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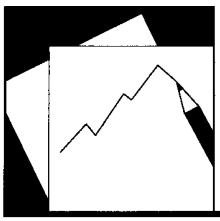

IMF Working Paper

Does Money Matter for Inflation in Ghana?

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Abstract

Money has only limited information value for future inflation in Ghana over a typical monetary policy implementation horizon (four to eight quarters). On the other hand, currency depreciation and demand pressures (as measured by the output gap) are shown to be important predictors of future price changes. Inflation inertia is high and inflation expectations are largely based on backward-looking information, suggesting that inflation expectations are not well anchored and hence more is needed to strengthen the credibility of Ghana's inflation-targeting regime.[1]

JEL Classification Numbers: E31, E41, and E58

Keywords: money demand, monetary policy credibility, inflation-targeting

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[1] The paper benefitted from comments by Peter Allum and the Bank of Ghana staff, which are well appreciated. Any remaining errors are author's responsibility.

I. INTRODUCTION

Since early 1980s, Ghanaian authorities have taken important steps towards developing their financial markets. Prompted by widening structural imbalances during the 1970s, caused by inconsistent macroeconomic policies that undermined output growth and macroeconomic stability, which then led to widening domestic and external balances, currency misalignment and high inflation, Ghanaian authorities have progressive dismantled exchange and credit controls since early 1980s. Ghana's exchange rate was realigned through a series of discrete devaluations, which enhanced competitiveness and eliminated large parallel market premiums. These were followed by steps to develop the local foreign exchange market, while the Bank of Ghana, the country's central bank, shifted to indirect control of liquidity and introduced open market operations in early 1990s. Treasury and central bank bills were introduced a few years earlier.

Market-oriented reforms led to a more open financial system and the rapid expansion of banking activities. During the latest decade, the second stage of financial reforms was launched, leading to the modernization of banking laws, further liberalization of the exchange system, including a partial liberalization of Ghana's external capital account, and shift to a floating exchange rate regime. As a result of these reforms, foreign investors have gained access to the longer-end of Ghana's domestic bond market while Ghanaian residents are permitted to hold foreign currency denominated bank accounts. The exchange rate is largely determined by market forces and the monetary authorities do not target a particular level of exchange rate as monetary policy is focused on inflation targeting. Domestic capital markets have started to develop, albeit still being nascent and shallow, and new investment options are being offered to the Ghanaians (such as corporate equities, treasury bills and bonds). Furthermore, new payment instruments, including credit and debit cards, are making inroads into the Ghanaian economy, which together with modern payment technology and electronic banking services are reducing the demand for cash in daily transactions and helping to expand banking services to rural areas.

As a result of the fundamental changes in Ghana's financial markets and operating environment, the authorities decided to modernize the institutional settings for monetary policy implementation. The 2002 Bank of Ghana Act was aimed at strengthening the independence of the country's central bank to conduct monetary policy while mandating it to adopt price stability as the primary objective of monetary policy (in the central bank law, growth and exchange rate stability are seconded to the price stability objective). Furthermore, monetary policy committee was established in 2002 and charged with the responsibility of formulating Ghana's monetary policy. In the period preceding the move to formal inflation targeting, which was announced in May 2007, the Bank of Ghana developed the institutional structures necessary for the implementation of its inflation targeting regime (Addison, 2008). During this transition period the central bank moved away from the previous framework focused on targeting reserve money and towards analyzing a broader set of variables and indicators to assess monetary policy.

Significant changes in the financial system can often lead to instability in the demand for money and the monetary transmission mechanism, with the effect of complicating monetary policy implementation. In particular, when a central bank targets a monetary aggregate in such circumstances, such as reserve money, the effectiveness of its target rests on the stability of the monetary transmission process and the constancy of money velocity, which may not remain so in practice. A strong argument for moving to inflation targeting, which does not rely on the stability of money demand, arises in that context (for instance, see Mishkin, 1999). When the relationship between money and inflation is subject to unexpected shifts, monetary targets lose their transparency and ability to accurately signal the monetary authorities' policy stance. This suggests that money may be a poor predictor of future inflation.[2] Others argue, however, that money may still convey important information on future movements in prices and output even when it is no longer a formal policy objective.

Research has tried to answer the question whether money matters for monetary policy implementation, but the evidence is mixed. Issing (2011) makes a forceful argument in favor of money in the aftermath of the global financial crisis, in the context of the European monetary union where broad money growth is one of the "pillars" of monetary policy. He proposes that by giving money a more prominent role in the central bank's policy decisions, it will enhance the policy implementation and contribute to financial stability. Gerlach and Svensson (2003) conclude that money and the output gaps have predictive powers over future inflation in the euro zone, but also point out that the formulation of the money variable is important. That is, the real money gap is shown to contain statistically significant information about future euro zone inflation trends, but broad money growth, used by the European Central Bank, fails to do so. Berger and Stavrev (2008a) find that money contains relevant information for future inflation in the euro area but caution that its marginal contribution to inflation forecast is limited. Scharnagl et al. (2010) show that money enhances the performance of monetary policy reaction function in the euro area and suggest that the information value of money relates to the uncertainty about current real output (this information is only available with a lag). For the United States, Berger and Österholm (2008b) note that the contribution of money to U.S. inflation forecast is limited and has diminished in more recent periods. (see also Bachmeier and Swanson (2005), and Hale and Jordà (2007)). Covering a group of 17 Sub-Saharan African countries, Barnichon and Peiris (2008) show that the real money gap has a statistically significant contemporaneous impact on inflation.[3]

With this in mind, we adopt the following research strategy in this paper to analyze the question for Ghana. Section II reviews Ghana's recent experience with inflation-targeting and

[2] This has been suggested, for instance, by Svensson (1999).

[3] Barnichon and Peiris (2008) employ annual data for the period 1970-2004. They use the General Methods of Moments (GMM) estimation technique to deal with the simultaneity between the same-period inflation and real money gap used in the estimation.

compares it with the experiences of other emerging market inflation-targeting countries. In Sections III and IV, an expectation-augmented Phillips-curve model is developed and estimated, which also incorporates money into the inflation dynamics. A crucial role in our inflation model is assigned for the real money gap, which requires knowledge of long-run demand for money, which we estimate. With these building blocks, we analyze empirically the question whether money has a significant role in Ghana's inflation dynamics. As a by-product, the empirical analysis provides an estimate for monetary policy credibility in Ghana. Section V concludes.

II. GHANA'S EXPERIENCE WITH INFLATION TARGETING

The suitability of inflation-targeting has been subject to intense studies, particularly in countries with less developed financial markets. A number of studies have examined experiences with inflation-targeting frameworks, including for emerging market countries (Rogers, 2010, and Angeriz and Arestis, 2007, for so called "inflation targeting lite" countries). These studies generally praise the performance of inflation-targeting, including in inflation targeting "lite" countries, for contributing to lower inflation expectations and helping in "locking-in" lower inflation. Furthermore, there appears to be consensus towards "flexible" inflation targeting, which takes into account a broader set of indicators, such as the exchange rate, which seems to be more important for emerging market and developing countries (see also Stone et al., 2009). Inflation targeting also appears to cope rather well with commodity price and financial market shocks (Rogers, 2010). An issue that many studies have focused on is whether countries satisfy the preconditions for adopting inflation targeting (see, for instance, Freedman and Ötker-Robe, 2010, and Amato and Gerlach, 2002). The general conclusion is that an inflation-targeting arrangement for implementing monetary policy has been successfully introduced even in countries where the preconditions have not been fully met. In addition, Heintz and Ndikumana (2010), while examining inflation dynamics in Sub-Saharan Africa, point out that monetary policy implementation in Africa needs to recognize inflation dynamics and structural rigidities in the economy and allow a sufficient scope for discretion so that the central bank is able to respond to various demand and supply shocks. The authors acknowledge that inflation-targeting improves monetary policy transparency and accountability, but caution against its strict application which could risk undermining long-term developmental objectives.

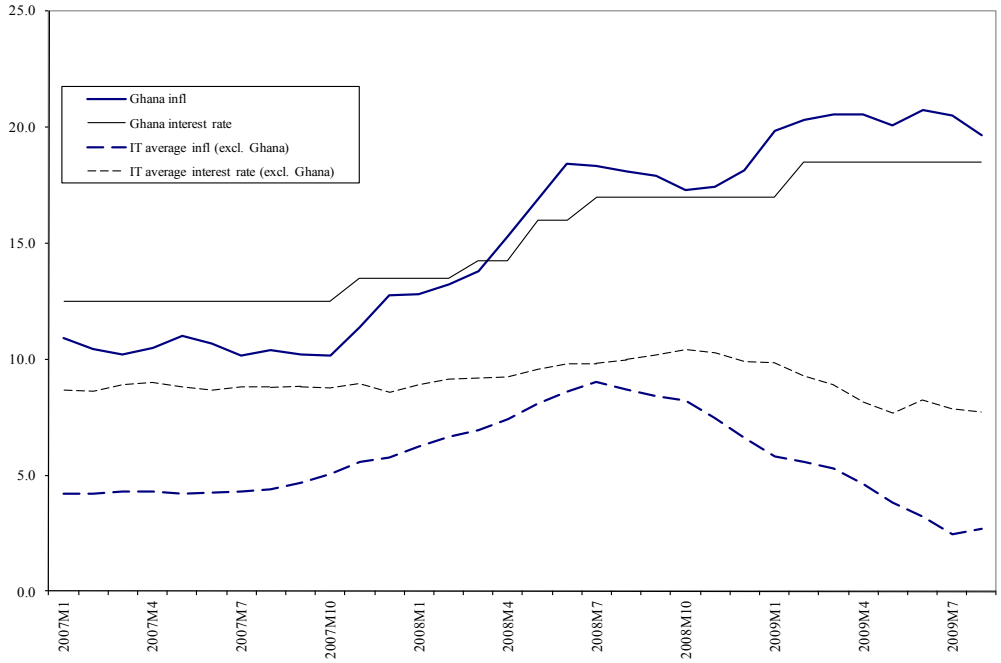
For Ghana, the early experience with inflation targeting has been less than satisfactory. Inflation rose from around 10 percent in mid-2007, when formal inflation-targeting framework was adopted, to more than 20 percent by early 2009. Inflation in Ghana started to recede towards the end of 2009 and has remained in single-digit levels since mid-2010, which has permitted the Bank of Ghana to ease monetary policy significantly. Compared to other inflation-targeting countries, accommodative domestic policies contributed to higher inflation outcomes in Ghana (Table 1). Other inflation-targeting emerging market countries were able to contain domestic inflationary pressures from higher global food and energy prices better in part because of tighter monetary policies, which then allowed them to start monetary policy easing earlier than in Ghana (Figure 1).

Table 1. Comparing Inflation Performances of Selected IT Countries

		Year-on-year inflation (in percent)					
	IT adopted (T)	T-1q	T+8q	Change	2007q1	2009q2	Change
Group I							
Hungary	2001q2	10.5	4.3	-6.2	9.0	3.7	-5.3
Poland	1998q4	10.4	8.5	-1.9	2.4	3.9	1.5
Israel	1997q2	10.4	5.9	-4.5	-0.9	3.6	4.5
Czech Republic	1998q1	10.0	3.9	-6.1	2.0	1.2	-0.8
Romania	2005q3	9.6	3.7	-5.9	3.7	5.9	2.2
Colombia	1999q3	9.0	8.0	-1.0	5.8	3.8	-2.0
Mexico	2001q1	8.9	5.6	-3.3	4.2	5.7	1.5
Indonesia	2005q3	7.4	6.5	-0.9	6.5	3.7	-2.9
Group II							
Slovak Republic	2005q1	6.0	2.7	-3.3	2.7	1.8	-1.0
Philippines	2002q1	4.5	4.1	-0.4	2.2	1.5	-0.7
Chile	1999q3	3.8	3.9	0.2	2.6	1.9	-0.7
Korea, Republic of	2001q1	3.2	4.5	1.3	2.2	2.0	-0.2
Brazil	1999q2	3.0	7.3	4.3	3.0	4.8	1.8
South Africa	2000q1	2.2	6.0	3.8	5.3	7.1	1.8
Thailand	2000q2	1.2	0.4	-0.9	2.0	-4.0	-6.0
Peru	2002q1	-0.1	2.8	2.9	0.2	3.0	2.8
Average (both groups)		6.2	4.9	-1.4	3.3	3.1	-0.2
Group I		9.5	5.8	-3.7	4.1	3.9	-0.1
Group II		3.0	4.0	1.0	2.5	2.3	-0.3
Ghana	2007q2 (May)	10.2	20.7	10.5	10.2	20.7	10.5
Ghana	2002q3 (MPC formed)	13.7	12.6	-1.1	…	…	…

Source: IMF, International Financial Statistics and staff estimates.

Figure 1. Inflation Outcomes and Policy Interest Rates of Selected IT Countries



III. POLICY CREDIBILITY AND INFLATION EXPECTATIONS

In this section, we develop a generic model to describe how the public formulates its inflation expectations and how these expectations may be related to monetary policy credibility. The key outcome of this section is that in a country with weak monetary policy credibility the public puts a larger weight on past events in the formulation of inflation expectations. Inflation expectations are consequently backward-looking and subject to a high degree of inertia because the expectations are revised only gradually based on actual inflation outcomes. When monetary policy is credible and the public has a lot of confidence on the monetary authorities' inflation objective, inflation expectations are significantly anchored to the stated inflation objective. As a consequence, temporary price shocks have only limited influences on inflation expectations.

Let us begin with a Phillips curve of the following form:

$$\pi_{4,t+1} = \pi^{e}_{4,t+1,t} + \alpha_y(y_t - y^*_t) + \alpha_z z_t + \varepsilon_{1,t+1} \qquad (1)$$

where $\pi_{4,t+1}$ is the four-quarter change in the consumer price index at period t+1, $\pi^{e}_{4,t+1,t}$ is the four-quarter expected inflation at t+1, based on information available at t, and y_t is the current quarter real output and y^*_t is the current trend output (estimated with a Hodrick-Prescott filter). The output gap measures the effects of demand pressures on inflation. We include z_t to denote other exogenous indicators that may be of relevance for forecasting future inflation (such as a real money gap and the exchange rate), while $\varepsilon_{1,t+1}$ is a normally distributed error term.

To make the Phillips curve equation operational, we need to specify how inflation expectations are formed in the economy. In the case of Ghana, data limitations prevent us from using actual, survey-based data for inflation expectations since such data are only available for a short period of time in Ghana. Therefore, we have to develop a proxy for inflation expectations. For a forward-looking Phillips curve, it is often assumed that expectations are formed rationally. We follow Gerlach and Svensson (2003) who assume that public's inflation expectations will depend on the central bank's implicit inflation objective and the credibility of this objective. We may think that the implicit inflation objective is the inflation rate that the public believes is acceptable to the monetary authorities (however, this may not be true or the implicit inflation objective may differ from the monetary authorities' formal inflation target that is not disclosed to the public). While this sounds somewhat arbitrary, it proves to be a reasonable and simple approximation that describe the formulation of inflation expectations in an economy such as Ghana. More formally, public's inflation expectations are formulated as follows:

$$\pi^{e}_{4,t+1,t} = \pi^{obj}_{4,t+1} + \alpha_{\pi}(\pi_t - \pi^{obj}_{4,t}) \qquad (2)$$

where $\pi^{obj}_{4,t}$ is what the public believes to be the central bank's implicit four-quarter inflation objective in period t. The implicit inflation objective may be time-varying, as in Gerlach and Svensson (2003), or constant. One possible approach is to assume, due to the lack of actual data on central bank's inflation target, that the implicit inflation objective is described by the underlying inflation trend in the data (for instance, estimated by a Hodrick-Prescott filter), which would then allow for time-variation in the inflation objective. However, this assumes that the monetary authorities' inflation objective is adjusted continuously, which is unlikely to be the case. Furthermore, it is difficult to time the discrete adjustments to the inflation objective without actual data on the Bank of Ghana's inflation target. A simpler way to generate inflation expectations is to assume that the monetary authorities' inflation objective remains constant (in the absence of data, we assume that the Bank of Ghana's twelve-month inflation objective is 10 percent, that is, $\pi^{obj}_{4,t} = 0.1$, for the estimation period). Both measures produce similar inflation expectations: when actual inflation rises, the public raises their inflation expectations because they observe that the monetary authorities accommodate higher actual inflation. This can occur either because the inflation target has been increased or because the monetary authorities allow inflation to exceed their constant inflation target. Weak credibility of the monetary authorities' inflation objective would therefore arise from ex post deviations from the inflation objective or frequent adjustments to the inflation objective. Therefore, the outcome with regard inflation expectations would not be very different for policy credibility whichever method we choose. Reflecting this discussion, it would be appropriate to assume that high inflation expectations more likely reflect weak monetary policy credibility (i.e., large deviations from the implicit inflation objective) than high target rate of inflation. A constant inflation objective performs better in the estimation and captures the essence of inflation dynamics.

The parameter α_π in equation (2) measures how much inflation expectations would be influenced by past inflation outturns relative to the targeted rate of inflation. When monetary policy is fully credible (that is, α_π= 0), inflation expectations are completely anchored to the central bank's inflation objective. Then ex post deviations from the inflation target would not matter for inflation expectations because the public expects that the monetary authorities are fully committed to their inflation target.[4] When the anchoring of monetary policy is weak (that is, α_π is large), inflation expectations would be influenced significantly by past inflation trends. Then past deviations from the implicit inflation objective become persistent for shaping public's inflation expectations. An important consequence of such lack of policy credibility is that inflation expectations depend largely on backward-looking inflation outturns and display high degree of inertia.

IV. Is There a Role for Money in Inflation Dynamics?

In order to answer this question empirically, we need to introduce a relationship that allows us to measure the impact of money on future movements in prices independently of its effect through other determinants, such as changes in the output gap. By combining equations (1) and (2), and replacing z_t in equation (1) with two money gap indicators and currency depreciation (which is measured by changes in the nominal exchange rate and serves as a proxy for imported inflation), we obtain a formulation that may be estimated using standard estimation techniques.[5] This equation underpins our interest in finding out how informative money is for future inflation.

$$\pi_{t+1} - \pi_{t+1}^{obj} = \alpha_\pi\left(\pi_t - \pi_t^{obj}\right) + \alpha_y(y_t - y_t^*) + \propto_m (m_t - m_t^*)$$

$$+ \beta_m(\Delta_4 log M_t - \Delta_4 log M_t^*) + \gamma \Delta log E_t + \varepsilon_{2,t+1} \qquad (3)$$

We have included in equation (3) lagged inflation gap ($\pi_t - \pi_t^{obj}$), which captures inertia in the inflation equation, output gap ($y_t - y_t^*$), real money gap ($m_t - m_t^*$), nominal money growth gap ($\Delta_4 log M_t - \Delta_4 log M_t^*$), and currency depreciation (change in the nominal exchange rate, $\Delta log E_t$). The term m_t denotes real broad money stock (M_t/P_t, where M_t is the nominal broad money stock (includes foreign currency deposits) and P_t is the price level) and the term m_t^* is the long-run optimal real broad money stock. The second money gap term attempts to reflect the importance of nominal money growth for future inflation, where $\Delta_4 log M_t$ is the four-quarter change in the nominal broad money stock whereas $\Delta_4 log M_t^*$ is the four-quarter change in the

[4] This has been argued, for instance, in the case of U.S. monetary policy.

[5] Changes in the exchange rate are important for domestic price movements in many developing countries, including Ghana, and hence it is expected to convey information about future changes in prices. We drop the index to four-quarter changes, which is understood to be the case.

optimal nominal broad money stock ($\Delta_4 log M_t^* = \Delta_4 m_t^* + \pi_t^{obj}$). With some reorganization, this equation can be rewritten as follows, allowing us to explain future inflation gaps in terms of inertia, output gap, real money gaps, change in the real money gap, and currency depreciation:

$$\pi_{t+1} - \pi_{t+1}^{obj} = (\alpha_\pi + \beta_m)(\pi_t - \pi_t^{obj}) + \alpha_y(y_t - y_t^*) + \propto_m (m_t - m_t^*)$$

$$+ \beta_m(\Delta_4 m_t - \Delta_4 m_t^*) + \gamma \Delta log E_t + \varepsilon_{2,t+1} \quad (4)$$

where the four-quarter change in the real money gap is given by $\Delta_4 m_t - \Delta_4 m_t^*$. In this equation we have two money gaps, which allows to distinguish between levels and changes in the real money gap for the inflation gap. The first is the real money gap, in level, which measures the difference between the real money stock and the optimal real money stock (to be determined in the subsequent section). The related parameter is $\propto_m$ which should receive a positive value. The second term is the change in the real money gap. The parameter associated with this term is β_m, which should receive a positive value and also appears in the first term of equation (4).

Long-Run Demand for Money in Ghana

We begin our empirical analysis by estimating a long-run demand for real broad money in Ghana (denoted by m_t^*). Finding a stable money demand relation is an important first step in giving support for the argument whether money matters for inflation in Ghana. It is, however, not a sufficient condition as it is also required that money aggregates contain information useful for forecasting future inflation. The optimal real money stock (m_t^*) enters equation (4) and is essential for the derivation of the real money gap and the four-quarter change in the real money gap in the above model.

The basic properties of empirical money demand functions are well documented in the literature for a variety of countries and time periods and hence it is unnecessary to dwell deeply into this issue here. Knell and Stix (2006) offer a comprehensive analysis, covering both industrial and developing countries, of the basic properties of empirical money demand functions since the 1970s, while Bahmani-Oskooee and Gelan (2009) analyze the money demand relations of 21 African countries, including Ghana (see also Sriram (2001)). The studies of Nell (2003) and Todani (2007) are relevant for our purposes as these studies establish a stable money demand relation for South Africa, but conclude that money provides little information on future prices movements.

There are only a handful of empirical money demand studies specific to Ghana. These studies differ by the time period, monetary aggregate, data frequency, and model specification chosen for estimation and provide a somewhat mixed picture on whether the demand for money has remained stable. An earlier study by Ghartey (1998) finds a stable demand function for narrow money in Ghana. Andoh and Chappell (2002) show that structural adjustment programs since the 1980s led to structural breaks in the demand for broad money. Bawumia and Abradu-

Otoo (2003) conclude that there is a stable long-run relationship between inflation and broad money in Ghana whereas Amoah and Mumuni (2008) 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 money no longer provides useful information for predicting future inflation and output.

For the purpose of our study, we estimate a long-run demand equation for real broad money (which also includes foreign currency deposits) over the period 1990Q1-2009Q4. The estimation results are provided in Appendix I. Besides providing evidence of strong income elasticity, the results indicate the presence of significant currency substitution. As a result, when Ghanaian cedi depreciates, it leads to an increase in the demand for broad money due to two channels: valuation effect (foreign currency denominated deposit liabilities increase in domestic currency value) and substitution effect (the public shifts from cedi denominated deposits to foreign currency denominated deposits). The evidence for a significant interest rate channel in Ghana was not established in the data, which possibly reflects the fact that financial deepening and the importance of an interest rate channel is a relatively recent phenomenon. Our results are consistent with Dagher and Kovanen (2011) who estimate a similar money demand equation for Ghana using the bound testing approach of Peseran et al. (2001).

Is Money Important for Future Inflation in Ghana?

Answering the question whether money is relevant for inflation in Ghana is the focus of this section. But before estimating equation (4), we first examine the cross-correlations between the inflation gap and its determinants. These are shown in Figure 2. To read this Figure, we note that cross-correlations are measured on the vertical axis (ranging from – 0.8 to 0.8) while the time periods are measured on the horizontal axis (T ranges from -8 to 8 quarters and refers to the period of the inflation gap). When T=0, both the inflation gap and its determinants are of the same period and hence the cross-correlations are contemporaneous. When T receives a positive value, it measure the cross-correlation between the current-period determinant and the relevant future period inflation gap.[6]

For the real money and money growth gaps, the cross-correlations with the inflation gap are rather similar. That is, the same-period cross-correlation are highly positive, but the cross-correlations declines quickly for any T>0, which suggests that the impact is quite instantaneous and short-lived. Given typical lags in monetary policy implementation (four to eight quarters),

[6] To illustrate this, for T=4, the cross-correlation between the inflation gap (at T=4) and real money gap (T=0) is a small negative number (-0.2) in Figure 2, which means that a positive real money gap at period T=0 would have an insignificant impact on the inflation gap at period T=4. For T<0, Figure 2 indicates the effects of past inflation gaps on the current-period determinants. For instance, in period T=-2 the high positive cross-correlation with the money gap (almost 0.6) suggests that a positive inflation gap at T=-2 has a significant impact of the current-period money gap (this could indicate that monetary policy is accommodating past inflation surges).

these two money gap are unlikely to be relevant for monetary policy in Ghana. For the output gap, the contemporaneous cross-correlation with the inflation gap is actually highly negative (around -0.7), which suggests a widening output gap may be associated with a contemporaneous fall in inflation. However, a typical positive cross-correlation becomes apparent after a lag of four quarters. The cross-correlation stabilizes at around 0.2 during the subsequent quarters. This indicates that the information value of the output gap for future inflation is more relevant as the forecast horizon becomes longer, which is consistent with the evidence from other countries.[7] Regarding the exchange rate, the cross-correlations suggest that changes in the nominal exchange rate have a rather immediate impact on the inflation gap, which peaks at T=2 in Figure 2, confirming the rapid rate of pass-through from the exchange rate to domestic prices. The pass-through impact weakens quickly thereafter.[8]

[7] The Bank of Ghana aims to achieve its medium-term inflation target over a horizon of 6-8 quarters.

[8] Please note that a decline (an increase) in the level of the exchange rate refers to a depreciation (appreciation). A negative cross-correlation, therefore, means that a currency depreciation is associated with rising inflation.

Figure 2. Cross-Correlation of Four-Quarter Inflation Gap with Output Gap, Real Money and Money Growth Gaps, and Currency Depreciation

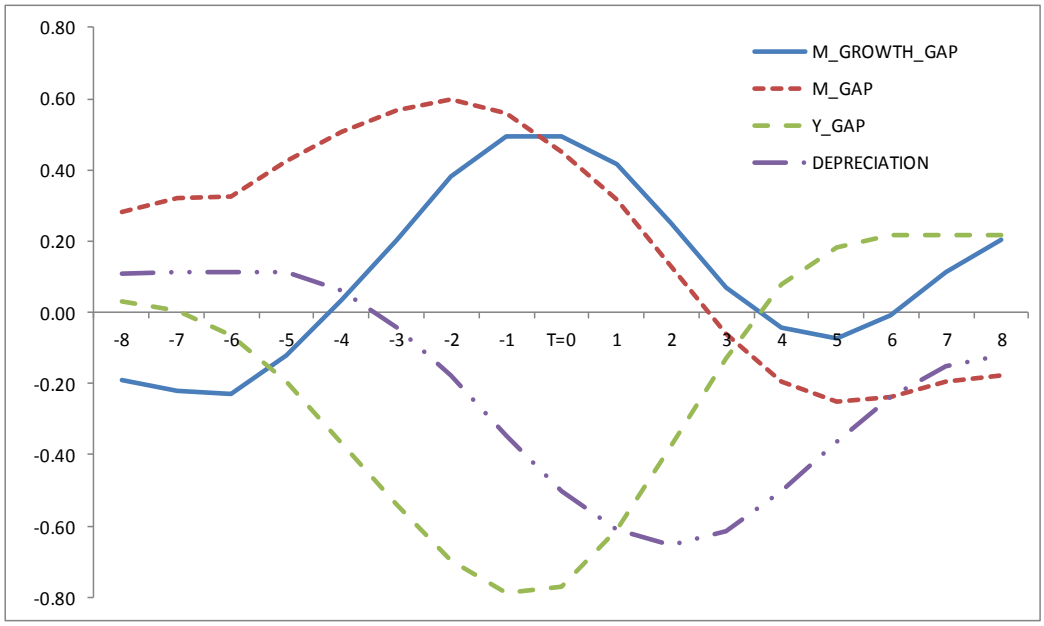


Table 2 reports the estimation results for different inflation gap models at four-quarter and eight-quarter lags.[9] The results confirm the relevance of inflation inertia, the output gap, and depreciation for future inflation. The average parameter estimate of the lagged inflation gap is statistically significant in all models and ranges from 0.52 to 0.97 across four-quarter and eight-quarter lags models. The parameter estimates for the output gap are also statistically significant in all model specifications and average 0.94 across four-quarter lags models and 1.22 across the eight-quarter lags models. Currency depreciation is statistically significant at the four-quarter interval, where the pass-through averages about 20 percent, but not at the eight-quarter interval.

[9] Statistical significances of estimated parameters are denoted as follows: *** = 1 percent, ** = 5 percent, and * = 10 percent marginal significance level. Data is for the period 1990q1 – 2009q4.

Table 2. Estimates of Four and Eight Quarters Ahead Inflation Gap Models

	A	8	C	D	E	F	G	H
Four-quarters ahead	Est. Prob.	Est. Prob.	Est. Prob.	Est. Prob.	Est. Prob.	Est. Prob.	Est. Prob.	Est. Prob.
Independent variable								
INFL_4Q_GAP	0.94 ***	0.86 ***	0.97 ***	0.62 ***	0.62 **	0.65 ***	0.66 ***	0.55 ***
Y_GAP	1.15 ***	0.94 **	1.08 ***	0.92 ***	0.92 **	0.87 **	0.91 *	0.72 ***
M_GAP	...	-0.05	...	...	0.00	...	0.01	...
D_4Q_M_GAP	...	...	-0.04	...	...	-0.03	-0.03	...
D_4Q_NEER	...	...	...	-0.21 **	-0.21 **	-0.20 **	-0.21 **	-0.22 ***
R-squared	0.38	0.40	0.40	0.46	0.46	0.47	0.47	0.45
Adjusted R-squared	0.37	0.38	0.38	0.44	0.44	0.45	0.44	0.43
S.E. of regression	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Sum squared resid	0.46	0.45	0.44	0.40	0.40	0.39	0.39	0.40
Log likelihood	79.71	80.71	79.82	84.53	84.53	84.30	84.35	...
Durbin-Watson stat	0.35	0.34	0.37	0.33	0.33	0.37	0.37	0.35
J statistic	...	...	...	...	...	...	...	0.05
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	GMM

	A	B	C	D	E	F	G	H
Eight-quarters ahead	Est. Prob.	Est. Prob.	Est. Prob.	Est. Prob.	Est. Prob.	Est. Prob.	Est. Prob.	Est. Prob.
Independent variable								
INFL_4Q_GAP	0.90 ***	0.84 ***	0.86 ***	0.91 ***	0.90 ***	0.84 ***	0.78 ***	0.52 ***
Y_GAP	1.29 ***	1.14 ***	1.48 ***	1.30 ***	1.14 ***	1.47 ***	1.12 ***	0.80 ***
M_GAP	...	-0.04	...	...	-0.05	...	-0.14 **	...
D_4Q_M_GAP	...	...	0.09 **	...	...	0.09 **	0.14 ***	0.10 *
D_4Q_NEER	...	...	...	0.01	0.05	-0.01	0.10	...
R-squared	0.26	0.27	0.34	0.26	0.27	0.34	0.41	0.12
Adjusted R-squared	0.25	0.25	0.32	0.24	0.24	0.31	0.37	0.09
S.E. of regression	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.10
Sum squared resid	0.52	0.51	0.47	0.52	0.51	0.47	0.42	0.62
Log likelihood	69.28	69.64	71.40	69.29	69.82	71.41	75.16	...
Durbin-Watson stat	0.36	0.35	0.51	0.36	0.35	0.51	0.51	0.29
J statistic	...	...	...	...	...	...	...	0.08
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	GMM

However, the estimation results for two money gap indicators are rather weak, raising questions about their relevance for monetary policy implementation. This seems to validate the view that money has little statistical significance for explaining future movements in inflation, regardless of the specific form of the money gap indicator. Both money gap indicators fail to obtain statistically significant parameter estimates at the four-quarter interval; however, the real money growth gap indicator receives a statistically significant and positive parameter estimate in all model specifications at the eight-quarter interval (the parameter estimate averages 0.11). The parameter estimate for the real money gap indicator is only statistically significant when both money gap indicators are included in the estimation (at eight-quarter interval; Model G),

but this result is more likely to be caused by the strong cross-correlation between the two money gap indicators and hence should be ignored.

By construction, the causality in the estimated model runs from the determinants dated at period t to the inflation gap dated either at period t+4 or t+8. However, the estimated residuals show significant autocorrelation and heteroscedasticity which could affect the validity of the standard tests. In order to address this issue, we test for the significance of estimated parameters with the Newey-West test statistic which is adjusted for heteroscedasticity and autocorrelation of unknown form. Furthermore, Ramsey's RESET test statistic is also used and is highly significant (not reported). This points to a statistically significant correlation between the explanatory variables and the error term and may be caused by measurement errors in the explanatory variables.[10] This would make the OLS estimates biased and inconsistent. One way to address this problem is to use the Generalized Method of Moments (GMM) estimates, which by construction satisfy the orthogonality condition.[11] These are reported in column H of Table 2 and are very similar to the other results.

The robustness of our estimates was also checked using recursive estimation techniques. This is reasonable given the substantial changes experienced in Ghana's financial markets during the sample period, reflecting reforms undertaken by the authorities, as well shifts in the monetary policy framework (i.e., the sample pre-dates the inflation targeting period). Such changes have the potential to alter relations between the inflation gap and its determinants (most importantly, the money variables). It turns out, however, that the parameter estimates remained remarkably stable, particularly during the second half of the sample, which is the period when the monetary operating framework was changed. Some parameter instability is evident in the 1990s, with macroeconomic instability (associated with more pronounced price and output volatility) likely to have been an important contributing factor.

Comparing our results with those from other studies, we note that demand pressures in Ghana (as measured by the output gap indicator) are transmitted to inflation to a significant degree within four quarters. This is faster that obtained for the euro zone countries by Gerlach and Svensson (2003), where only about one-quarter of the demand pressures are transmitted within four quarters and slightly more within eight quarters. Barnichon and Peiris (2008) report similar results for a group of African countries using annual data. The relatively rapid pass-through of demand pressures to inflation may reflect the importance of supply shocks in Ghana (for instance, due to drought), which have been significant and other have rather immediate

[10] Alternatively, a statistically significant RESET test could be due to omitted variables or misspecification of the functional form of the estimated equation.

[11] Two lags of each explanatory variable were used as instruments. The test statistics are consistent with the presence of heteroscedasticity and autocorrelation of unknown form. The J-statistic tests for overidentification of the model.

effects on the consumer prices, as well as the weak anchoring of inflation expectations, which is evident in the highly significant inflation inertia (the subsequent section will discuss this in more detail). For comparison, the results for the euro zone show that inflation inertia is not a significant driver of future inflation dynamics, but it appears to be an important factor in many African countries (as reported by Barnichon and Peiris, 2008). Third, the empirical evidence for Ghana does not support the presence of a strong money channel for inflation. If anything, real money growth channel shows weak importance for future inflation dynamics. This result differs from Gerlach and Svensson (2003) and Barnichon and Peiris (2008), who demonstrate that the real money gap indicator is important for future inflation in the euro zone and in many African countries. The nominal effective exchange rate, which has not been included in other studies, indicates strong importance from imported inflation in Ghana.

How Credible is Ghana's Monetary Policy?

As we discussed earlier, from equation (2) we can infer information about monetary policy credibility in Ghana (parameter α_π, which we do not estimate directly). Using the results for both four-quarter or eight-quarter lags models, α_π averages 0.63.[12] Using this, the estimate for monetary policy credibility equals $1 - \alpha_\pi$ = 0.44, which is rather low.[13] This indicates that inflation expectations in Ghana are substantially influenced by backward-looking information (see equation (2)). However, this conclusion depends on a number of assumptions, including the way we specified the inflation objective (π^{obj}) and inflation expectations. The estimate for inflation inertia may also be subject to estimation error. Notwithstanding, the results are helpful in highlighting the importance of past inflation outturns in the formulation of public's inflation expectations. Furthermore, by linking this to monetary policy credibility underscores the need to strengthen monetary policy implementation in Ghana.

The linkages between past inflation outcomes and inflation expectations are illustrated in Figure 3. It plots the actual inflation outcomes and the estimate for inflation expectations from our models for the period 2005Q4-2009Q4, as well as the Bank of Ghana's survey-based inflation expectations. The figure shows that when the actual inflation rises (falls), inflation expectations are adjusted upwards (downwards) with a relatively short lag. For instance, in the end of 2009, inflation expectations begun to recede soon after actual inflation started to fall.

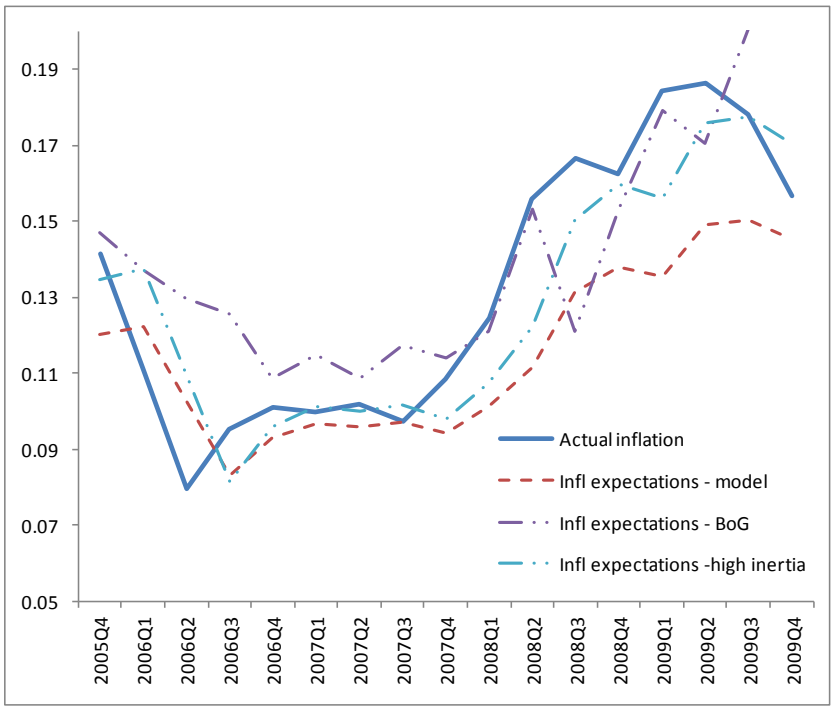
However, our empirical model generates inflation expectations that are lower than the survey-based inflation expectations reported by the Bank of Ghana (Figure 3). This suggests

[12] In the eight-quarter lags models, this is obtained by adjusting for the average estimate of β_m, which equals 0.11 (see equation (4).

[13] Monetary policy credibility is a difficult concept to measure and hence one needs to interpret these results with caution. For instance, surveys of inflation expectations amongst businesses and consumers can provide indications on how well price expectations are aligned with the inflation target.

that the estimated inflation inertia is likely to understate the "true" but unobserved inflation inertia. To illustrate this possibility, we generated inflation expectations using a higher value of α_π = 0.9, which produces an outcome that mimics closely the pattern of survey-based inflation expectations. Also note that the model-based inflation expectations are broadly in line with the actual inflation outturns in 2007, but fell behind in the subsequent period when actual inflation increased rapidly.

Figure 3. Actual and Expected Inflation



V. CONCLUSIONS

This paper examines the question whether money provides useful information for explaining Ghana's inflation dynamics. This is an important issue for monetary policy and has received quite a bit of attention in the literature, including in countries with developed financial markets (such as the euro zone and the United States where monetary policy is implemented through the interest rate channel). The importance of money aggregates in the policy deliberations varies across central banks.[14] The empirical evidence is rather mixed on the usefulness of money for monetary policy implementation.

In Ghana, the interest rate channel has become increasingly important for monetary policy transmission now that monetary policy is implemented in the context of an inflation-targeting arrangement. Notwithstanding, money aggregates remain as part of the information set, along with other financial and real sector data, that are reviewed regularly as monetary policy decisions are made. We find a stable money demand relation for Ghana over the sample period, consistent with the results of Dagher and Kovanen (2011). This could lead to a conclusion that "money targeting" is a suitable monetary policy strategy. However, finding a stable money demand relation does not allow one to conclude, without other evidence, that money provides a useful contribution to the inflation dynamics in Ghana.

Indeed, we find that empirical support for money in the inflation process in Ghana is weak, at best. This result is similar to the results obtained by Nell (2003) and Todani (2007) for South Africa (also an inflation-targeting country) and suggests that despite the finding of a structurally stable money demand function, money no longer remains a reliable indicator of monetary policy. Furthermore, the weak information value for money in Ghana is in line with the empirical evidence for other countries and suggests that its importance is not only limited but likely to decline in the future. Therefore, while the Bank of Ghana might continue to review trends in money aggregates when determining its monetary policy stance, such information is likely to be of limited value and should not be given significant weight in policy deliberations. This conclusion supports Bank of Ghana's inflation-targeting regime, formally adopted in 2007, that underscores the role of the interest rate channel for effective monetary policy transmission. Efforts to strengthen this channel would enhance monetary policy implementation. Our estimation results confirm that the exchange rate and the output gap provide key transmission channels for inflation. The pass-through to domestic prices from exchange rate changes is strong and rapid, underscoring the lingages between a stable exchange rate and price stability in Ghana. The output gap is a proxy for demand pressures

[14] While the European Central Bank has formally assigned a role for broad money in the conduct of monetary policy, money has a more limited role in the monetary policy implementation in the U.S.

and highly relevant for inflation, with an average impact lag to inflation about four to eight quarters.

The empirical results also underscore the importance of monetary policy credibility in Ghana. When inflation expectations are well anchored and determined largely by economic fundamentals, temporary deviations in actual inflation from the policy target have less impact on public's inflation expectations and therefore will reduce the need for monetary policy to adjust to shocks. Ghana's weak policy credibility is imbedded in the estimated high degree of inflation inertia where inflation expectations are determined to a large extent by past inflation outcomes rather than be foreward-looking and based on the monetary authorities' inflation objective (which is known to the public).

There are several areas where further research could be useful. One relates to the modeling of inflation dynamics in Ghana, which is at its infancy. Progress in this area would bring benefits to monetary policy implementation. Another area that needs to be strengthened is data quality, which is particularly weak on real sector activities where all relevant data is not available (e.g., wages and employment) or is available at low frequencies (e.g., annual). The publication of quarterly national accounts by the Ghana Statistical Services, which started in May 2011, is an important step in the right direction.

REFERENCES

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

Amato, Jeffery D. and Stefan Gerlach, 2002, "Inflation Targeting in Emerging Market and Transition Economies: Lessons After A Decade," *European Economic Review*, 46, pp. 781-90.

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.

Andoh, Samuel K. and David Chappell, 2002, "Stability of the Money Demand Function: Evidence from Ghana," *Applied Economics Letters*, 9, pp.875-878.

Angeriz, Alvaro and Philip Arestis, 2007, "Assessing the Performance of Inflation Targeting Lite Countries," The World Economy, pp. 1621-45.

Bachmeier, Lance J. and Norman R. Swanson, 2005, "Predicting Inflation: Does the Quantity Theory Help?," *Economic Inquiry*, 43, pp. 570-85.

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.

Barnichon, Régis and Shanaka J. Peiris, 2008, "Sources of Inflation in Sub-Saharan Africa," *Journal of African Economies*, 17(5), pp. 729-46.

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.

Berger, Helga and Emil Stavrev, 2008a, "The Information Content of Money in Forecasting Euro Area Inflation," IMF Working Papers, 08/166 (Washington: International Monetary Fund).

Berger, Helga and Pär Österholm, 2008b, "Does Money Matter for U.S. Inflation? Evidence from Bayesian VARs," IMF Working Papers, 08/76 (Washington: International Monetary Fund).

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

Dagher, Jihad and Arto Kovanen, 2011, "On the Stability of Money Demand in Ghana: A Bounds Testing Approach," IMF Working Papers, (Washington: International Monetary Fund), forthcoming.

Freedman, Charles and Inci Öther-Robe, 2010, "Important Elements for Inflation Targeting for Emerging Markets," IMF Working Papers, 10/113 (Washington: International Monetary Fund).

Gerlach, Stefan and Lars E.O. Svensson, 2003, "Money and Inflation in the Euro Area: A Case for Monetary Indicators?," *Journal of Monetary Economics*, 50, pp. 1649-72.

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

Hale, Galina and Oscar Jordà, 2007, "Do Monetary Aggregates Help Forecast Inflation?," *Federal Reserve Bank of San Francisco Economic Letter*, 10, pp. 1-3.

Heintz, James and Léonce Ndikumana, 2010, "Is There a Case for Formal Inflation Targeting in Sub-Saharan Africa?," Political Economy Research Institute, Working Papers, 218, March, University of Massachusetts, Amherst, Massachusetts.

Issing, Otmar, 2011, "Lessons for Monetary Policy: What Should the Consensus Be?," IMF Working Papers, 11/97 (Washington: International Monetary Fund).

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.

MacKinnon, James G., 1996, "Numerical Distribution Functions for Unit Root and Cointegration Tests, *"Journal of Applied Econometrics*, 11, pp. 601-18.

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.

Phillips, P.C.B. and P. Perron (1988). "Testing for a Unit Root in Time Series Regression," *Biometrika*, 75, pp. 335–46.

Roger, Scott, 2010, "Inflation Targeting at 20: Achievements and Challenges," IMF Working Papers, 09/236 (Washington: International Monetary Fund).

Scharnagl, Michael, Christina Gerberding, and Franz Seitz, 2010, "Should Monetary Policy Respond to Money Growth? New Results for the Euro Area," *International Finance*, 13(3), pp. 409-41.

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

Stone, Mark, Scott Rogers, Seiichi Shimizu, Anna Nordstrom, Turgut Kişinbay, and Jorge Restrepo, 2009, "The Role of the Exchange Rate in Inflation-Targeting Emerging Economies," IMF Occasional Papers, 267, (Washington: International Monetary Fund).

Svensson, L.E.O., 1999, "Monetary policy Issues For the Eurosystem," Carnegie-Rochester Series on Public Policy, 51-1, pp. 79–136.

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).

APPENDIX I: Model of Long-Run Money Demand

Appendix Table 1: Estimates Parameters of Money Demand

	COINTEGRATION EQ.
M2_PLUS_REAL_LOG(-1)	-1.00
RGDP_LOG(-1)	1.58
STDEV	0.13
T-STAT	11.99
D_NEER(-1)	-3.98
STDEV	1.29
T-STAT	-3.09
DEP_LOG(-1)	-2.91
STDEV	2.55
T-STAT	-1.14
CONSTANT	-4.00

	COINTEGRATION EQ.
ALPHA	-0.11
STDEV	-0.03
T-STAT	-3.36

Appendix Table 2: Trace Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.36	55.06	47.86	0.01
At most 1	0.19	21.93	29.80	0.30
At most 2	0.08	6.37	15.49	0.65
At most 3	0.00	0.21	3.84	0.65

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Appendix Table 3: Maximum Eigenvalue Test

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.36	33.12	27.58	0.01
At most 1	0.19	15.57	21.13	0.25
At most 2	0.08	6.16	14.26	0.59
At most 3	0.00	0.21	3.84	0.65

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

APPENDIX II: Description of Data

Variable	Definition
M2+	Broad money, including foreign currency deposits (in millions of cedis)
P	Consumer price index (100 = 2000)
RGDP	Real GDP (in millions of cedis)
NEER	Nominal effective exchange rate index (100 = 2000)
DEP	Average deposit interest rate offered by banks (annual percent)

Sources: Ghanaian authorities and author's estimates.