation-targeting arrangement where the operating target of monetary policy is a short-term money market interest rate. The effectiveness of monetary policy therefore does not rest on the stability of money velocity or the monetary transmission mechanism. Money and credit aggregates are reviewed by the monetary policy committee to assess the stance of monetary policy, along with other financial and real sector information. However, in order for money to be useful for monetary policy, it needs to contain information helpful in forecasting future changes in the price level. Having a stable money demand relation, by itself, does not allow one to reach that conclusion. Empirical studies suggest that the information value of money is likely to be quite limited in most cases (see, for instance, Nell (2003) and Todani (2007),

[10] Earlier studies on Ghana have provided mixed results regarding money demand stability (see Section II).

who conclude for South Africa that money has a limited information content in predicting future price changes). Whether this is also the case in Ghana is left for future research.[11]

[11] In recent times, a rapid money growth has been observed in the midst of falling inflation in Ghana.

REFERENCES

Addison, Ernest,2008, "Lessons from Inflation-Targeting Developing Countries: The Case of Ghana," International Symposium on Monetary Policy and Price Stability in the West African Economic and Monetary Union Zone, Dakar, Senegal.

Akinlo, A Enisan, 2005, "The Stability of Money Demand in Nigeria: An Autoregressive Distributed Lag Approach," *Journal of Policy Modeling*, 28, pp. 445-452.

Amoah, Benjamin and Zakari Mumuni, 2008, "Choice of Monetary Policy Regime in Ghana," Working Paper, Monetary Policy Analysis and Financial Stability Department, WP/BOG-2008/07, Bank of Ghana.

Baharumshah, Ahmad Zubaidi, Siti Hamizah Mohd, and A. Mansur M. Masih, 2009, "The Stability of Money Demand in China: Evidence from the ARDL Model," *Economic Systems*, 33, pp. 231-244.

Bahmani-Oskooee, Mohsen and Abera Gelan, 2009, "How Stable is the Demand for Money in African Countries," *Journal of Economic Studies*, 36(3), pp. 216-235.

Bahmani-Oskooee, Mohsen and Hafez Rehman, 2005, "Stability of the Money Demand Function in Asian Developing Countries," *Applied Economics*, 37, pp. 773-792.

Bawumia, Mahamadu and Philip Abradu-Otoo, 2003, "Monetary Growth, Exchange Rate and Inflation in Ghana: An Error-Correction Analysis," Working Paper, Monetary Policy Analysis and Financial Stability Department, WP/BOG-2003/05, Bank of Ghana.

Buch, Claudia M., 2001, "Money Demand in Hungary and Poland," *Applied Economics*, 33, pp. 989-999.

Ghartey, Edward E., 1998, "Monetary Dynamics in Ghana: Evidence from Cointegration, Error Correction Modeling, and Exogeneity," *Journal of Development Economics*, 57, pp. 473-486.

Gil-Alana, 2004, "Modeling U.S. Interest Rates In Terms of I(d) Statistical Models," *The Quarterly Review of Economics and Finance*," 44, pp. 475-86.

Knell, Markus and Helmut Stix, 2006, "Three Decades of Money Demand Studies: Differences and Similarities," *Applied Economics*, 38, pp. 805-818.

Lee, Chien-Chiang and Mei-Se Chien, 2008, "Stability of Money Demand Function Revisited in China," *Applied Economics*, 40, pp. 3185-3197.

Mishkin, Frederic S., 1999, "International Experiences With Different Monetary Policy Regimes," *Journal of Monetary Economics*, 43, pp. 579-605.

Nell, Kevin S., 2003, "The Stability of M3 Money Demand and Monetary Growth Targets: The Case of South Africa," *The Journal of Development Studies*, 39(3), pp. 151-180.

Pesaran, M. Hashem, Yongcheol Shin, and Richard J. Smith, 2001, "Bounds Testing Approaches to the Analysis of Level Relationships, *"Journal of Applied Econometrics*, 16(3), pp. 289-326.

Pradhan, Basanta K. and Arvind Subramanian, 2003, "On the Stability of Demand for Money in A Developing Economy: Some Empirical Issues," *Journal of Development Economics*, 72, pp. 335-351.

Rose, Andrew K., 1988, "Is the Real Interest Rate Stable?," *Journal of Finance*, 43, pp. 1095–1112.

Sriram, Subramanian S., 2001, "A Survey of Recent Empirical Money Demand Studies," *Staff Papers*, International Monetary Fund, 47(3), pp. 334-365.

Todani, K.R., 2007, "Long-Run M3 Demand in South Africa: A Cointegration VAR Model," *South African Journal of Economics*, 75(4), pp. 681-692.

Wu, Ge, 2009, "Broad Money Demand and Asset Substitution in China," IMF Working Papers, 09/131 (Washington: International Monetary Fund).

Figure 1. Selected Data, 1990Q1–2009Q4

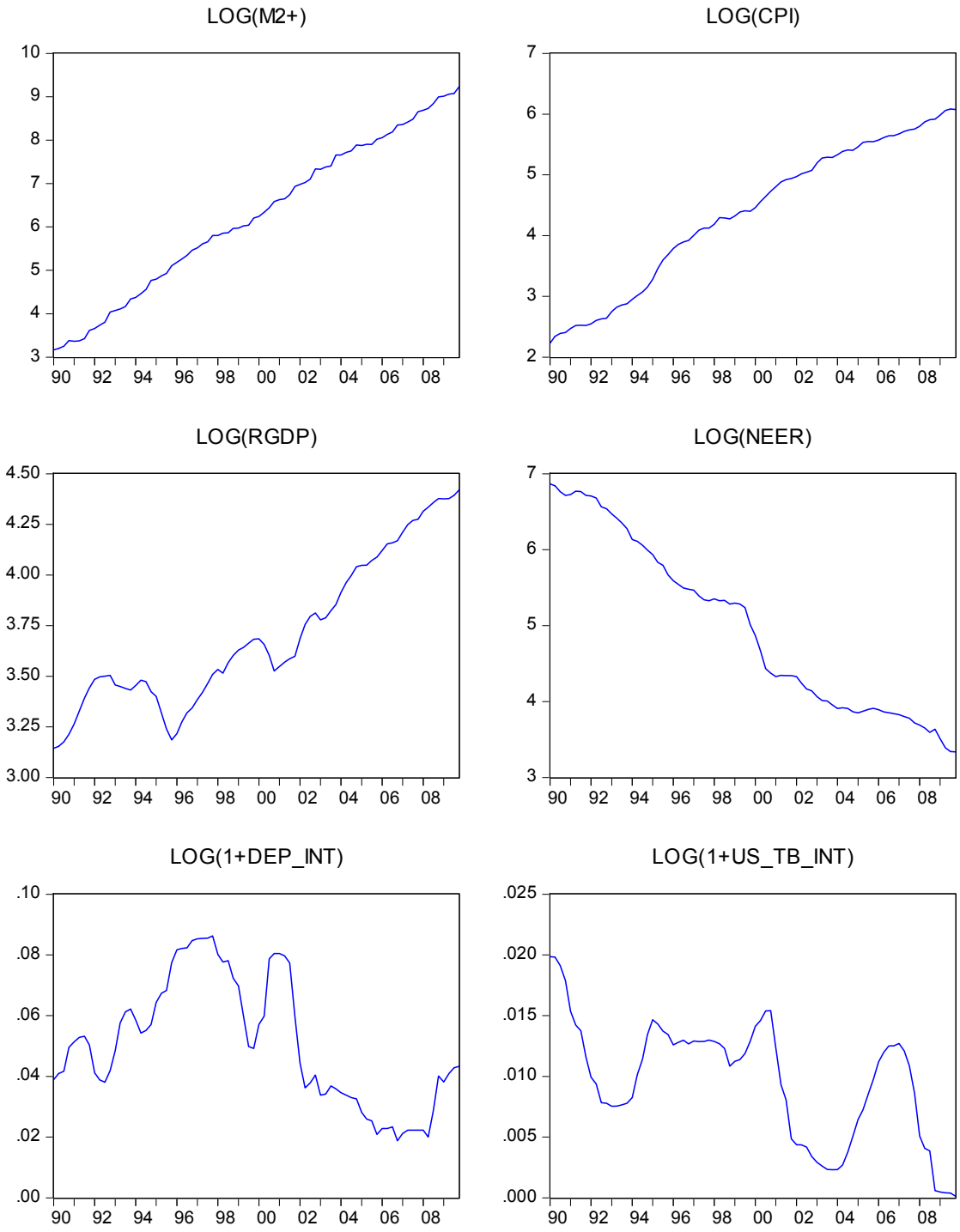


Figure 2. CUSUM Test

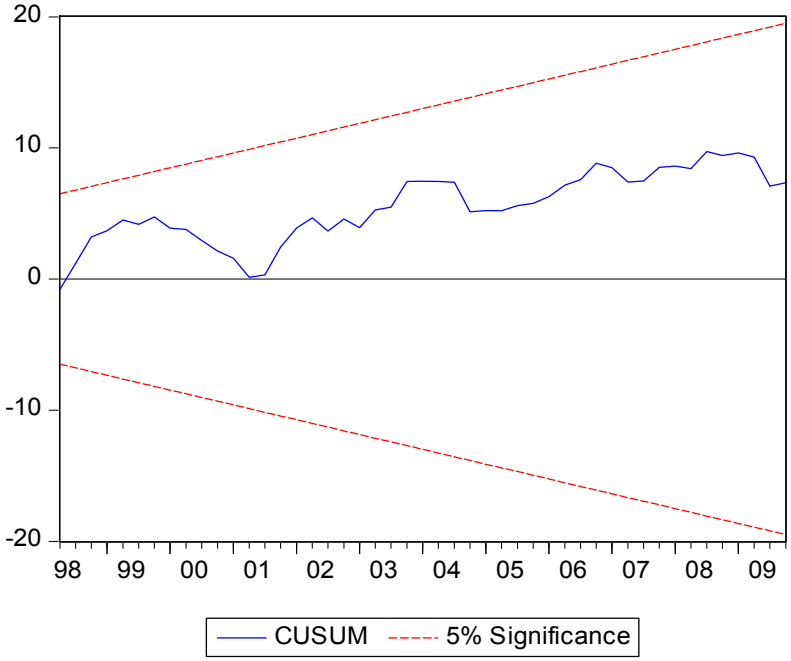
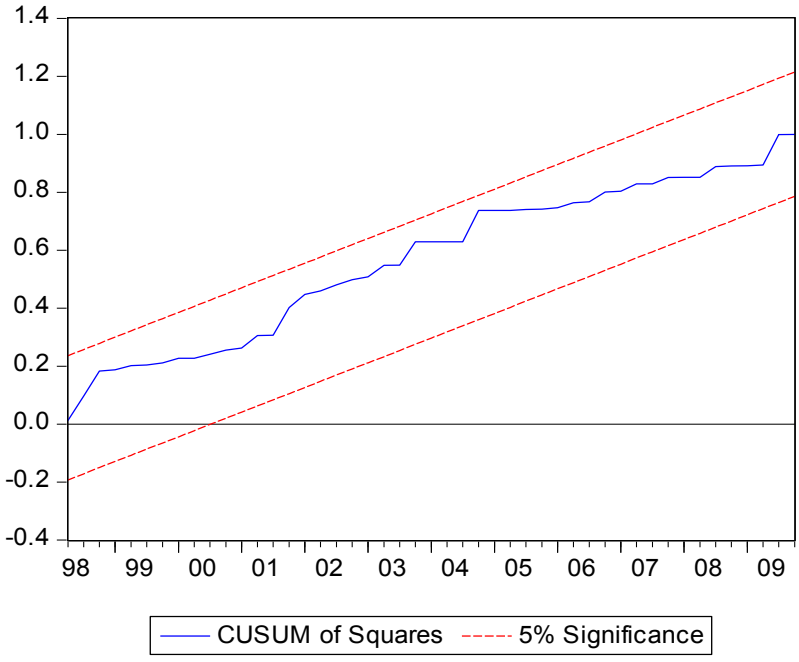


Figure 3. CUSUM of Squares Test



Appendix Table 1. Summary Statistics, 1990Q1–2009Q4

	D(LOG M2)	D(LOG M2+)	VELOCITY	LOG(1+DEP_INT)	LOG(1+TB_INT)	LOG(RGDP)	INFL
Mean	0.07	0.08	6.44	0.05	0.06	3.71	0.05
Median	0.05	0.06	6.19	0.05	0.06	3.60	0.04
Maximum	0.30	0.25	11.98	0.09	0.11	4.42	0.18
Minimum	-0.04	-0.02	3.60	0.02	0.02	3.15	-0.02
Std. Dev.	0.08	0.06	1.99	0.02	0.02	0.36	0.04
Skewness	1.03	0.91	0.99	0.24	-0.02	0.50	0.68
Kurtosis	3.52	3.16	3.40	1.84	2.09	2.04	3.42
Jarque-Bera	14.9	10.9	13.5	5.2	2.8	6.4	6.7
Probability	0.0	0.0	0.0	0.1	0.3	0.0	0.0
Sum	5.8	6.1	509.1	4.0	5.1	293.3	3.8
Sum Sq. Dev.	0.4	0.3	307.8	0.0	0.0	10.4	0.1
Observations	79	79	79	79	79	79	79

Sources: Ghanaian authorities and authors' calculations.

Appendix Table 2. Data Definitions

Variable	Definition
M2	Broad money, excluding foreign currency deposits (in millions of cedis)
M2+	Broad money, including foreign currency deposits (in millions of cedis)
P	Consumer price index (100 = 2000)
Y	Real GDP (in millions of cedis)
NEER	Nominal effective exchange rate index (100 = 2000)
Deposit rate	Average deposit interest rate offered by banks (annual percentage)
TB rate	Three-month treasury bill interest rate (annual percentage)
US TB rate	Three-month treasury bill interest rate (annual percentage)
USD Libor	Three-month U.S. Libor interest rate (annual percentage)
GH¢/USD	The exchange rate of Ghanaian cedi against the U.S. dollar.
Velocity	Ratio Y/M2+

Sources: Ghanaian authorities and authors' estimates.