Monetary Policy Rules: Lessons Learned from ECOWAS Countries

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1. Introduction

Since the revival of the Economic Community of West African States' (ECOWAS) monetary integration process on 21 April 2000[1], interest of the research has been focusing on: a) an assessment of the viability of a monetary union between the community member countries (Benassy and Coupet, 2003; Itsede, 2002; Tella, 2002; and Addison et al., 2005); b) the type of monetary cooperation to establish; and c) an assessment of the convergence process among member countries in the community (Masson and Patillo, 2001; Ukpong, 2002; and Nnanna, 2002).

This paper studies another view that considers the monetary management of the three main central banks of the ECOWAS countries. Analyzing the monetary policies of ECOWAS member countries enables one to identify their heterogeneity and recommend measures to accelerate monetary policy harmonization.

The three main central banks are the Bank of Ghana (BoG), the Central Bank of Nigeria (CBN) and the BCEAO which common central bank of the West African Economic and Monetary Union. In the mid-1980s and the beginning of the 1990s, the three central banks instituted reforms to shift towards using indirect instruments of monetary policy, based on modifications to the central bank interest rate as the primary policy tool. This paper seeks to examine the extent to which the three main central banks modify their interest rates in response to domestic economic conditions or, alternatively, whether movements in central banks interest rates are driven primarily by changes in external economic conditions. It focuses in particular on the period after financial and monetary liberalization and assesses to what extent the three central banks react to changes in domestic inflation and output, to external constraints involving reserve levels and French interest rates, as well as to other relevant variables such as domestic credit and credit to the private sector. The findings suggest that the BCEAO does react to domestic economic variables in a limited way, particularly to inflation. Our estimates are consistent with an interpretation that the BCEAO matches first changes in French interest rates, but in the short run it retains significant freedom in reacting to domestic economic variables. Several Taylor rules are estimated through alternative measures of the output gap and inflation gap. The results of the BoG and the CBN reaction function estimations reveal a very nuanced picture regarding monetary policy. The two central banks seem to react to inflation but not really to the output gap. We also find that a number of variables that are identified ex ante the BoG and the CBN do not really seem to have an impact on the ex post setting of the monetary policy instrument.

The paper consists of six sections. The next section evaluates the trends in monetary policy of the three biggest economies of ECOWAS: Nigeria, Ghana, and the West African Economic and Monetary Union (WAEMU) as a whole economy. The section thereafter reviews the literature on the monetary policy reaction function, with the next section focusing on the presentation of the modelling framework of the paper. The penultimate section presents and discusses the results of the research, while the final section concludes.

2. Monetary policy, financial reform and financial system development in ECOWAS

Reforms in monetary and exchange rate policies

This study focuses on the three largest economies of ECOWAS: Nigeria, WAEMU, and Ghana. All three these economies had undertaken monetary reforms since the end of the 1980s with the aim of reinforcing the management of their monetary policy. The reforms were first aimed at liberalizing the monetary market, and then at increasing the central banks' autonomy vis-à-vis the public treasury departments in dealing with the choice of policy objectives and instruments in money-market management.

The stability of both prices and the exchange rate is the main objective of the monetary policy implemented by the BCEAO. After the 1975 reform, this policy underwent major changes in October 1989, followed by further improvements in 1993 and 1996. The new monetary management structure makes extensive use of market-based mechanisms, in particular of indirect methods and instruments of liquidity management. It includes three things:

(i) The money market, which operates through bids, with a tendering system for central bank injection and withdrawal of liquidity;
(ii) Permanent refinancing procedures implemented exclusively for credit agencies; and
(iii) A system of bank reserves. More accurately, the modification of the central bank intervention rate grid represented a major innovation. The revised intervention rate grid comprises a rediscount rate, a discount rate and a money-market interest rate. The variations in the rediscount rate are determined by those in the monetary-market interest rate.

The main objective of the CBN is: "to ensure price stability and promote economic development through strong monetary and exchange rate policies" (CBN, 2002 and 2005). The same concerns about *maintaining* price stability and economic growth are underscored in the mission statement of the BoG.

In the aftermath of monetary reforms undertaken in Ghana and Nigeria from the mid-1980s, the management of monetary policy in the WAEMU area relied on indirect instruments of banks' liquidity regulation.

In Ghana and Nigeria a flexible exchange rate regime was instituted in 1986 with the introduction of the foreign exchange market to the tendering process. At the same time, the monetary policies of the two countries were geared at for using indirect instruments of monetary policy management. In February 1988, Ghana abandoned the control on banking rates, and in 1990, the banks obligation to provide the agricultural sector with loans. In 1987, the setting of bank rates (minimum and maximum) was removed in Nigeria.

From the 1990s, the CBN resorted to the minimum discount rate as an instrument for currency and credit management. In Ghana, the review of the set of instruments is marked by the introduction of different maturity bills of the central bank, as well as Treasury bills. Central bank bills were used in open-market operations to control bank liquidity, while Treasury bills helped to fund the government budget and reduce the latter's option to resort to central bank funding.

From the perspective of monetary policy targets, all the three central banks have resorted to monetary aggregate targets, inflation and GDP growth rate targets. Foreign assets and credit aggregates are also part of target variables.

Stylized facts

Following the monetary reform of the mid-1980s, the three central banks considered here indicated their intention to shift towards using indirect monetary policy instruments based on modifications of central bank interest rates as the primary policy tool. From the mid-1980s, two distinct periods can be identified for CBN and BoG interest rates. During the first period, from 1980 to 1993 in Nigeria and from 1980 to 1997 in Ghana, the central banks regularly raised their interest rates. During the second period, the two central banks undertook a series of stepwise rate reductions that resulted in a reduction of the Nigerian minimum rediscount rate from 26% in 1993 to 7% in 2007. From 1997 to 2007, the BoG's discount rate decreased from 45% to 18.5%. The 1990–1993 period in WAEMU is characterized by a gradual increase in the BCEAO interest rates, which was a response to the capital flight that occurred before the January 1994 devaluation of the CFA Franc. Before January 1994, the BCEAO interest rates were maintained at a high level to offer holders of CFA assets a risk premium. In the period immediately following the January 1994 CFA Franc devaluation, monetary policy decisions were determined almost exclusively with the aim of maintaining the CFA Franc peg to the French Franc (Ténou, 2002).

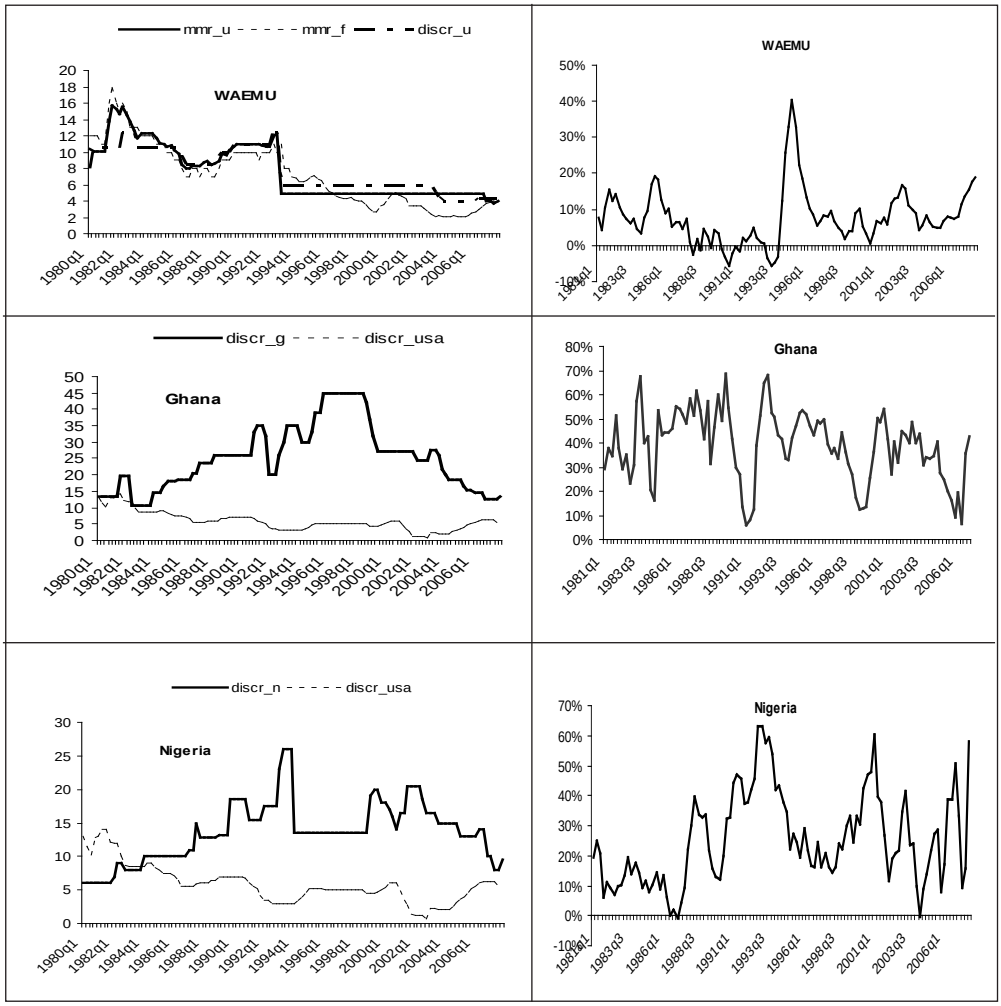
Following the devaluation, three distinct periods can be identified for the BCEAO interest rates. The first period, from December 1994 to October 1996, consist of a series of stepwise rate reductions that resulted in the discount rate falling from 10% to 6.5%. This was also a period of stepwise reductions in Bank of France short-term interest rates. Between October 1996 and December 2002, the BCEAO interest rates remained within a very narrow range (5.75–6.5%), in keeping with the relative stability of French interest rates, except at the end of the period. During this period, annual reports of the BCEAO indicate that the central bank primarily revised the reserve requirement as monetary policy tool. From 2003 to 2007, the BCEAO reacted to the downturn in activity by lowering interest rates again.

Graphs in the first column of Figure 1 show the main refinancing rate of the three

central banks. For comparison, the discount rates of the Bank of France and the discount rate of the US Federal Reserve are also given. To a great extent, the interest rates of the BCEAO reflect the evolution of the Bank of France's interest rates, whereas those of the CBN and the BoG are not correlated with the Federal Reserve discount rate of the United States.

Other variables may be important for the three central banks. For example, the money growth rate is an important target variable. BCEAO assigns a growth rate target of 4.5% per year (BCEAO, 1995, 2005 and 2007) to the M2 monetary aggregate, while it varies for the BoG and the CBN at about 14% (Central Bank of Nigeria, 2002, 2005 and Bank of Ghana, 2005). During the study period, the growth rate of M2 consistently overshot the target, as can be seen in Figure 1.

Figure 1: Interest rates and M2 growth rate quarter to quarter (-4)



3. Literature review

Theoretical framework

The introduction of rational expectations to the study of economics in the mid-1970s revolutionized the direction and thinking of macroeconomic research and policy recommendations. Based on solutions for time-inconsistency problems, one of the recommendations of the literature is that policy rules should be superior to discretion (Kydland and Prescott, 1977; and Calvo, 1978). The rationale is that discretion results in either consistent but suboptimal planning, or in economic instability. Given these theoretical recommendations, the key issue is to find a practical rule that is simple and easily understood so that it is obvious to economic agents when policy makers deviate from the policy.

The simple monetary rule proposed by Taylor (1993) is an attempt to address this issue. It is specified as:

$$i_t = r^* + \pi_t + \alpha(\pi_t - \pi^*) + \beta(y_t - y_t^*) \quad (1)$$

where i is the nominal federal funds rate; r^* is the equilibrium real federal funds rate; π_t is the rate of inflation over the previous four quarters; π^* is the target inflation rate; and $y_t - y_t^*$ is the percentage deviation of real GDP from its target level. In this framework, the federal funds rate rises if inflation rises above its target value π^* or if real GDP rises above its target level. When both inflation and GDP are on target, the nominal federal funds rate will be equal to the sum of the equilibrium real value r^* and target inflation π^*. For clarity, the nominal interest rate rule can be rewritten as:

$$i_t = k + \alpha(\pi_t - \pi^*) + \beta(y_t - y_t^*) \quad (2)$$

where $\kappa = r^* - \alpha\pi^*$. Equivalently, the rule can be written in terms of the real interest rate:

$$r_t = \kappa + \alpha\pi_t + \beta(y_t - y_t^*) \quad (3)$$

Taylor (1993) sets both the inflation target π^* and the equilibrium real interest rate r^* equal to 2 and assigns an equal weight of 0.5 to the inflation and output gap terms. With these values, he shows that this simple rule tracks the actual path of the federal funds rate reasonably well. The parameter values in Equation 3 reflect the preferences of the monetary authority, and a stability condition of α greater than zero is frequently assumed. It is easy to see that if α is less than zero rising inflation would, ceteris paribus, cause the real interest rate to fall, providing a positive stimulus to output. This also implies that the estimated coefficient for inflation in a nominal interest rate rule of the type in Equation 2 must be greater than 1 for the stability condition to hold. Although Taylor proposes parameter values of α and β (both are assumed to equal 0.5) as reasonable benchmarks, the optimal value of these parameters would ultimately depend on the structure of the model under consideration (Svensson, 1999).

The theoretical basis of the Taylor Rule was refined through several contributions by Svensson (1997, 1999) where he shows that this rule is a solution for an optimal control programme within the standard inflation-targeting framework: the central bank seeks to stabilize inflation at a target level and to limit the cyclic fluctuations of the activity by stabilizing it around its potential level. The macroeconomic model generally used to discuss monetary policy rules is the so-called "neoclassical synthesis" which relied on the New Keynesian Phillips Curve (NKPC) in modelling the development of prices (Taylor, 1998). The NKPS Theory has allowed demonstrating that monetary policy could affect output, even in the short run.

One of the main assumptions in a Taylor rule is that usually central bankers are influenced to set interest rates according to the degree of the inflation gap deviation. This has been discussed puted by economists such as Orphanides (2000) and Svensson (1997, 1999, 2000), who were unsatisfied with such an opportunistic approach to a mechanical monetary policy rule to create stabilization, arguing that it is not sufficient to explain the monetary policy pursued by the Federal Reserve of the USA during the Greenspan period (1987Q3 to 1997Q4). The next section will develop this issue in more detail.

Empirical issues related to Taylor-type rules

Following Taylor (1993), a number of researchers have estimated Taylor rules and variants. This area of research has uncovered a number of issues that must be taken into consideration when designing Taylor-type rules.

First, given the fact that there are different ways to measure inflation and to estimate the equilibrium real interest rate and potential output, the robustness of estimation results can be sensitive to data selection. Kozicki (1999) compares the tractability of a Taylor rule with four alternative measures of inflation for the US. These measures include year-on-year inflation calculated with the CPI, core CPI, the GDP price deflator, and a measure of expected inflation obtained from an average of private-sector forecasts. Kozicki then calculates the interest rates that the Federal Reserve would have set if it had followed a

Taylor rule resulting from these alternative inflation measures. As expected, the federal funds rates differ significantly. Regarding the estimation of the equilibrium real interest rate: as a Taylor-type rule typically consists of an unobserved equilibrium real interest rate, and in most cases an unobserved inflation target, a frequently-used approach to deal with this problem is to assume a value for one of the two variables and then estimate the other. Examples of this approach are found in Kozicki (1999), Clarida, Gali and Gertler (2000), and Judd and Rudebusch (1998), who calculate the equilibrium real interest rate as the difference between the average federal funds rate and the average inflation rate. Given this estimate of the equilibrium real interest rate, the estimated inflation target is then extracted from the constant term in the estimated Taylor-type rule. Alternatively, starting with an inflation target, the equilibrium real interest rate can be calculated from the constant term. Rudebusch (2001) estimates the equilibrium real interest rate from an IS equation.

Regardless of the rationale for including[2] the output gap, the subjective nature of measuring potential output creates uncertainty about its accuracy. Taylor (1993) measures potential output by applying a time trend to actual output. Other measures used in the literature include regressing actual output on segmented linear trends and quadratic trends, HP filters, and more structural approaches. Therefore, different potential output measures can result in quite different policy recommendations (Orphanides, 1999). Using different measures of potential output, Kozicki (1999) shows that the Taylor interest rate differs by a minimum of 0.9 percentage points to a maximum of 2.4 percentage points.

Second, the timing of information provided to the monetary policy authority can affect the structure of the policy rule and policy outcome. This causes some researchers to question the appropriateness of using contemporaneous observations of inflation and output in an instrument rule, while in reality central banks must rely on lagged information (Levin et al., 1998; and McCallum and Nelson, 1999). Others have questioned the merit of using revised data to estimate a historical policy rule, as policy makers typically rely on real-time data when setting interest rate paths (Batini and Haldane, 1999).

Third, the structure of the Taylor Rule assumes that policy makers consider only current information when making policy decisions (Orphanides, 1997[3]). This view is at odds with the forward-looking nature of central banks. As a result, a number of researchers favour forward-looking versions of the rule (Clarida et al., 1998, 2000; Williams, 1999; and Sack and Wieland, 1999). Finally, a widespread modification to the Taylor rule is to include terms representing interest rate smoothing behaviour by central banks (Williams, 1999; and Sack and Wieland, 1999).

Empirical literature related to Taylor rule

This subsection reviews empirical evidence from the literature on monetary policy rules. The focus is on reviewing some of the key studies on the Taylor Rule and its subsequent reaction functions. This subsection is not exhaustive, but concentrates on relevant studies in the area of applied research studies on the Taylor Rule in developed and developing countries.

Using quarterly data for the 1979–1997 period, Verdelhan (1999) estimated a reaction function of the European Union Central Bank, considering as explanatory variables the

contemporary values of the inflation rate, the output gap and the interest rate lag. The results of his estimation indicate that the reaction coefficients of the central bank to the inflation and the output gap are 0.3 and 0.6, respectively while the interest rate smoothing coefficient is 0.7. In a comparative study of central banks' reaction functions, Joundeau et al. (1998) have estimated Taylor-type reaction functions of the Federal Reserve Banks and the German Bundesbank. Other studies, such as Taylor, (1999a and 1999b) and Woodford (2001) support the fact that the interest rate of the US Federal Reserve is sensitive to the inflation gap and output gap. Another study, carried out by Clarida et al. (1998), also estimates Taylor-type rules for Germany, Japan, UK, France, and Italy. Cadoret et al. (2004) estimated a Taylor rule by using quarterly data over the 1988–1998 period, and found that the Bank of France and the Bundesbank had implemented non-conventional monetary policies. Indeed, during that period, the Bundesbank's reaction coefficient for the output gap was 0.12, and -0.16 for the inflation gap. At the same time, the reaction coefficient of the Bank of France to the inflation gap was 1.38, and -0.64 for the output gap.

Some studies on developing countries, and particularly African countries, are based on Taylor rule estimations. The majority of these studies lead to non-conventional results. Abuka et al. (1998) considered the output gap and inflation gap as explanatory variables in addition to the constant term for Uganda over the period 1990–1998, and obtained a relatively weak coefficient value of 0.11 for the inflation gap. The output gap's coefficient is negative (-1.16), which is in contrast to theory. By re-estimating the equation, as adjusted by external sector variables (such as the variation of international reserves and the real exchange rate), the results are improved, but they do not allow a satisfactory description of the historical pattern of interest rates. Similar results are obtained by Okot (2008) on the basis of Ugandan quarterly data ranging from 1988 to 2006. Agu (2007) failed to establish a Taylor-type reaction function for the CBN. Ténou (2002) carried out an estimation of a modified Taylor rule for the BCEAO. The modified Taylor rule consists of substituting the inflation gap with the differentials between WAEMU and French inflation rates and interest rates. The BCEAO appeared to react positively to the output gap and to differentials of interest rates and inflation rates, as was expected.

4. Modelling framework

The reaction function describes the strategy followed by the central bank to stabilize the economy. It represents the solution to the minimization of a loss function regarding the instruments of monetary policy and the structure of the economy (Bordes, 1997) as follows:

$$\begin{cases} L = \left[\sum_{i\text{-}1}^{n} \alpha_i \left(y_i - y_t^* \right)^2 \right] + b\left(x - x^* \right)^2 \\ \\ y_i = c_i x; \qquad i = 1,...,n \end{cases} \tag{4}$$

where L is the measure of the loss suffered by the monetary authorities and y is the variable representing the monetary policy goal. There are n goals and y_i^* is the target of this variable for goal i, x is the instrument that the monetary authorities control and x^* is the targeted value of this instrument.

The analytical solution to the minimization problem of monetary authorities' loss function led to a reaction function in which the monetary policy instrument depends on economic state variables:

$$x = cste + \sum_{i=1}^{n} e_i y_i \tag{5}$$

The main criterion adopted by the monetary authorities is clearly an inflation target. The focus of this paper is to compare the monetary policy management of the main central banks of the ECOWAS area and, therefore, the annual inflation targets of each of the central banks have been considered in the specification of the reaction functions. Furthermore, only observed inflation was used. There is no consensus on how to approach this issue. Clarida et al. (1998) believe that a forward-looking framework is better suited to the data than a backward-looking framework when estimating the reaction of the

European Central Bank (ECB), while Rudebusch and Svensson (1998) argue that the two formulations are appropriate for the estimation of the reactions function of a vast majority of central banks. Regarding the estimation of reaction functions of developing countries' central banks, the backward-looking framework is necessary because of the lack of data on inflation expectations.

To achieve their goals, the central banks manipulate the short-term nominal interest rate, depending on the state of the economy. In addition, central banks tend to smooth the interest rate changes – a practice justified by the loss of credibility which might arise from sudden policy changes. A partial adjustment is assumed, as indicated by Clarida et al. (1998): in each period, the current interest rate is adjusted to reduce the gap between the desired interest rate and the interest rate of the preceding period. The interest rate with one period lag is therefore introduced as a variable in the reaction functions.

Thereafter, the other variables that central banks consider as goals have to be determined. In addition to the price stability goal, the three banks included annual monetary growth targets in their monetary programme. For the BCEAO, 4.5% of the monetary aggregate M2 growth target is selected. The monetary growth targets vary at around 15% for the BoG and CBN, (Central Bank of Nigeria 2002 and 2005 and Bank of Ghana 2005). Furthermore, the output gap is included as a monetary policy goal in many studies. In the monetary programmes of the central banks studied, the corresponding variable is real GDP growth rate.

After looking at the internal factors influencing the conduct of monetary policy, this study turns to considering the way in which the three central banks deal with external factors influencing their economies. Svensson (1997) has shown that an optimal reaction function derived from an inflation-targeting strategy can be expressed as a Taylor rule adjusted by monetary aggregate targets and by the exchange rate.

It may be the case that exchange rates significantly influence the management of monetary policy, especially in the current context where countries attempt to converge to the single currency of ECOWAS. Bear in mind that the WAEMU countries are in a fixed-exchange-rate regime with respect to the euro. Moreover, monetary history in Ghana and Nigeria is characterized by the implementation of programmes aimed at the eradication of exchange rate instability (Sowa et al., 1999; and Nnanna, 2002). In addition, the reduction of exchange rate fluctuations is one of the ECOWAS single currency convergence programme goals.

With regard to the BoG and the CBN, the goal of exchange rate stability may be represented by the national currency rate in terms of US Dollar. The exchange rate stability goal for the BCEAO before 1999 may be represented by the difference between the interest rate of the Bank of France and the domestic interest rate. After this date, the difference in interest rates is the difference between the ECB rate and the domestic interest rate.

While admitting that targets and objectives of monetary policy may differ from one country to the next, the following reaction function can be considered as representative of the behaviour of the three central banks:

$$i_t = \rho i_{t-1} + (1-\rho)\left(r + \alpha\pi^*\right) + (1-\rho)\left(1+\alpha\right)\pi_t + (1-\rho)\beta\left(y_t - y_t^*\right) + (1-\rho)\gamma 1 z_t \qquad (6)$$

where z_t represents the exchange rate, the credit in the economy or to the private sector, the foreign exchange reserves, and money growth rate. γ1 is the sensitivity coefficient of the interest rate to variable *z*. The adjustment of the Taylor Rule according to this variable is justified by the fact that the latter appears to be an intermediate target in the context of the monetary programmes of the three central banks. Therefore, z_t may be a measure of the difference between the BCEAO interest rate and that of the ECB.

Given the historic practice of monetary-base targeting by some central banks of ECOWAS member countries, including the CBN, the following reaction function could also characterize the behaviour of the central banks:

$$i_t = \rho i_{t-1} + (1-\rho)\left(r + \alpha\pi^*\right) + (1-\rho)\left(1+\alpha\right)\pi_t + (1-\rho)\beta\left(y_t - y_t^*\right) + (1-\rho)\delta(m_t - m^*) + (1-\rho)\gamma 2z1_t \quad (7)$$

where new variables are the growth of money, and m_t and m^* target its value and any other intermediate target variable different from the monetary growth rate.

5. Empirical results

Time series properties

The study uses quarterly data from 1980Q1 to 2007Q4. Apart from real GDP, the data are from the International Financial Statistics of the International Monetary Fund (IMF). Series of real GDP are taken from the World Development Indicators (2008). The real GDP of the WAEMU is measured as the sum of the member countries' real GDP, except for Guinea-Bissau, as data are not available for a longer period. The data for quarterly GDP figures are obtained after transforming the annual data using the methodology developed by Goldstein and Khan (1976).

The unit root tests that were carried out confirm that the GDP, consumer price index and exchange rate of Ghana and Nigeria are I(1). In the case of WAEMU, the interest rate and exchange rate appear to be stationary (I(0)), whereas the GDP and consumer price index are I(1). The definition of variables and the results of the unit root tests are presented in Annexure B. Due to the currency devaluations that the three countries experienced, some of the series are affected by structural breaks. For these series, the test developed by Zivot and Andrews (1992), which takes into account breaks in trends of the series, has been used instead of the classical ADF test.

Computation of target variables

Calculation of output gaps

Four measures of output gaps have been used in this study. The first two are obtained using the Hodrick-Prescott filter (with the smoothing coefficient equal to 7000 and 1600, respectively). The last two measures of the output gap are obtained from potential output, which is derived from the quadratic or cubic function of time. The output gaps are respectively written as , , and . Considering the magnitude of supply shocks affecting developing countries, the supply curve can display a polynomial shape.

Inflation measures and inflation gap calculation

Two measures of inflation were used in the study: inflation and core inflation. Although inflation rates are included in the target variables of the three central banks, they have been able to control core inflation as much as central banks in developed countries since the monetary reforms implemented in the mid-1990s. In fact, the inflation rate resulting from the consumer price index is subject to quite volatile movements in the short term. In order to avoid inappropriate responses to occasional price variations, some central banks worked through the elaboration of a precise measure of core inflation.

There are many methods to calculate core inflation. These are primarily the methods based on the exclusion of specific factors, smoothing methods and econometric methods. The core inflation calculated by excluding special factors is based on the elimination of the price index of a fixed subset of components. These components may exacerbate temporary inflation shocks. The components most often excluded are: food, energy, fresh produce, and taxes on goods and services (Pikbougoum, 2002). Similar to the method of component elimination, statistical methods for estimating structural inflation exist that use the distributions of consumer price index components. In the absence of distribution data for the consumer price index components for the three countries, it would have been difficult to use one of the two methods presented above. The third method, the smoothing method, consists of using one of the numerous filters available, ranging from a simple moving average, to the Kalman filter and the decomposition of Beveridge and Nelson. These techniques are non-economical and the theory provides little information on the form of the underlying process and, therefore, on the type of filter that should be selected (Jacquinot, 1998).

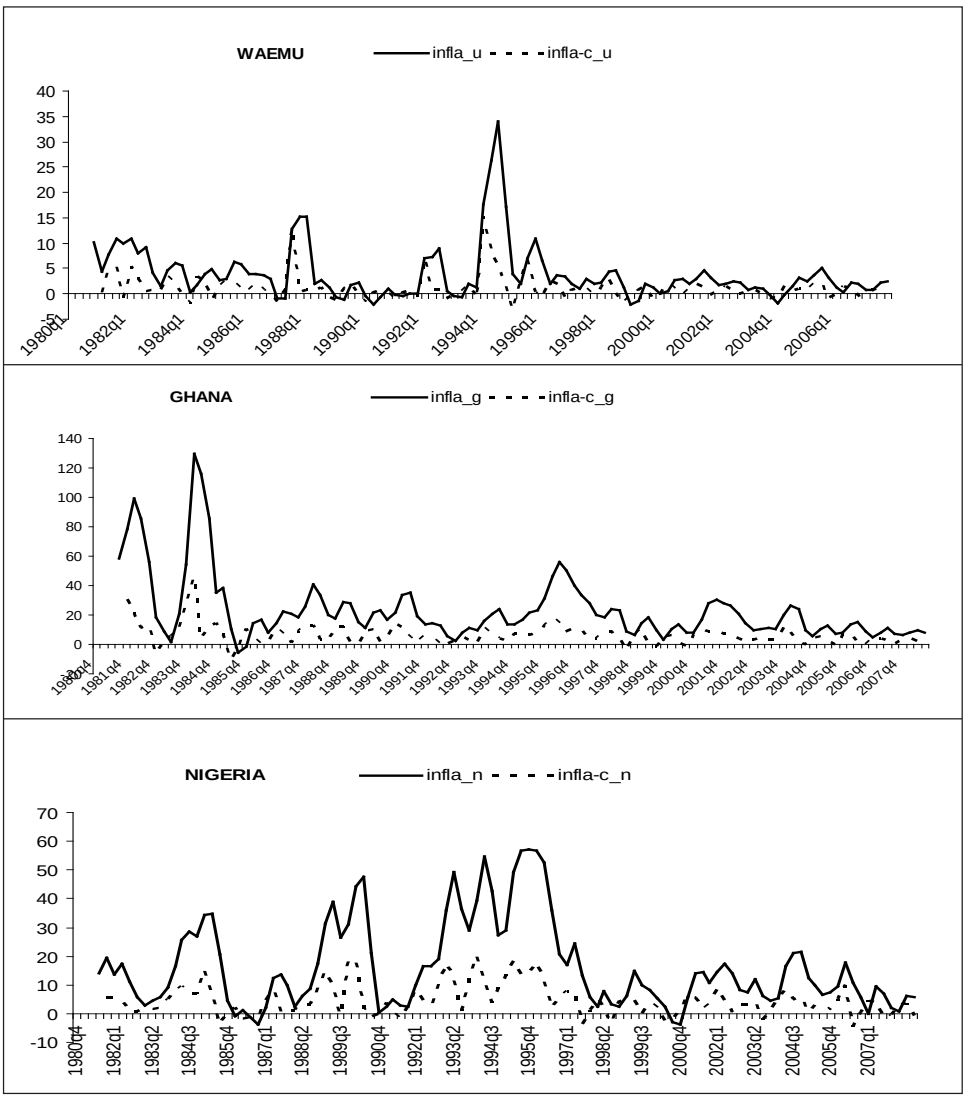
The core inflation series of the countries were calculated according to the econometric method inspired by Quah and Vahey (1995). The latter exploits the vertical character of the Phillips curve in the long term, and identifies core inflation as that component of inflation that has no long-term effect on output. Inflation measured as the relative variation of the consumer price has been split into two parts: one respects long-term neutrality (core inflation), while the other does not (short-term inflation). The effect of long-term neutrality of inflation on production has been taken as a criterion to identify core inflation in VAR models combining GDP, inflation (relative variation of consumer price index) and deterministic terms (constants, seasonal coefficients, and dummies for breaks in price and output data series). For each country (Ghana, Nigeria and WAMEU as a whole), VAR models have been estimated by using the OLS method. The identification method allowing this decomposition of inflation is the one formulated by Blanchard and Quah (1989). The results obtained from the decomposition of the countries' inflation rates are presented in Figure 2.

5.2.3 Inflation gap calculation

For WAEMU, the inflation gap is the difference between inflation and the 2% reserve target set by the monetary authorities of the union. When core inflation is considered the measure of inflation, the inflation target is set equal to 0.5%. The inflation gap and core inflation gap are calculated for the 1989–2007 period. For Ghana, the inflation target is the average of the inflation rate over the 1987–1995 and 1996–2007 periods. Similarly,

for Nigeria the targeted inflation rate is a *broken curve*, and equalizes the average of inflation rates between the two periods 1991–1996 and 1997–2007. When core inflation is regarded as the measure of inflation, the inflation gap is the difference between the core inflation rate and its average calculated according to the above two periods.

Figure 2: Series of inflation (infla) and core inflation (infla-c)



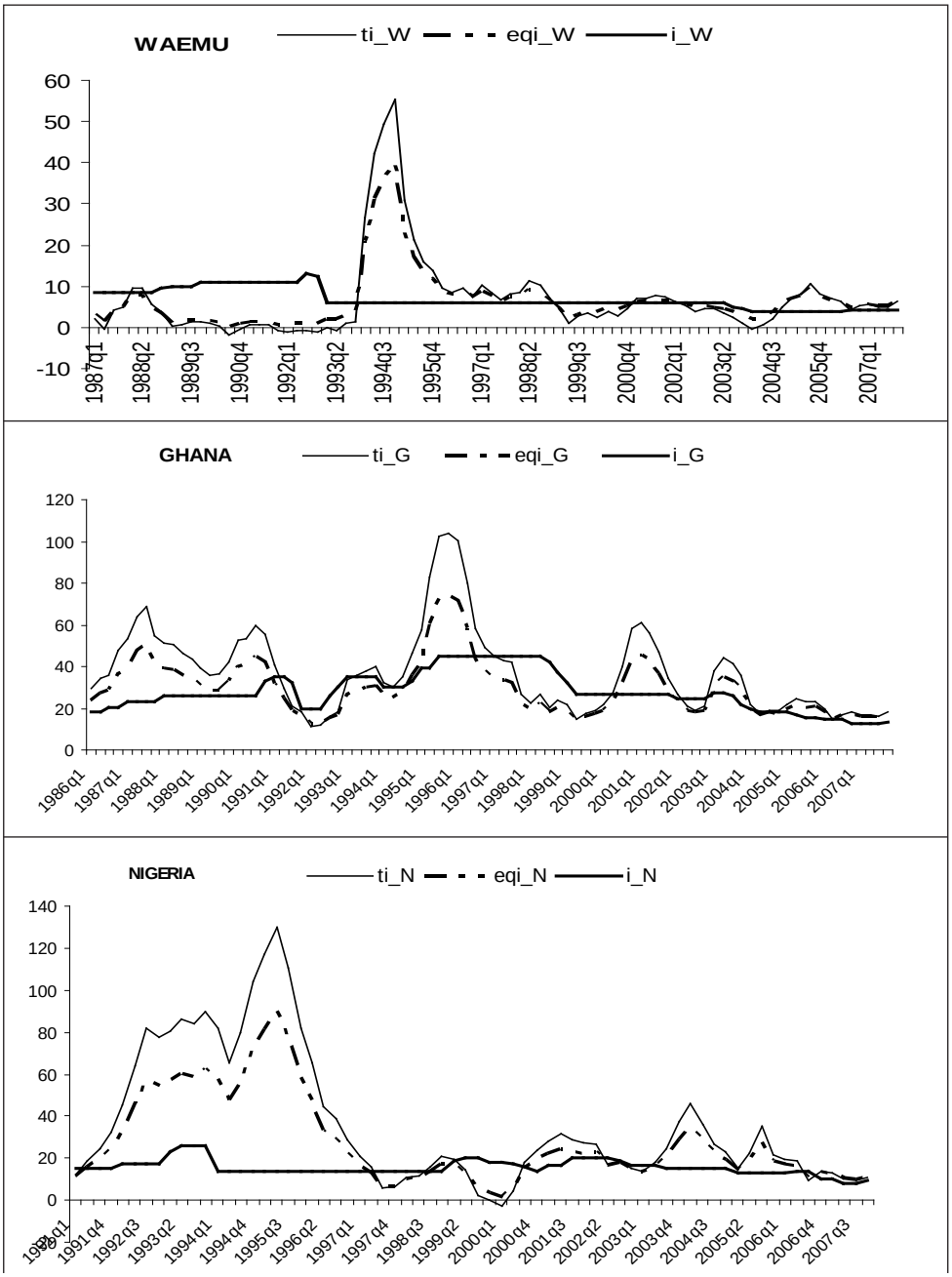
Adequacy of countries' monetary policy to Taylor Rule

We have evaluated the consistency of the selected countries' monetary policy according to the Taylor Rule by referring to the original Taylor Rule. Thus, the sensitivity of the interest rate to the inflation gap and output gap has been set equal to 0.5. Checking how consistent monetary policy is to the Taylor Rule is then done by means of algebraic simulations, whereby we compare the observed short-term interest rates ()

to the Taylor interest rate (*ti*) and to the equilibrium interest rate (*eqi)*.

The three central banks' choice of the period of estimation of the reaction functions relies on taking into account several constraints, principally the introduction of financial liberalization in the countries, the monetary policy regimes, and the relevance of the results of estimations. For Ghana, the period of estimation is from 1987 to 2007; i.e., from the beginning of the foreign exchange market liberalization to 2007. The 1989–2007 period for estimating the reaction functions of the BCEAO was referred to earlier. Thus, it covers the period from the 1989 monetary reform until today. Regarding the reaction function of the CBN, the estimation and simulation period is from 1992 to 2007.

Figure 3: Central banks' short-term interest rates (i), equilibrium interest rates (eqi) and Taylor interest rates (ti)



The graphs in Figure 3 indicate that the consistency of monetary policies to the Taylor Rule seems rather weak: the gaps are significant between the observed and the simulated rates. In the case of Nigeria, the consistency of monetary policy with the Taylor Rule improves over time. That is, short-term interest rates converge towards Taylor interest rates. We distinguish two regimes, one in which short-term interest rates are clearly lower than Taylor interest rates and equilibrium interest rates, therefore monetary policies are clearly accommodating. Starting from the mid-1990s, a second regime emerges in which monetary policies become more restrictive. Therefore, short-term interest rates are higher than Taylor interest rates and the equilibrium interest rate.

In Ghana, monetary policy mostly was accommodating in the 1980s. For the rest of the period, BoG applied a more conventional monetary policy. In the WAEMU area, the central bank clearly applied a restrictive monetary policy during the whole period.

Results of econometric estimations

Econometric model specification

Several Taylor rules are estimated with quarterly data for different periods of estimation. The best estimations are reported here. The dependent variables, denoted (*dir*), are the BCEAO discount rate, the BoG rediscount rate and the CBN minimum rediscount rate. The main exogenous variables are:

- ecinf: Difference between inflation rate and inflation target. Inflation rates are based on countries' consumer price index. Annualized growth rates of consumer price indexes were calculated;
- ecinfc: Difference between core inflation and core inflation target. The variable is calculated as defined above ;
- gap: Deviation of the real GDP from potential real GDP;
- exrate: The local currency/dollar exchange rate (at the end of the quarter);
- nexr: The nominal effective exchange rate;
- m1g: Annualized growth rate of the M1 monetary aggregate;
- m2g: Annualized growth rate of the M2 monetary aggregate ;
- *exrateg:* Annualized growth rate of the variable "exrate";
- nexrg: Annualized growth rate of the variable "nexr";
- *fassetg:* Annualized growth rate of foreign assets;
- *cpsg:* Annualized growth rate of credit to the private sector;
- CFA Franc pre-devaluation dummy: Dummy variable used to capture the 1990–1993 period when the BCEAO interest rates were kept high to offer holders of CFA assets a risk premium in order to prevent the devaluation of the CFA Franc. D9093 equals 1 between 1990 and 1993, and is nil elsewhere;
- Nigerian 1996 monetary reform: Dummy variable used to capture the stepwise interest rate reductions undertaken by the CBN in the Nigerian 1996 monetary reforms. From 1996 to 2007, D96 equals 1 and 0 elsewhere; and
- Ghanaian 1992 monetary reform: Dummy variable used to capture the rapid rise in the BoG rediscount interest rate. During this period, the BoG counteracted inflation by revising reserve requirement and significantly increasing interest rates (Harrigan et al., 2000). D922953 equals 1 between 1992Q2 and 1995Q3, and 0 elsewhere.

Lag variables are denoted by *NAME(t-k)*, where *k* is the number of lag periods. Equation 4 takes the standard form:

$$i_t = c + c(1)^* i_{t-1} + c(2)^* \left(\pi_{t-1} - \pi^*\right) + c(3)^* \left(y_{t-1} - y^*\right) + c(4)^* z_{t-1} \quad (8)$$

where $c = (1 - \rho)\left(r + \alpha\pi^*\right)$; $c_1 = \rho$; $c_2 = (1 - \rho)\left(1 + \alpha\right)$; $c_3 = (1 - \rho)\beta$ and

$c_4 = (1 - \rho)\gamma 1$

Econometric results

Equation 4 was estimated by using the inflation gap (ecinf) and core inflation gap (ecinfc), alternatively. Table 1 presents the respective coefficients in the most relevant equations:

Table 1: Estimates of Taylor rule coefficients by OLS, with output gap1

Estimates	Ghana 1987Q1–2007Q4		Nigeria 1992Q1–2007Q4			WAEMU 1989Q1–2007Q4	
	(1)	(2)	(1)	(2)	(3)	(1)	(2)
C	1.58**	0.53ns	2.7***	2.4***	2.7***	0.98***	0.96***
dir(-1)	0.89***	0.93***	0.80***	0.83***	0.8***	0.82***	0.82***
Ecinf	0.08***		0.04***		0.04***	0.03*	
Ecinfc		0.13*		0.07**			0.04ns
Gap			-0.05ns	-0.04ns		0.20***	0.16***
gap(-1)					0.01ns		
gap(-2)	-0.65ns	-1.8**					
CFA Franc pre-devaluation dummy						1.1***	1.02***
Ghanaian 1992 monetary reform	2.23***	2.4***					
Nigerian 1996 monetary reform			-3.6***	-2.2***	-3.4***		
AR(1)	0.22**						
A justed R^2	0.94	0.95	0.75	0.73	0.75	0.91	0.91
F-stat	314.09	203.3	67.47	59.9	67.2	233.5	228.6
DW	2.04	1.9	1.83	1.8	1.83	1.72	1.72
Ljung Box Q stat			3.48	5.96	3.9	4.99	9.2

*** Significant at 1%, ** significant at 5%, * significant at 10%, ns: not significant.

Countries' regression equations include the lagged interest rate variable, of which the coefficient is significant and large. The three central banks seem to use a smoothing method for adjusting interest rates: in Equation 1, $\rho \subset [0.80; 0.93]$. All the equations show a weak but significant impact of inflation on interest rates, which is in line with the declared goal of the central banks.

Surprisingly, the output gap seems to be taken into account only by the BCEAO. The coefficient of the variable is negative and not significant in the reaction function of the CBN and BoG. Overall, the fit of models is good, including the lagged interest rate, and the residual autocorrelation assumption can be rejected, in accordance with the standard Ljung-Box test.

Using core inflation in the regression increases the size of the central bank reaction to inflation, but decreases the overall fit of the BoG and the BCEAO reaction function. Both the constant term and the inflation term became non-significant in the reaction functions of the BoG and BCEAO.

The negative sign of the coefficient of output gap in the BoG and the CBN reaction function can be attributed to the calculation of the output gap. In order to assess this hypothesis, the output gap specifications (gap2, gap3, gap4) defined above have been used alternatively in different regressions. The results of these regressions, which are summarized in Table 2, are not different from the first ones. The three central banks' interest rates react significantly to inflation, however, the reaction coefficients are weak. The constant term and the interest rate smoothing coefficient also appear to be significant. Except for the BCEAO, the three alternative specifications of the output gap appear non-significant in the reaction functions of the BoG and the CBN. These results are given in Table 2.

Table 3 displays the theoretical coefficients implicit in Equation 1, i.e., ρ, α and β, according to the above estimations. Output gap 4 was used in the regression equations for the BoG and CBN, and output gap 1 for the BCEAO.

Real interest rates calculated assuming the BCEAO inflation target equals 2%, and that of BoG and CBN 10%, respectively.

The three central banks' reaction coefficients to inflation are negative. A logical explanation for this may be the importance of supply-side shocks in ECOWAS countries. In such a situation, central banks would rather not increase the interest rates when inflation increases.

The reaction coefficients of the three central banks to the output gap have the expected positive sign. Compared with the coefficient of the inflation rate, this means that the central banks more strongly adjust interest rates to prepare for the risk of inflation that arises from demand-side shocks.

As the calculation of quarterly GDP by linearization of annual GDP may have affected estimates, the output gap that is calculated from quarterly GDP was substituted by the industrial output gap (*igap*). The latter data are available in quarterly frequencies for Nigeria. The results of the estimation are summarized in the equation below; where figures in parentheses indicate the student "t" statistics. Estimates are not significantly different from the first ones. The CBN reacts to inflation variation, but not to the industrial output gap. This indicates that the interpolation of quarterly GDP data has not strongly biased estimates.

$$\begin{array}{lllll} dir = 0.8*i(-1) + 2.7 + 0.04*ec\text{inf}\_n + 0.01igap\_n - 3.4*D96 & & & & \\ \quad (14.3) \quad (3.2) & (3.4) & (0.13) & (-3.98) & (9) \end{array}$$

Ajusted R^2 = 0.75, DW = 1.83 Ljung-Box Q-Statistics(4) =3.8896 Sign Level = 0.42

Table 2: Estimates of Taylor Rule coefficients by OLS, with different measures of output gap

Estimates	Ghana 1987Q1–2007Q4				Nigeria 1992Q1–2007Q4				WAEMU 1989Q1–2007Q4			
	gap1	**gap2**	**gap3**	**gap4**	**gap1**	**gap2**	**gap3**	**gap4**	**gap1**	**gap2**	**gap3**	**gap4**
C	1.58**	0.69ns	0.69ns	0.75ns	2.7***	2.7***	2.6***	1.5**	0.98***	0.98***	0.97***	0.98***
dir(-1)	0.89***	0.94***	0.94***	0.94***	0.80***	0.8***	0.8***	0.9***	0.8***	0.8***	0.8***	0.8***
Ecinf	0.08***	0.02***	0.02***	0.02***	0.04***	0.04***	0.04***	0.03***	0.03*	0.03**	0.02**	0.02**
Gap					-0.05ns	-0.04 ns	-0.02 ns	0.02 ns	0.2***	0.16***	0.11***	0.11***
Gap(-2)	-0.65 ns	-0.01 ns	-0.004ns	0.02 ns								
CFA Franc pre-devaluation dummy									1.1***	1.2***	1.3***	1.4***
Ghanaian 1992 monetary reform	2.23***	2.55***	2.56***	2.5***								
Nigerian 1996 monetary reform					-3.6***	-3.5***	-3.5***	-2.9***				
AR(1)	0.22**	0.22**	0.22**	0.22***								
Adjusted R^2	0.94	0.94	0.94	0.94	0.75	0.75	0.75	0.8	0.91	0.91	0.92	0.92
F-stat	314.09	367.91	367.90	368.34	67.5	67.5	67.5	139.0	233.50	239.13	241.0	241.8
DW	2.04	2.06		2.06	1.83	1.84	1.84	1.9	1.72	1.75	1.75	1.75
Ljung-Box Q-Stat (4)					3.48				4.99	6.00	5.9	5.9

*** Significant at 1%, ** significant at 5%, * significant at 10%, ns: not significant.

Table 3: Policy sensitivity to variables

	r	ρ	α	β
BoG	2.5	0.94	-0.67	0.33
CBN	5	0.9	-0.70	0.20
BCEAO	2.45	0.8	-0.85	0.90

Real interest rates calculated assuming the BCEAO inflation target equals 2%, and that of BoG and CBN 10%, respectively.

As the error term in the OLS estimates is not always normally distributed, the most relevant equations have been re-estimated using the three-stage least squares (TSLS) estimator. In order to account for possible nonlinearity in the real GDP trend, the reaction functions were re-estimated with the non-linear least squares (NLLS) estimator. Note that in some specifications the output gap is the difference between output and potential outputs derived from polynomial trends; that is a non-linear trend. The results of these different estimations are somewhat similar to the previous ones and are presented in Annexure D.[4]

Considering these results, an attempt is made to adjust the reaction functions according to other variables that are declared as monetary policy targets by central banks of the countries considered. The absence of relevant variables in the specification of reaction functions can affect the quality of the estimators. In the case of Ghana and Nigeria, the Taylor rules were adjusted by several other targets, such as money growth rate, foreign assets, credit to the private sector and domestic credit.

Among these targets variables, two measures were used to measure the impact of monetary policy on economic activity fundamentals. Credit to the private sector and domestic credit are expected to reflect partly the development roles of the BoG and the CBN. The results of the alternative Taylor rule specifications are presented in Table 4. Estimates indicate that the growth of credit to the private sector affects positively, but to a limited extent, the setting of interest rates of the BoG, but not those of the CBN. The positive sign of the coefficients matches expectations.

It could not be established whether growth rates in monetary aggregates have a significant impact on the monetary policy instruments of the two central banks. In the case of the CBN the result is surprising, as Nigeria's monetary policy is anchored in a monetary-targeting framework.

An investigation was conducted to determine if the variation in foreign assets leads to a reduction in interest rates. It could not be established whether foreign assets had any significant impact on the setting of a monetary policy instrument by the two central banks.

Given the history of foreign exchange in Ghana and Nigeria, one of the primary means to addresses instability in the foreign exchange market has been programmes aimed at reducing the gap between the official and parallel market exchange rates (Agu, 2007; and Sowa and Acquaye, 1999). The centrality of exchange rate in the formulation of monetary policy comes from the fact that, for most countries, the overriding objective of monetary policy is price stability. Consequently, volatility in the exchange rate is generally counterproductive to the goals of price stability. This also explains the political sensitivity of exchange rate regimes in both developing and developed economies (Nnanna, 2002). Foreign exchange premia translate into a high incentive for speculative transactions in the

market and this often destabilizes the market. Consequently, the two central banks have been mandated to reduce uncertainty[5] in their foreign exchange markets. However, the estimated equations could not establish whether the setting of the core monetary policy instrument of the BoG is directly influenced by the movements of the exchange rate. Some specifications of the reaction function of the CBN indicate that the exchange rate influences trends in the monetary policy instrument, albeit very weakly. This indicates that the exchange rate is somewhat important in the conduct of monetary policy in Nigeria.

Table 4: Adjusted Taylor rules

Estimates 1987Q1–2007Q4	**Ghana**				**Estimates 1992Q1–2007Q4**	**Nigeria**		
	(1)	**(2)**	**(3)**	**(4)**		**(1)**	**(2)**	**(3)**
C	-1.2ns	0.9ns	0.8ns	0.2ns	*c*	3.7***	4.2***	4.4***
dir(-1)	0.9***	0.9***	0.87***	0.9***	*dir(-1)*	0.7***	0.7***	0.68***
Ecinf	0.04**	0.08***	0.07***	0.07***	*Ecinf*	0.05***	0.05***	0.06***
gap(-2)	-0.7ns	-0.4ns	-0.97**		*Gap*	-0.18ns		-0.16ns
m2g(-2)	0.07***				*m1g(-2)*	0.02ns		
exrateg(-2)					*exrateg(-2)*			
fassetg(-2)		-0.01ns			*fassetg(-2)*			
cpsg(-1)			0.04***	0.03**	*cpsg(-1)*		0.01ns	
					nexrg(-1)			0.01**
Ghanaian 1992 monetary reform	1.5**	1.77**	2.4***	2.0***				
Nigerian 1996 monetary reform					*Nigerian 1996 monetary reform*	-4.7***	-4.3***	-4.8***
AR(-1)		0.23**	0.26**	0.28**				
AR(3)		- 0.32***		-0.35***				
Adjusted R^2	0.94	0.95	0.94	0.95	*R2A*	0.76	0.76	0.77
F-stat	238.5	233.0	245.4	209.0	*F-stat*	46.0	57.1	48.2
DW	2.13	2.3	2.05	2.2	*DW*	1.7	1.7	1.8
Ljunk Box Q stat	—-	—-	—-	—-	*Ljunk Box Q stat*	4.08	3.87	3.9

*** Significant at 1%, ** significant at 5%, ns: not significant.

Taking into account the linking of the CFA Franc to the French Franc (and thereafter to the euro), we incorporated the differential between the BCEAO interest rate and that of the Bank of France (and thereafter the BCE) into the reaction function of the BCEAO. The results of the estimates in the equation below indicate that the interest rate dynamics of the Bank of France (later BCE) significantly influence the interest rate of the BCEAO. The coefficient of the interest rate spread is more important than that of the output gap. This means that in explaining the monetary policy of the BCEAO, the dynamics of the interest rate of the Bank of France (the BCE) are more significant than the economic

conditions of the WAEMU. The modified Taylor rule estimated in1989–2007[6] is:

$$i = 4.67 + 0.21*i(-) + 0.23*gap(-2) + 0.35*d\text{int}(-1) + 0.02*ec\text{inf}(-1) + 5.05D9093$$
$$\bar{R}^2 = 0.96 \quad DW = 1.95 \quad \text{Ljung-Box Q-Stat} = 2.14 \qquad (10)$$

Table 5 provides the theoretical reaction coefficients implicit in the above equation as the implicit real interest rate. The BCEAO appears to react actively to the interest rates of the Bank of France ($\gamma = 0.44$). It also reacts to the variations of the output gap ($\beta = 0.3$) but very weakly to those of the inflation gap ($\alpha = 0.03$).

Table 5: Theoretical reaction coefficients of the BCEAO – adjusted Taylor rule

	r	ρ	α	β	γ
Own estimate	3.90	0.21	0.03	0.30	0.44
Ténou (2002) estimate	3.92	0.79	0.31	1.25	0.96

The strong variance in the results of this paper and those of Ténou (2002) are due to differences in periods of estimation. This study's estimates relate to the period between 1989 and 2007, whereas Ténou's estimates were done from 1991 to 1999. The weakness of the reaction coefficients that resulted from the econometric estimation of the present paper is explained by the influence of the 1995–2002 period. During this period, the BCEAO, after an initial slowdown in interest rates, maintained its policy instrument at an almost constant and somewhat higher level. At the time, the central bank largely resorted to reserve coefficients to control liquidity in the WAEMU area. This measure was aimed at discouraging capital flight which might have occurred after the 1994 CFA Franc devaluation. The low level of the lag interest rate coefficient in the regression equation can be specifically explained by the break that was recorded in the trend of the interest rate after the CFA Franc devaluation. The low levels of the other regression coefficients are explained by the weak variability of the interest rate between 1995 and 2002. By re-estimating the reaction function with a dummy variable that captures the low variability of the interest rate between 1995 and 2002, the sizes of the reaction coefficients are clearly increased. However, the significance of the inflation gap coefficient is not retained, but the results of the initial regression remain intact.

6. Conclusion

Our empirical results provide a nuanced picture of the monetary policy of the BCEAO. Central bank rates in France (now the eurozone) strongly influenced the BCEAO discount rate and related movements. This is a logical consequence of the CFA Franc's peg to the French Franc (and now the euro). Apart from the interest rates of the Bank of France, our empirical results also suggest that interest rates of the BCEAO react to changes in WAEMU economic conditions. Evidence was provided that the BCEAO takes into account the inflation rate and the output gap. However, the correlation between the inflation rate and central bank interest rate is very weak. It is worth noting that the magnitude of the BCEAO reaction coefficient to the output gap is somewhat high. This is because the BCEAO overreacts to demand-side shocks.

The main observation from the results of the efforts to model the reaction functions of the central banks of Ghana and Nigeria is that the monetary policy applied differs from that announced *a priori*. Except for the lag term of interest rate, the inflation rate and output gap appear not to have any influence on the adjustment of the interest rates of the BoG and the CBN. In addition, the negative sign of the two central banks' reaction coefficient to the output gap shows that the BoG and CBN do not adjust their interest rates in response to increased economic activity. In the light of these results, some adjusted Taylor rules have been estimated. The results of these alternative estimations were found to be similar to those of the original Taylor Rule. More specifically, interest rates are not sensitive to the exchange rate, the growth rate of money, or the dynamics of domestic credit or credit to the private sector. Neither are they sensitive to the variation of foreign assets or reserves. This suggests that the ex ante variables presented by the BoG and CBN as monetary policy instruments – the rediscount rate and the minimal rediscount rate – do not seem to have been used *a posteriori* as monetary policy targets.

These results raise issues about the effectiveness of the monetary policy. In particular, many things are still required in order to assure the effectiveness of interest rates as a monetary policy instrument. Assuring that central banks have instrumental independence would help attain this goal and progress toward the monetary convergence process within the ECOWAS area.

Notes

1. In Accra, Ghana, six non-WAEMU West African countries stated their intent to form a monetary union by 2003 before extending it to WAEMU countries in 2005, thus creating a monetary zone for ECOWAS. These countries are: Cape Verde, The Gambia, Ghana, Guinea, Nigeria and Sierra Leone. The agenda has been revised several times. Currently, the ECOWAS monetary union is expected to become operational in 2019.

2. A common view is that the output gap represents monetary policy makers' goal of output stability (Svensson, 1999). Others view the output gap as a proxy for expected future inflation (Favero and Rovelli, 1999).

3. Orphanides, Athanasios. 1997. "Monetary Policy Rules Based on Real-Time Data." *Finance and Economics Discussion Series*, Federal Reserve Board, 1998-03 (December).

4. As an instrument in TSLS regression, we use the current and lagged inflation and output gap terms.

5. The reduction of exchange rate volatility is one of the ECOWAS convergence criteria.

6. An AR(3) process was used to correct for the residuals from autocorrelation.

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Annexure A: Analysis of Series' order of Integration

Table A1: Unit root test (series with break)

		Break Localization			Date of break (quarter/year)	Decision	Order of integration
		Intercept +trend	Trend	Intercept			
UEMOA							
	TC_U			(-23.449)	Q2 / 1993	S	
	TMM_U			(-9.164)	Q1 / 1993	S	
	M1PIB_U		(-3.518)		Q2 / 2002	NS	I(1)
	M2PIB_U		(-3.949)		Q2 / 2002	NS	I(1)
GHANA							
	TC_G			(-4.363)	Q2 / 1995 and Q3 / 1999	NS	I(1)
	REER_G			(-4.827)	Q4 / 1992 and Q4 / 2000	NS	I(1)
	M1PIB_G		(-3.772)		Q2 / 2003	NS	I(1)
	M2PIB_G		(-3.009)		Q2 / 2003	NS	I(1)
	RESERV_G		(-3.187)		Q4 / 2002	NS	I(1)
NIGERIA							
	TC_N			(-1.736)	Q2 / 1992 and Q2 / 1994	NS	I(1)
	REER_N		(-2.900)		Q2 / 1994	NS	I(1)
	FASSET_N			(-2.230)	Q2 / 2003	NS	I(1)
FRANCE							
	TMM_F		(-3.941)		Q4 / 1994	NS	I(1)

Zivot and Andrews (1992) is used to test for the order of integration of series with just one break. The test developed by Clemente, Montanes and Reyes (1998) is applied when series exhibit two breaks. The optimal break point is endogenously determined.
Student Statistics are under blankets

Table A2: Unit root test (series without break)

				Decision	Order of integration
		ADF	**Phillips-Perron**		
UEMOA					
	PIB_U	(-2.339)	(1.927)	NS	I(1)
	CPI_U	(-1.167)	(-0.944)	NS	I(1)
	FASSET_U	(-2.236)	(1.489)	NS	I(1)
	RESERV_U	(0.387)	(2.396)	NS	I(1)
	INFLAC_U	(-6.290)	(-6.224)	S	
GHANA					
	PIB_G	(10.239)	(12.104)	S	
	CPI_G	(-0.486)	(6.065)	NS / S (conflict)	I(1)
	FASSET_G	(-0.486)	(6.065)	NS / S (conflict)	I(1)
	INFLAC_G	(-5.677)	(-5.434)	S	
NIGERIA					
	PIB_N		(2.790)	/ NS	I(1)
	CPI_N	(-1.687)	(2.656)	NS	I(1)
	M1PIB_N	(0.026)	(3.955)	NS / S (conflict)	I(1)
	M2PIB_N	(0.959)	(6.674)	NS / S (conflict)	I(1)
	RESERV_N	(2.266)	(3.949)	NS / S (conflict)	I(1)
	INFLAC_N	(-5.167)	(-4.959)	S	
FRANCE					
	CPI_F	(-1.789)	(-0.380)	NS	I(1)

Student Statistics are under blankets

Annexure B: Estimates of Taylor rule reaction coefficients

Table B: Estimates of Taylor rule reaction coefficients with OLS, TSLS and NLLS

Variables	Ghana			Nigeria			WAEMU		
	OLS	TSLS	NLLS	OLS	TSLS	NLLS	OLS	TSLS	NLLS
C	1.58**	1.2*	1.0*	2.7***	2.7***	2.2***	0.98***	0.95***	0.83****
dir(-1)	0.89***	0.9***	0.9***	0.80***	0.8***	0.85***	0.82***	0.83***	0.85***
Ecinf	0.08***	0.07***	0.08***	0.04***	0.05***	-0.01ns	0.03*	0.02*	0.013*
Gap				-0.05ns	-0.02ns	-0.02	0.20**	0.15**	0.16
gap(-2)	-0.65ns	-0.6ns	-0.6						
CFA Franc pre-devaluation dummy							1.1***	1.08***	2.0
Ghanaian 1992	2.2***	2.2***	2.0						
monetary reform Nigerian 1996 monetary reform				-3.6***	-3.9***	-3.9			
AR(1)	0.22**								
Adjusted R^2	0.94	0.94	0.9	0.75	0.6	0.67	0.91	0.92	0.9
F-stat	314.09			67.47		45.02	233.50		211.0
DW	2.04	1.6	1.6	1.83	1.2	1.7	1.72	1.73	1.7
LM(4)				3.48			4.99		

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Contents

List of tables

List of figures

Abstract

This paper analyses the monetary policy conduct of some central banks in Economic Community of West African States (ECOWAS) member countries in the post-monetary reforms era, to establish whether they follow the Taylor Rule or its subsequent modified reaction functions. Interest rate policy rules have been estimated to ascertain this. Despite the declared use of indirect monetary policy management, the empirical evidence suggests that Ghana and Nigeria's monetary policies are not consistent with the monetary policy rule according to the original Taylor formula or its adjusted variants. The robustness tests carried out using different estimation methods and inflation and output gap measurements, have not led to a significant improvement in the results of regressions. Interest rates weakly react to the variations of inflation and the output gap. Similar results are observed even if interest rates equations are adjusted by exchange rate, money, foreign assets and credit aggregates. In the case of the West African Economic and Monetary Union (WAEMU), the central bank seems to apply a Taylor rule which is adjusted by the interest rate of France.

Key words: *Monetary policy, Taylor rule, interest rate*

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