Reactions to Shocks and Monetary Policy Regimes: Inflation Targeting Versus Flexible Currency Board in Ghana, South Africa and the WAEMU

By: Fadia Al Hajj, Gilles Dufrénot, Kimiko Sugimoto, and Romain Wolf

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Fadia Al Hajj[1], Gilles Dufrénot[2], Kimiko Sugimoto[3], Romain Wolf[4]

Abstract

The aim of this paper is to examine the monetary policy actions through which the central banks in the Sub-Saharan African countries have searched to eliminate the negative impacts of the shocks facing their economies. We compare two types of monetary policy regimes: a currency board regime (in the CFA zone countries) and an inflation targeting policy regime (in Ghana and South Africa). We compare the properties of both policies when the central banks respond to three negative shocks hitting the economies: a recessionary demand shock, a supply shock increasing inflation and a negative fiscal shock. We propose an FPAS model (forecasting and monetary policy analysis system) that extends the usual FPAS models used in the literature to evaluate the impact of several policies in response to different types of exogenous shocks. We find that both policies are inappropriate to help the economies exiting from the effects of negative demand shocks (the adjustment relies mainly on fiscal policy), both are essential when negative shocks to primary balance occur (fiscal policy aggravates the negative effects of the shocks), while inflation targeting dominates the currency board regime as a strategy to cope with positive shocks to inflation.

Key words: inflation target, currency board, African countries

JEL classification: E52; F41; Q33

[1]Aix-Marseille Université and Aix-Marseille School of Economics (GREQAM & CNRS & EHESS), Email : fadiaelhajj@hotmail.com.

[2] Corresponding author. Aix-Marseille Université and Aix-Marseille School of Economics (GREQAM & CNRS & EHESS), Banque de France, CEPII. Château Lafarge, Route des Milles, 13290, Aix-en-Provence Les Miles. Email: gilles.dufrenot@univ-amu.fr.

[3] Konan University, Japan. Email: kimiko@center.konan-u.ac.jp.

[4] Banque de France, Direction de la Conjoncture et des Prévisions Macroéconomiques (DCPM). Email : romain.wolf@banque-france.fr.

1- Introduction

The recent years have seen a resurgence of the debate on monetary policy regimes in Sub-Saharan Africa, since the continent was hit by three major shocks. The first shock was a huge increase in the inflation rates in the wake of the increase in the energy and food price during the years 2006 and 2007. Two years later, 2009 began with another shock, namely a contraction in their GDP growth in a context of a great economic recession all over the world. Thirdly, the 2008-2009 international financial crisis also brought a mounting evidence of its negative impact on budget deficits and public debt ratio, through several channel: cuts in foreign aid, a decrease in some commodity prices and a drop of fiscal revenues.

These events have placed the issue of policy-mix back on the policy agenda. Before the recent great recession, the policymakers in Africa subscribed to the view that central banks had to focus on the control of inflation, with fiscal policy more or less passive (governments had to come up to fiscal sustainability by checking budget surpluses and a rapid decrease in their public debt ratio). However, the disappointments with passive policies when the economies are hit by severe exogenous shocks gave a renewed support to the idea that the harmful effects of the shock on the economies could be reduced under activism rather than under “laissez faire”. The aim of this paper is to examine the monetary policy actions through which the central banks in the Sub-Saharan African countries have searched to eliminate the negative impacts of the shocks facing the economies. We compare two types of monetary policy regimes: a currency board regime and an inflation targeting policy regime. In both cases, the monetary policy framework is that of nominal anchors. The difference is that in the first case, the domestic currency is tied to a foreign currency, while a domestic expectations-based anchor is chosen in the second case.

In Sub-Saharan Africa only two countries have chosen to officially adopt an inflation targeting policy: Ghana since May 2007 and South Africa since February 2000. The latter conducts a flexible inflation targeting aiming at stabilizing both inflation and output around some targets. The former pursues a hybrid strategy based on flexible inflation targeting but simultaneously seeks to manage the path of the exchange rate. A flexible currency board regime has been adopted by a group of countries since more than 60 years. The WAEMU countries have a common currency, the CFA Franc which is backed by the French Treasury through a

mechanism called the "Compte d'opérations" [5]. France guarantees the conversion of the CFA Francs into euros unlimitedly and permanently, by making advances to the central bank. As a consequence the creation of domestic money is controlled by a set of rules that amount to partially backing the domestic currency on foreign reserves.

In this paper, we compare the properties of both policies when the central banks respond to three negative shocks hitting the economies: a recessionary demand shock, a supply shock increasing inflation and a negative fiscal shock. The effects of such shocks have received a great attention in the policy circles over the last years. In order to capture the key transmission channels relevant to analyzing the CB's interventions under each monetary regime, we propose an FPAS model (forecasting and monetary policy analysis system) that extends the usual FPAS models used in the literature to evaluate the impact of several policies in response to different types of shocks (see Berg et al., 2006, Laxton et al. 2009). Compared to DSGE models, the FPAS models have been used to forecast inflation by the central bankers, by virtue of their simplicity, tractability and their understandable structure. Furthermore, they have proven to have reasonable empirical properties. The core framework features a small open new Keynesian economy with rational expectations with four behavioral equations: an aggregate demand curve, a Phillips curve, an exchange rate equation and an uncovered parity condition.

We extend the core framework by introducing some specificities of the three economies: the importance of lending conditions in the credit market, the role of government budget constraints through a fiscal reaction function adapted to the African countries, a Taylor rule which incorporates an objective of real exchange rate stabilization and a flexible currency board rule. The coefficients of the model are calibrated (not estimated) in such a way that the values simulated of the endogenous variables replicate their historical values between 2002 and 2012.

A first contribution of this paper is the analysis of the monetary policy reaction to shocks in a context of policy-mix. Typically, previous papers analyzing the monetary policy stabilization policy in the African countries under either inflation targeting and currency board regimes neglect the role of the fiscal policy actions and constraints. The only way in which the

[5] The West African Economic and Monetary Union (WAEMU) consists of eight countries which share the same currency, the CFA Franc: Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo. Their central bank (the Banque Centrale des Etats d'Afrique de l'Ouest, BCEAO) manages the common monetary policy.

interaction between monetary and fiscal policies is regarded is through fiscal dominance[6]. Here, we do not assume any kind of fiscal dominance. Instead, we consider that the issue of sound government finances is central in the African countries policy circles, thereby implying that the fiscal authorities can be forced to adopt fiscal consolidation policies (to reduce the public debt ratio) even in circumstances where the economies are hit by negative shocks. In such circumstances, several configurations of the policy-mix in response to negative shocks can emerge.

In some cases, we retrieve a well-known result in the literature that the cost of an inflation targeting policy can be an increase in the public debt ratio, if both monetary and fiscal policies are countercyclical. In other situations, monetary or fiscal policies are alternatively harmful (because they aggravate the negative effects of the shocks) and therefore the stabilization of the output and/or inflation rely on the other policy. For instance when the economies experience cost-push shocks that raise the inflation rate, the reaction of the central banks (cutting the interest rate or reducing the liquidity in the banking system) needs to be counteracted by expansive fiscal policies to dampen the negative impact of the restrictive monetary policy on the economies. Another example, when the countries face a negative demand shock, the currency board regime is ill-advised in terms of helping to slow down the GDP decline, because the countercyclical policy needed to attenuate the impact of the shock relies entirely on fiscal policy.

A second contribution of the paper is to highlight the importance of the real exchange rate in the Taylor rule in determining the speed of dissipation of the negative shocks. Ghana and South Africa, though they have both adopted a policy of inflation targeting, differ on one important point. In the latter, the interest rate is the unique instrument of monetary policy. In the former, the setting of the interest level according to the inflation gap is complemented by interventions in the foreign exchange markets to match the real exchange rate and its target. This means that, in practice, in Ghana monetary policy works with two instruments: discretionary changes in the CB's discount rate and indirect changes stemming from the variations of the foreign reserves (which impact the monetary aggregates and in turn the market interest rates). The negative shocks in the economy are accommodated more rapidly with two instruments than with only one.

[6] See for instance Fraga et al. (2003).

A third contribution is that the currency board regime can be totally de-stabilizing when the central bank search to react to a shock raising inflation. In this case, the right adjustment of the macroeconomic variables for the shock to die out relies on fiscal policy.

Finally, we find that both the inflation targeting and currency board regimes help stabilizing the inflation rate and the output following a negative shock on the primary balance. They act as a substitute to restrictive fiscal policies.

The remainder of the paper is organized as follows. In Section 2, we extend the standard framework of FPAS model to study the reaction of monetary policy to adverse shock. Section 3 contains the analysis of the reaction of monetary policies to different negative shocks. Finally, Section 4 concludes.

2- An open-economy FPAS model for Ghana, South Africa and the WAEMU

The baseline FPAS model with rational expectations is composed of four behavioral equations: an aggregate demand curve, a Phillips curve, an exchange rate equation and an uncovered parity condition. In this paper the core framework is extended to incorporate some specificities of the three economies: the importance of lending conditions in the credit market, the role of government budget constraints through a fiscal reaction function adapted to the African countries, a Taylor rule which incorporates an objective of real exchange rate stabilization and a flexible currency board rule.

We consider a rational expectations system that determine the dynamics of the domestic aggregate output y_t, the ratio of primary balance to GDP b_t, the inflation rate π_t, the real exchange rate z_t, domestic credit C_t, net foreign assets nfa_t, the real exchange rate r_t, and debt ratio d_t. We consider the following variables as exogenous: foreign aid, aid_t, net transfers from abroad $transf_t$, terms of trade TOT_t, foreign output and net foreign assets, y_t^W, nfa_t, the world real interest rate r_t^W and the French interest rate r_t^f.

The model is a New Keynesian model of aggregate demand and aggregate supply describing a small open economy with rational expectations. External demand shocks are captured in a IS curve, while unexpected changes in foreign prices are assumed to impact the domestic prices through a real exchange channel. The interest rate transmission channel to the economy is introduced through a bank lending channel, in order to capture the constraints faced by the

private sector in domestic capital markets which are characterized by a high banking intermediation. We finally consider that a world depression can be a source of potential shock to the economy through fiscal shock (the African countries are aid recipients and the donors lend funds in proportion to their revenues. Therefore an economic recession in the industrialized countries reduces the amount of aid available to the African countries and this in turn increases their primary deficits).

Furthermore, we do not introduce the usual condition of uncovered interest rate parity. Indeed, Ghana and the WAEMU have a relatively limited level of integration with the international capital markets. South Africa exerts a de facto control on inflows and outflows of capital.

As is standard in the literature, we present a model in log-linearized form with the variables of interest expressed in terms of deviations from their equilibrium level.

2.1.- Aggregate demand

We consider a forward-looking equation that combines several aspects of the literature on the transmission mechanisms of the different determinants of aggregate demand. The equation in expressed in terms of the output-gap. The micro foundations for relating the current and future output are standard (log-linear approximation of a model of representative consumer with an intertemporal CES utility function where consumption is equal to aggregate demand). We also consider irrational expectations by introducing partially backward-looking expectations. Rather than directly introducing the interest rate as a determinant of the aggregate demand, we consider a bank-lending channel à la Bernanke and Gertler (1995). Any change in the central bank discount rate induces changes in bank deposits and bank lending, thereby influencing domestic credits and then the output. This can be motivated in the standard micro models by assuming that a consumer faces a borrowing constraint that influence his intertemporal substitution behavior in lieu of the interest rate. Government fiscal balance also enters as a key determinant of demand as well as foreign demand. The equation is as follows:

$$y_t - y_t^* = \beta_0 + \beta_1(E_t y_{t+1} - y_{t+1}^*) + (1-\beta_1)(y_{t-1} - y_{t-1}^*) + \beta_3(z_t - z_t^*) - \beta_4(b_t - b_t^*) + \beta_5(C_t - C_t^*) + \beta_6(y_t^W - y_t^{W*}) + \varepsilon_t^y \quad (1)$$

$$\varepsilon_t^y = \varphi_y \varepsilon_{t-1}^y + \nu_t^y \quad , \nu_t^y \sim N(0, \sigma^2)$$

where $(y_t - y_t^*)$ is the domestic output-gap, $(z_t - z_t^*)$ is the real exchange rate gap, $(b_t - b_t^*)$ is the fiscal gap and b_t is the primary balance as share of GDP, $(C_t - C_t^*)$ is the lending gap and $(y_t^W - y_t^{W*})$ is the world output-gap. A decrease in z_t represents a real appreciation. $E_t x_{t+1}$ means the expectation made at time t of the future value of a variable x at time t+1. A star indicates the equilibrium value of a variable. We assume that $0 < \beta_1 < 1$ (an expected future income yields an increase in current demand), $\beta_3 > 0$ (a depreciation raises the output), $\beta_6 > 0$ (the domestic and foreign business cycles are synchronized). ε_t^y is a demand shock with a variance $\sigma_y^2/1 - \varphi_y$.

There are several motivations for considering domestic credit as a determinant of aggregate demand. In forward-looking IS equations, it is the long-run interest rate, rather than the short-run interest rate, that matters to account for intertemporal substitution behaviors. Changes in the money base (and thus in domestic credit) can be used as a proxy for the long-run rates. Another motivation is the bank-lending channel as we already mentioned above. Indeed, any change in the central bank's discount rate shifts the supply of loans by the commercial banks and in turn affect the output. It is assumed that $\beta_5 > 0$ (an increase in the ratio of domestic credit as share of GDP raises the output).

2.2.- Bank-lending channel and domestic credit

Given the high level of banking intermediation in Ghana, South Africa and WAEMU countries, we propose to interpret the presence of the credit gap in the aggregate demand equation as reflecting a bank lending channel, in the case of Ghana and South Africa, and as the consequence of loans to depository institutions in the case of the WAEMU countries.

In Ghana and South Africa, the ratio of domestic credit provided by the banking sector to GDP, C_t, depends upon the short-run interest rate (bank lending channel) and upon banks' expectations of future output-gap:

$$C_t - C_t^* = \delta_0 - \delta_1(r_t - r_t^*) + \delta_2(E_t y_{t+1} - y_{t+1}^*) + \varepsilon_t^C \qquad (2a)$$

$$\varepsilon_t^c = \varphi_c \varepsilon_{t-1}^c + \nu_t^c \quad , \nu_t^c \sim N(0, \sigma^2)$$

r_t is the real interest rate defined as the central bank's nominal interest rate minus the expected inflation rate, $r_t = i_t - E_t\pi_{t+1}$, where i_t is the nominal interest rate and π_t is the inflation rate between time t-1 and t. r_t^* is the interest rate corresponding to the long-run equilibrium of the

interest rate. We assume that δ_1>0 (banks' borrowing cost in the money market reduces the profitability of their loan activity, thereby implying a decrease in domestic credit). The second term in the right-hand side of the equation indicates that the subjective beliefs of the loan officers in the banks about the future economic conditions are a leading indicator for the cyclicality in the lending activity. This second term captures the Minsky Financial instability hypothesis to explain busts and booms in the credit cycle (for a recent paper, see Battacharya et al., 2011). We assume that $\delta_2 > 0$. ε_t^C is a shock stemming from the banking sector (for instance a credit crunch if the shock is negative) with a variance $\sigma_C^2/1-\varphi_c$.

In the case of the WAEMU countries, as explained below, monetary policy functions like a fixed-exchange rate regime (or flexible currency board) with a limited role for the interest rate which evolves like the French discount rate. Domestic credit depends upon the central bank's loans to depository institutions which are reflected in the changes in domestic assets. Denoting the domestic assets by $asset_t$, we have

$$C_t - C_t^* = \delta_0 + \delta_1(a_t) + \delta_2(E_t y_{t+1} - y_{t+1}^*) + \varepsilon_t^C \qquad (2b)$$

where $a_t = \left[\frac{assets_t}{assets_t + F_t}\right](asset_t - asset_{t-1})$ and F_t is foreign reserves. An increase in the domestic assets held by the central bank (weighted by the ratio of these assets over the money supply) resulting from higher loans to the banking sector raises credits made by the banking sector. Therefore δ_1 and δ_2 are both positive.

2.3.- Fiscal policy and debt dynamics

The introduction of a public finance variable in the aggregate demand equation is standard. The novelty here is that this variable is endogenous. Indeed, in the African countries fiscal space is used for increasing public spending that are expected to exert a positive effect on growth (health, education, infrastructure)[7]. Among the different ways of creating fiscal space, the countries often face the following three alternatives: reducing spending in low-priority areas, increasing aid inflows such as grants or official development assistance, reducing their debt ratio or pushing it to a more sustainable level, increasing domestic revenues. Further, the empirical literature shows that changes in the terms of trade can increase the fiscal vulnerability of countries that are exporters of commodities. All these elements are considered

[7] For an example, see Gottschalk et al. (2009).

in the following equation in which the fiscal gap is defined by assuming that the fiscal authorities adjust the ratio of primary budget balance b_t in response to the deviation of the expectation of debt ratio d_t from its sustainable level d_t^*, foreign aid aid_t, the output gap and the inflation gap

$$b_t - b_t^* = \theta_0 + \theta_2(E_t d_{t+1} - d_{t+1}^*) + \theta_3 aid_t + \theta_4(y_t - y_t^*) + \theta_5(TOT_t) + \varepsilon_t^b \qquad (3)$$

$$\varepsilon_t^b = \varphi_b \varepsilon_{t-1}^b + \nu_t^b \quad , \nu_t^b \sim N(0, \sigma^2)$$

We assume that $\theta_2 > 0$ (we have fiscal sustainability in the sense of Trehan and Walsh, 1991), $\theta_3 > 0$ (any grant is a non-fiscal revenue that improves the primary balance), $\theta_4 > 0$ (fiscal policy is countercyclical) and $\theta_5 > 0$ (an increase in the terms of trade improves the fiscal balance). ε_t^b is a fiscal shock with a varianceσ_b. A negative shock reflects different situations: the possibility that grants are withdrawn or diminished (therefore requiring a fiscal adjustment from the recipient government) or a decrease in external borrowing.

In the equation above d_t is endogenous and described by the standard recursive equation governing the dynamics of the debt ratio:

$$d_t = (1 + \lambda) d_{t-1} - b_t, \qquad (4)$$

where λ is the average value of the discrepancy between the public debt interest rate and the real GDP growth rate (divided by 1 plus the real GDP growth rate). We take the average, over the years 2002-2011. One important question concerns the sign of λ. In Ghana and the WAEMU countries, a high proportion of their debt is external debt with a debt service contracted at concessional levels (very low interest rates). Therefore, λ can be approximated by the ratio $-g/(1+g)$, where g is the average of the growth rate of the real GDP. Therefore $\lambda < 0$. Based on previous empirical studies on the fiscal reaction function for South Africa, we also assume that $\lambda < 0$ (see Burger et al., 2012).

We define b_t^* as the long-run value of the sustainable primary balance defined as $b_t^* = \lambda d_t^*$, where d_t^* the targeted debt ratio.

2.4.- Aggregate supply

Aggregate supply is described by a Phillips curve that combines a backward-looking acceleration equation and the expectations of future inflation. The micro foundation is for instance Roberts (1997), which encompasses the standard backward-looking model ($\alpha_1 = 0$)

and forward-looking models in which imperfect information or rigidities are introduced (see Taylor, 1980, Rotemberg, 1982):

$$\pi_t = m_0 + (1 - m_1)\{\alpha_1 E_t \pi_{t+1} + \alpha_2 \pi_{t-1} + \alpha_3 (y_t - y_t^*)\} + m_1 (z_t - z_{t-1}) + \varepsilon_t^\pi \qquad (5)$$

$$\varepsilon_t^\pi = \varphi_\pi \varepsilon_{t-1}^\pi + \nu_t^\pi \quad , \nu_t^\pi \sim \mu(0, \sigma^2)$$

ε_t^π is a cost-push shock with a variance $\sigma_\pi^2 / 1 - \varphi_\pi$.

The additional point here is that we include the real exchange rate as an explanatory variable in the equation to account for the real exchange rate pass-through. π_{t+1}^* is the inflation target for time t+1 set by the central bank and we assume that monetary policy is credible $E_t \pi_{t+1} = \pi_{t+1}^*$. We assume incomplete pass-through ($0 < m_1 < 1$). In this partially forward-looking Phillips curve, we assume that the consumer price inflation is the result of domestic inflation and foreign inflation with $\alpha_1 > 0$, $\alpha_2 > 0$, $\alpha_3 > 0$.

2.5.- Monetary policy

Case 1. - The WAEMU countries: a flexible currency board regime

The institutional restrictions on money creation in the WAEMU countries are such that the monetary system functions like a flexible currency board regime. The functioning of the Compte d'Opérations implies that money stock is partially back by foreign currency reserves. In the long-run the money stock must grow at the same rate as in the anchor country (the euro area), changes in the foreign reserves reflects balance of payments surpluses or deficits. The money stock is defined like in a system of fixed exchange rates:

$$M_t = h_t (F_t + asset_t) \qquad (6a)$$

where F_t is foreign reserves and h_t is the money multiplier. Any discrepancy between the growth rate of money stock ΔM_t and its target ΔM_t^* is a consequence of changes in the balance of payments implying changes in foreign reserves. The central bank can sterilize the effect on money stock by adjusting the amount of the domestic assets. A sterilization policy is thus reflected by $-\Delta F_t = \vartheta \Delta asset_t$, with $\vartheta = 1$, in case of complete monetary autonomy. The central bank's behavior is therefore described by the following reduced form equation which is familiar in the models of the monetary approach to the balance of payments:

$$a_t = a_0 - \varphi_1 f_t + (1-\varphi_1)\{\varphi_2(y_t - y_{t-1}) + \varphi_3(r_t - r_{t-1}) + \varphi_4 h_t + \varphi_5 \pi_t\} + \varepsilon_t^a \quad (6b)$$

$$\varepsilon_t^a = \varphi_a \varepsilon_{t-1}^a + v_t^a \quad , v_t^a \sim N(0, \sigma^2)$$

where $f_t = \left[\frac{F_t}{assets_t + F_t}\right](F_t - F_{t-1})$. The presence of both the real interest rate and the real output in this equation is motivated by the fact that the target money stock is the money stock that equals the money people desire to hold (money demand). We assume that monetary policy is transparent and credible, so that the agents in the economy want to hold the amount of money for which the growth rate of money stock does not systematically deviate from that of the reserve currency country (in our case the euro area countries). In this case ΔM_t^* is a function of the changes of determinants of money demand, typically the real income, the nominal interest rate and the inflation rate. By using the fisher relationship, that relates the nominal and real interest rates, we can substitute the real interest rate to the nominal interest rate. ε_t^a is a shock on the domestic assets with a variance $\sigma_a/1-\varphi_a$. The nominal interest rate is assumed to be that of France, since in previous studies it has been shown that the WAEMU discount rate and the French rate are highly correlated (see Dufrénot, 2011). But the real rates may differ. Depending upon the values of the parameter φ_1, we have several configurations of the degree of monetary autonomy. If $\varphi_1 = 1$, then the central bank keeps perfect control over the money base. If $\varphi_1 = 0$, then, there is no monetary policy autonomy. Previous empirical papers in the literature have shown that in the case of the WAEMU countries we have partial monetary policy autonomy with $\varphi_1 = 0.7$ (see Veyrune, 2007). Since we do not have a strict currency board and that only a fraction of the BCEAO's foreign reserves must be backed by foreign reserves, changes in the foreign components of the money supply will result in a less than proportionate change in the domestic component. The sign of the other parameters depends upon the impact of the other explanatory variables on money demand: $\varphi_2 > 0$, $\varphi_3 < 0$, $\varphi_4 < 0$, $\varphi_5 > 0$.

Finally, the real exchange rate is endogenous and its dynamics is influenced by the determinants of the relative prices (domestic versus foreign prices). The determinants of the real exchange rates in the WAEMU countries have been extensively studied in the empirical literature (see, among others, Dufrénot and Yehoue, 2005, Abdih and Tsangarides, 2010, Roudet et al., 2007). Core factors affecting the long run and short-run real exchange rates are the terms of trade TOT_t, government spending, the primary balances b_t, the degree of openness $OPEN_t$, the relative productivity $RPROD_t$ (domestic relative to foreign):

$$z_t = \omega_0 + \omega_1 OPEN_t + \omega_2 TOT_t + \omega_3 RPROD_t + \omega_4 b_t + \varepsilon_t^z \qquad (6c)$$

where $\varepsilon_t^z$is a real exchange shock and we assume that $\omega_1 < 0, \omega_2 > 0, \omega_3 > 0$. Indeed, a higher openness induces higher external imbalances that are corrected through a depreciation; higher terms of trade yield to an appreciation due an increase in the price of non-traded goods; an increase in the relative productivity yields a real appreciation (Balassa-Samuelson effect). ω_4 can be either positive or negative depending upon whether higher government spending is directed towards traded or non-traded goods.

Case 2. – Ghana and South-Africa: an inflation targeting policy

Monetary policy is described by a Taylor rule in an open economy, with the exchange rate gap as an additional variables to the usual inflation and output-gap[8]. The central bank adjusts its discount rate according to the relative importance given to the inflation target and to the real activity:

$$r_t - r_t^* = \rho_0 + \rho_1(E_t\pi_{t+1} - \pi_{t+1}^*) + \rho_2(E_t y_{t+1} - y_{t+1}^*) + \rho_3(z_{t-1} - z_{t-1}^*) + \varepsilon_t^r \qquad (7a)$$

$$\varepsilon_t^r = \varphi_r \varepsilon_{t-1}^r + \nu_t^r \quad , \nu_t^r \sim N(0, \sigma^2)$$

where π_t^* is the targeted inflation announced by the central bank at time t to prevail at time t+1, and r_t^* is the real interest rate corresponding to the targeted inflation. Both countries have adopted a regime of managed float, which implies that$\rho_3 \neq 0$. We assume that the central bank responds to depreciation by raising the interest rate and vice versa. We therefore have $\rho_3 > 0$. The interest rate is also raised in response to an expected inflation rate above the target and expected output-gap above its long-run value ($\rho_1, \rho_2 > 0$). Theoretically, due to so called Trilemma, the monetary authorities cannot adopt an independent monetary policy while achieving at the same time a stable exchange rate under the assumption of perfect capital mobility. However, it is known from the literature that some countries that adopted IT also intervene in foreign exchange markets. This is the case of Ghana and South Africa.

The real exchange rate is described by an equation like (6c), but we add the interest rate differential to account for the impact of capital and financial flows on the nominal (and thus real) exchange rate:

[8] See Taylor (2001).

$$z_t = \omega_0 + \omega_1 OPEN_t + \omega_2 TOT_t + \omega_3 RPROD_t + \omega_4 b_t + \omega_5 (r_t - r_t^F) + \varepsilon_t^z \qquad (7b)$$

where $\omega_1 > 0, \omega_2 < 0, \omega_3 < 0, \omega_4 < 0, \omega_5 > 0$. r_t^F is the foreign interest rate (USA).

We further assume that $\varepsilon_t^z = \varphi_z \varepsilon_{t-1}^z + \nu_t^z \quad , \nu_t^z \sim N(0, \sigma^2)$.

To sum up, the simulations are done using three models that consist of the following equations:

-for the WAEMU countries: (1), (2b), (3), (4), (5), (6b), (6c).

-for Ghana and South Africa: (1), (2a), (3), (4), (5), (7a), (7b).

We assume that all shocks are AR (1) processes.

3- Analyzing the effects of different shocks

3.1- Solving the model

Our models can be casted into a second order multivariate model:

$$B_0 Y_t = A_0 + B_1 Y_{t-1} + \mathrm{D} X_t + \mathrm{C} E_t Y_{t+1} + U_t \quad , \quad U_t = \Phi U_{t-1} + v_t \qquad (9)$$

where B_0, B_1, C are 7x7 matrices, D is a 7x10 for Ghana and South Africa and 7x12 for WAEMU. v_t is a vector of iid innovations. A_0 and E are 7x10 vectors containing respectively the constants and the shocks. The exact expressions of the matrices are given in appendix 1. The vectors of variables are defined as follows:

For Ghana and South Africa:

$Y_t' = (\tilde{y}_t, \tilde{c}_t, \tilde{b}_t, \tilde{d}_t, \tilde{\pi}_t, \tilde{r}_t, \Delta z_t)$, $E_t' = (\varepsilon_t^y, \varepsilon_t^c, \varepsilon_t^b, 0, \varepsilon_t^\pi, \varepsilon_t^r, \varepsilon_t^z)$

$X_t' = (y_t^w, aid_t, TOT_t, \pi_t^*, \tilde{\varepsilon}_{t-1}, open_t, Rprod_t, r_t - r_t^f, b_t^*, z_t^*)$

For WAEMU:

$Y_t' = (\tilde{y}_t, \tilde{c}_t, \tilde{b}_t, \tilde{d}_t, \tilde{\pi}_t, a_t, \Delta z_t)$, $E_t' = (\varepsilon_t^y, \varepsilon_t^c, \varepsilon_t^b, 0, \varepsilon_t^\pi, \varepsilon_t^a, \varepsilon_t^z)$

$X_t' = (\tilde{y}_t^w, aid_t, TOT_t, \pi_t^*, \tilde{\varepsilon}_{t-1}, open_t, Rprod_t, f_t, h_t, b_t^*, \Delta r_t \; z_t^*)$

Y_t is the vector of endogenous variables; X_t is the vector of exogenous variables; $E_t$is the vector of shocks. A solution can be found using the method of undetermined coefficients.

We define:

$$e_t = Y_t - PY_{t-1} + e_0$$

where P is a matrix to be determined and which has full rank

Substituting this into (9) we get:

$$B_0(e_t + PY_{t-1} - e_0) = A_0 + B_1 y Y_{t-1} + \Delta X_t + CE_t(e_{t+1} + PY_t - e_0) + U_t$$

$$= A_0 + B_1 Y_{t-1} + \Delta X_t + CE_t e_{t+1} - CE_t e_0 + CE_t\{P(PY_{t-1} + e_t - e_0)\} + U_t$$

$$= A_0 + B_1 Y_{t-1} + \Delta X_t + CE_t e_{t+1} - CE_t e_0 + CP^2 y Y_{t-1} + cPe_t - cPe_0 + U_t \quad (10)$$

To eliminate Y_{t-1} and the constant term we need the following two conditions:

$$BP - B_1 - CPP = 0 \qquad \text{and} \qquad e_0 = A_0(CP - C - B_0)^{-1}$$

This yields:

$$B_0 e_t = CE_t e_{t+1} + DX_t + CPe_t + U_t \quad (11)$$

which implies:

$$e_t = (B_0 - CP)^{-1} CE_t e_{t+1} + (B_0 - CP)^{-1}\Delta X_t + (B_0 - CP)^{-1} U_t$$

or:

$$e_t = \pi_1 E_t e_{t+1} + \pi_2 \Delta X_t + \pi_3 U_t$$

Solving recursively, we obtain:

$$e_t = \sum_{j=0}^{\infty} \pi_1^j E_t[\pi_2 X_{t+j} + \pi_3 U_{t+j}] \quad (12)$$

Since $U_t = \Phi U_{t-1} + v_t$ where v_t is a vector of i.i.d. process with zero mean, we have the following moving average MA(∞) representation:

$$U_{t+j} = U_1 + \sum_{i=0}^{\infty} \Phi^i v_{t+j=i} \quad (13)$$

Replacing in (12) using the definition of e_t , we obtain the general solution:

$$Y_t = PY_{t-1} + \sum_{j=0}^{\infty} \pi_1^j E_t\{\pi_2 X_{t+j} + \pi_3 \sum_{i=0}^{\infty} \Phi^i v_{t+j-i} + \pi_3 U_1\} \quad (14)$$

where X_t is assumed to be exogenous with the expected value provided by the historical data. To find a value of P[9] that satisfy the quadratic equation $BP = B_1 + CPP$, we use a generalized scheme decomposition. Once P is obtained, we get e_0 by replacing in $e_0 = A_0(CP - C - B_0)^{-1}$. The values retained for the calibration of the parameters of the model yield a solution which is unique and stationary.

3.2- Model calibration and solution

We calibrate the model to match the key macroeconomic features of the three economies over the last 10 years from 2002 to 2012. 10 years is reasonable to avoid structural instability in the parameters. We therefore do not calibrate the model over a too long period. Moreover, we examine the dynamic effects of different shocks that occurred within the recent ten years. These include supply shocks such as the surge in the energy and food prices in 2006 and 2007, financial and recession shocks from 2008 onwards. The calibrated parameters for the different equations and countries are reported in Tables B1 till B3, in Appendix 2. Some values are chosen from previous studies in the literature.

A first issue is the determination of the equilibrium values of the endogenous variables. z_t^* and C_t^* are assumed to be constant and equal to the average values of the real effective exchange rate and net domestic credit as share of GDP between 2002 and 2011. The debt ratio equilibrium value d_t^* is set to 70% for WAEMU and Ghana. This corresponds to WAEMU's public debt target in the Stability and Convergence Pact. Though, Ghana is not a member of the WAEMU area, the *country* is expected to belong to a common monetary area in the forthcoming years and this will require a convergence of macroeconomic policies between the WAEMU and WAMZ countries[10]. We therefore set the target debt ratio at the same level as for the WAEMU countries. This implies a negative benchmark for the primary balance b_t^* of -4% for Ghana and -2% for WAEMU. Since there is no explicit announced target for the ratio of

[9] The solution for P for the three countries can be found in Appendix 1.

[10] The West African Monetary Zone (WAMZ) was formed in 2000 and is a group of 6 countries in West Africa that plan to have a common currency with the WAEMU countries by the year 2020. These countries are the Gambia, Ghana, Guinea, Liberia, Nigeria, Sierra-Leone.

debt to GDP in South Africa, we have to rely on an ad-hoc assumption. From the South African Reserve bank's and South African Ministry of Finance' reports and the IMF regional economic outlook from 2002 onwards, it is usually considered that a debt ratio below 50% is a sustainable level. This implies that the benchmark value for the ratio of primary deficit is -1.7%. The inflation target is set to 2% for WAEMU (similar to the implicit target in the euro area given that the CFA Franc is anchored on the Euro), 6% for South Africa (the upper limit of the inflation target band (as shown by Klein (2012); though the official target is between 3% and 6%, the central bank seems to have aimed for the upper bound) and 5% for Ghana (medium-term goal since the inflation targeting policy has been formally adopted in 2007). Finally, the long-run interest rate is set to the average of the period 2007-2011 for Ghana and WAEMU and the average of the period 2002-2011 for South Africa. For Ghana and South Africa, we compute the average since the year of adoption of the inflation target policy.

3.3 Impulse response functions to different shocks

We compute the impulse response functions corresponding to the following shocks:

- A negative demand shock on ε_t^y, for instance a recession as occurred during the years 2008-2009 in the aftermath of the subprime crisis;
- A positive shock to ε_t^π, representing inflationary pressure stemming for instance from currency depreciation, higher inflation expectations or cost-push shock as was the case during the surge in oil and food prices that happened in 2006-2007.
- A negative shock on ε_t^b, representing negative side effects for the African countries of the international crisis (reduction in foreign aid, negative terms of trade shocks occurring through the external account changes);

Each shock is introduced as a standard deviation of 1. The variables are shown in terms of deviations from their steady state.

The question of which policy-mix should be preferred –fiscal and inflation targeting versus fiscal and currency board policies – can be examined according to different criteria. We deal with this issue by considering jointly the variability of the macroeconomic indicators, the capacity of the policies in absorbing the shocks rapidly (by limiting their persistence) and their stabilizing properties (whether they induce changes in the variables in the right direction). By

persistence, we mean the length of time before a given change – relative to its equilibrium value - in a variable vanishes. The concept of variability adopted here is not statistical, but interpreted with a policy perspective. For instance, a policy-mix with a fiscal policy boosting production and a monetary policy leading to a contraction of the output is considered as involving a lower variability of the output than a policy-mix with both policies changing the output in the same direction. We further propose to compare the monetary policy regimes by considering their cost in terms of public debt ratio (which is a key concern for the Sub-Saharan African countries).

3.3.1 Reactions to a negative demand shock

South Africa and Ghana

The effects are depicted in Figures 1 till 3. A negative demand shock (contraction in aggregate demand) yields a decrease in the expected production under its equilibrium level. This pushes the expected inflation rate below its target (negative output and inflation gaps) and triggers a countercyclical reaction from both the central bank and the government. The central bank reacts by cutting the interest rate and the government increases the primary deficits (negative fiscal gap). The reduced interest yields a higher amount of credits (positive credit gap) and a depreciation of the exchange rate (negative exchange rate gap). These two effects boost growth and raise inflation. The reduced fiscal gap is equivalent to an increase in public demand that ignite the negative impact of the shock on output. During the transition from the initial impact of the shock to the final restoration of equilibrium, the economy experiences an increase in the debt ratio.

WAEMU

A negative demand shock reduces production below its equilibrium level as shown in Figure 4. This yields a decrease in money demand. The CB validates this decrease by reducing money supply after the shock. It does so by selling assets in the money market and this is equivalent to reducing the monetary base ($a_t \; decreases$) . This implies a restriction in the amount of credit loans by the banking sector (negative credit gap) and a further output decrease. Therefore, if we would consider the reaction of monetary policy alone, a negative demand shock would have a

harming effect on the GDP and would yield to deflationary pressures. The only way to inhibit the decrease in the output is through a countercyclical fiscal policy (higher primary deficit and debt ratio) as is observed in the corresponding IRF, in Figure 5.

Figure 1. – Impact of a negative demand shock in % on the GDP in South Africa and Ghana

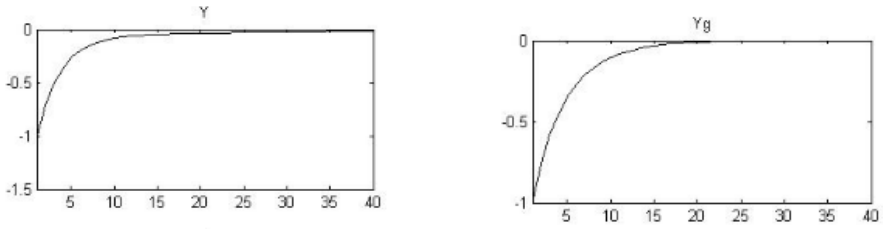


Figure 2. - Reactions to a negative demand shock respectively of inflation, interest rate, credit, real exchange rate, primary balance and debt ratio in % in South Africa

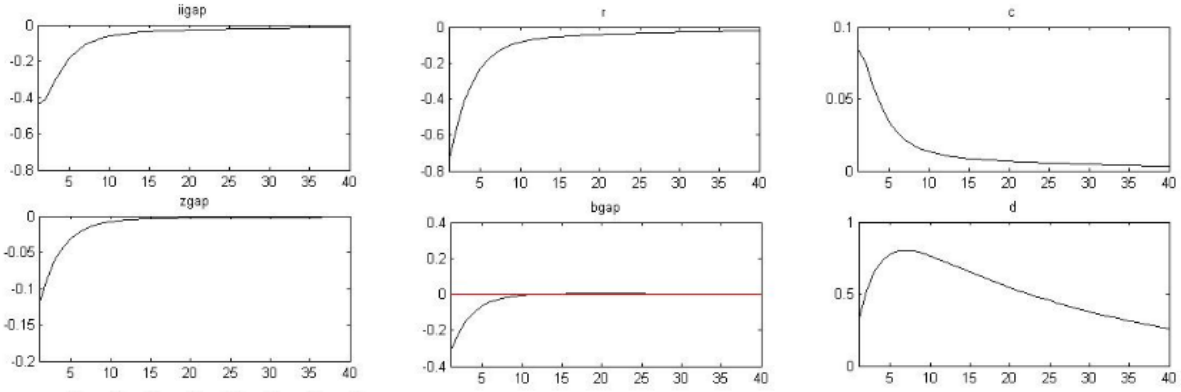


Figure 3.- Reaction to a negative demand shock respectively of inflation, interest rate, credit, real exchange rate, primary balance and debt ratio in % in Ghana

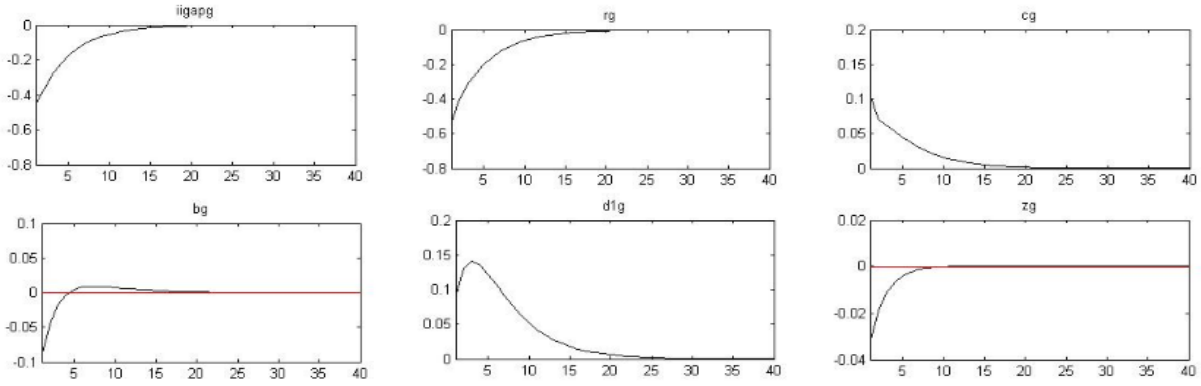


Figure 4. Impact of a negative demand shock in % on the GDP in WAEMU

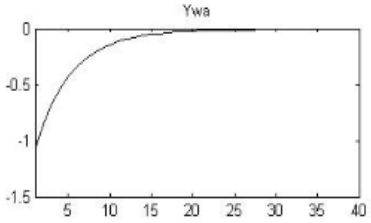


Figure 5. - Reaction to a negative demand shock respectively of inflation, ratio of domestic assets, credit, real exchange rate, primary balance and debt ratio in % in WAEMU.

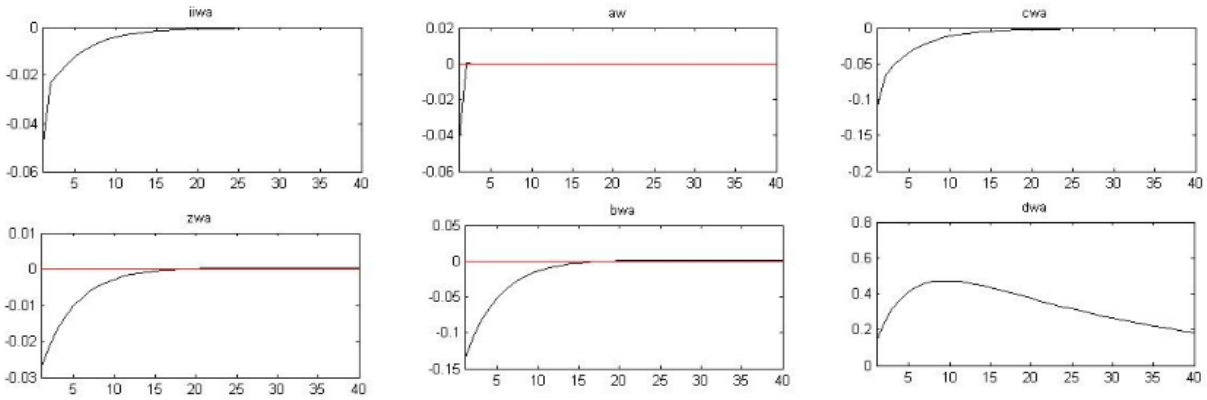


Table 1 summarizes the main properties of the policies. The monetary authorities in Ghana and South Africa are able to respond to a negative demand shock by lessening the decrease in production (through interest rate cuts), while the task is proved more difficult in the WAEMU countries (the money supply is endogenous and responds passively to changes in the demand for money). The currency board seems to be a disadvantage in itself since the countercyclical policy needed to attenuate the impact of the shock relies entirely on fiscal policy. Therefore, the stabilization of the output-gap after a given negative demand shock may require a larger change in the fiscal policy under a currency board regime than under inflation targeting (compare Ghana and the WAEMU). This leads excess government debt (the debt ratio is higher and its dynamics more persistent in the WAEMU than in Ghana). To sum up, the IRFs provide arguments in favor of an active fiscal policy in both Ghana and the WAEMU, but for different reasons. In Ghana, the fiscal policy amplify the reaction of monetary policy. In the WAEMU, it is a good substitute for the passive monetary policy (at the cost of a higher public indebtedness).

However, the story is different if we compare South Africa with Ghana. In the former country, the interest rate cut is higher and last a longer period, thereby explaining the importance of the

credit channel in dampening the effects of the shocks on the output. Per se, the monetary policy would be enough to cope with the shock. The additional countercyclical reaction of the fiscal policy translates into an excess and persistent public debt ratio. This would militate against the use of fiscal policy in addition to monetary policy.

Table 1.- Main properties of the policies when reacting to a negative demand shock

Monetary policy	●Persistent effects on credits in South Africa: source of higher variability of the output. ●Stabilizing properties on the output under inflation targeting, but de-stabilizing effects under currency board. ●Higher variability of the output under inflation targeting (because is a complement to fiscal policy) than under currency board (because the negative shock yields a contraction of the money supply). ●In South Africa, higher variability of the output than in Ghana, because cuts in the interest rate are of a higher magnitude and more persistent over time). ●In South Africa, inflation targeting induces a higher cost in terms of the level and dynamics of the public debt ratio
Fiscal policy	●Cost in terms of public debt ratio under currency board ●Stabilizing properties on production, but increases the variability of the output under inflation targeting

3.3.2 Reactions to a positive shock to inflation

Table 2 summarizes the properties of the policy-mix under both inflation targeting and currency board after a positive shock to inflation. An interesting feature is that inflation

targeting stabilizes both inflation and the output, while the currency board regime yields to de-stabilizing effects, thereby implying a higher variability of these variables.

South Africa and Ghana

The effects are shown in Figures 6 till 8. A positive inflation shock causes the inflation rate to go above its target value, thereby implying an initial raise in the interest rate by the CB. This reduces the GDP below its equilibrium value (negative output gap) since credits to the economy are restricted (negative credit gap).

However, a few periods after the initial growth decrease, the CB changes the orientation of its monetary policy by lowering the interest rate. This moderates the declines in the output, and in the inflation rate till these variables return to their equilibrium level. The dynamics of the real exchange rate is accordingly characterized by an appreciation followed by a depreciation.

The results shown here, for Ghana and South Africa, suggests that their CB cope with inflation pressures by adopting a two-step approach. Following the initial increase in the general level of prices, the CB proceeds to a large cut in the interest rate, implying the additional inflation to die out quickly, but at the cost of an output reduction and a higher debt ratio.

Then, in a second step, the monetary authorities search to prevent a too strong GDP decrease by providing a stimulus through a moderate interest rate decrease. Such a behavior from the CB is illustrative of flexible inflation targeting rather than a strict inflation targeting policy in the sense that these countries aim at stabilizing both inflation and the output, by keeping the output around its targeted level. A flexible inflation target policy helps in the policy-mix by allowing fiscal policy to be countercyclical. This is illustrated for instance in Figure 8 for Ghana where the reaction of the primary balance to the inflation shocks is characterized by a fiscal consolidation (increase in fiscal balance, when the GDP decrease dies out). This helps limiting the increase in the debt ratio.

These finding contradicts a widespread view according to which, in the developing countries, a monetary tightening in response to inflation shocks yields to explosive debt dynamics when fiscal policy responds in a countercyclical manner to negative shocks[11]. Here, a flexible inflation targeting policy implies that the interest rate is raised when inflation goes above its

[11] See Loyo (1999).

target, and is then cut once the output goes below its target. Per se, the adjustment of the interest rate alone could be enough to stabilize the output and reduce its variability.

The initial shock dissipates more slowly in South Africa than in Ghana. Indeed, insofar as the coefficient ρ_3 associated with the exchange rate in the Taylor rule is small (0.04), this country's situation is that of a standard inflation targeting regime in a closed economy. When, however, as is the case in Ghana, the real exchange rate enters as a key argument of the Taylor rule (ρ_3 equals 0.7), the so-called "divine coincidence" situation does not apply. Indeed, to stabilize the output-gap, the central bank cannot control the inflation rate solely, but must also ensure simultaneously that the exchange rate moves in the right direction. As shown by the empirical studies, in some countries including Ghana, the central banks, while pursuing a policy of inflation targeting, also intervene in foreign exchange markets when the exchange rate deviates from its target. These intervention modifies the exchange reserves, and thus the money supply and in turn affect the interest rates. In Ghana, the monetary policy response to the initial shock thus affects aggregate demand, not only through a direct interest rate channel, but also through an exchange rate channel (the addition of both effects increases the magnitude of the central bank's reaction to the inflation shock which dies out faster than in South Africa). In Ghana, the exchange rate is used in lieu of the fiscal policy to attenuate the effects of the shock on the output. Accordingly, the public debt ratio dies out rapidly, while in South Africa it does not because the fiscal policy is strongly countercyclical over the entire period.

WAEMU

The effects of a positive inflation shock is depicted in Figures 9 and 10. An increase in inflation yields an increase in the demand for money. The CB responds to the higher demand by buying assets in the money markets which increases the monetary base and the money supply. This results in a higher amount of distributed credits by the banking sector, which boosts the output above its equilibrium level. As shown in Figure 10, the changes in assets and credit have a persistent effect on production. This has a destabilizing effect on inflation, because prices grow as the result of increasing demand. In this case fiscal policy matter to control the mean-reverting dynamics of inflation. The initial shock is removed by a restrictive fiscal policy or a fiscal consolidation (increase in the budget balance gap). The result is a decrease in the debt ratio. Therefore, the economic imbalances that results from a positive supply shock (higher inflation and output) are aggravated by the monetary policy and the only

possible mechanism to reverse this is to reduce public demand through a restrictive fiscal policy. So it is important that fiscal policy is not "deviant" in the WAEMU countries and that the government achieves fiscal surpluses for not contribution to aggravate inflation. If public spending is primarily directed towards traded goods (an assumption implying that ω_4 in Equation (6c) is negative), fiscal consolidation yields an appreciation of the real exchange rate (positive exchange rate gap). This further contributes to reduce both inflation and the output.

Figure 6. – Impact of a positive inflation shock in % on inflation in South Africa and Ghana

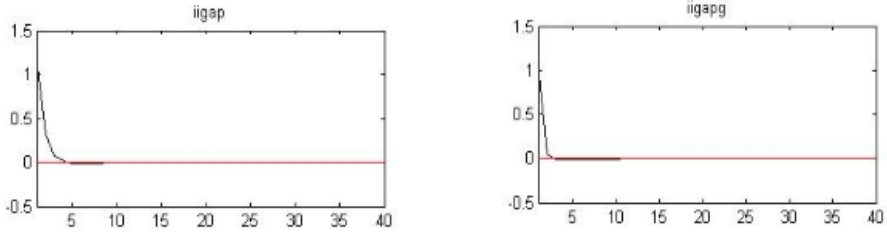


Figure 7.- Reactions to a positive inflation shock respectively of interest rate, credit, output, real exchange rate, primary balance and debt ratio in % in South Africa

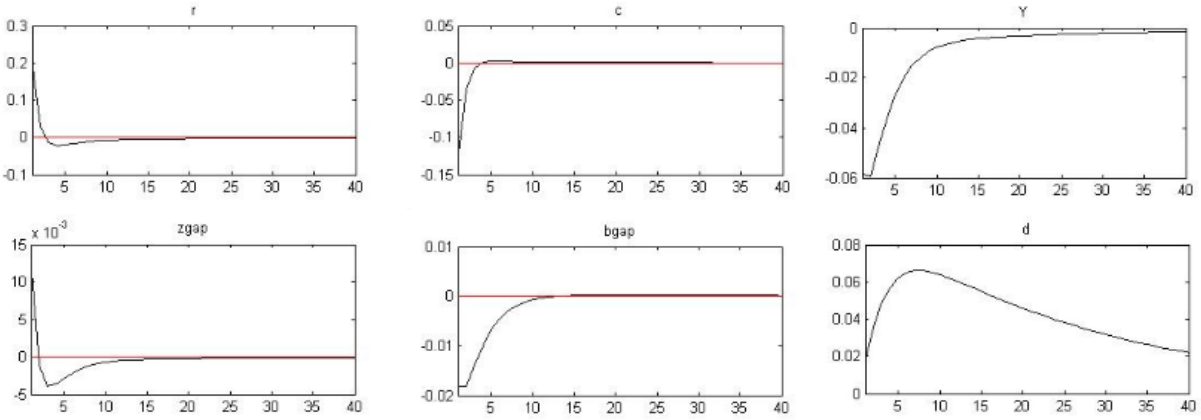


Figure 8.- Reactions to a positive inflation shock respectively of interest rate, credit, output, real exchange rate, primary balance and debt ratio in % in Ghana.

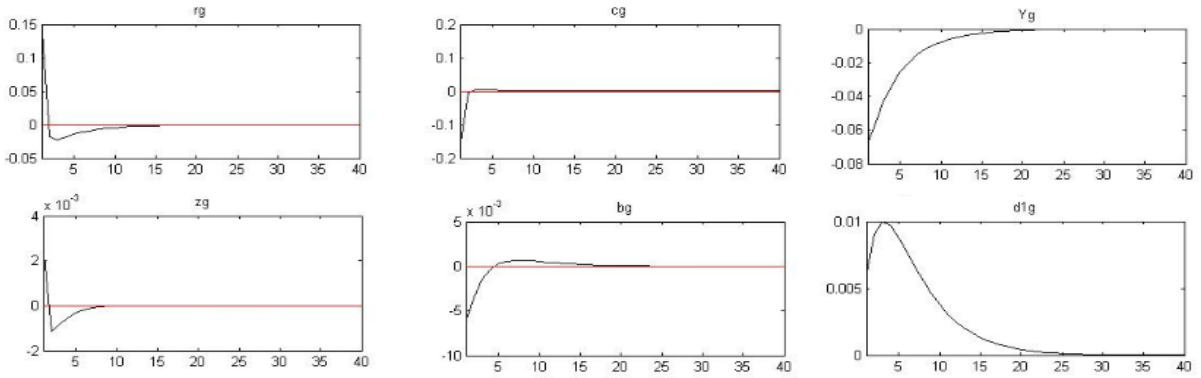


Figure 9.- Impact of a positive inflation shock in % in the WAEMU

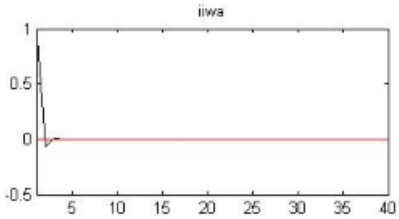


Figure 10.- Reaction to a positive inflation shock respectively of ratio of domestic assets, credit, output, real exchange rate, primary fiscal balance and debt in % in the WAEMU

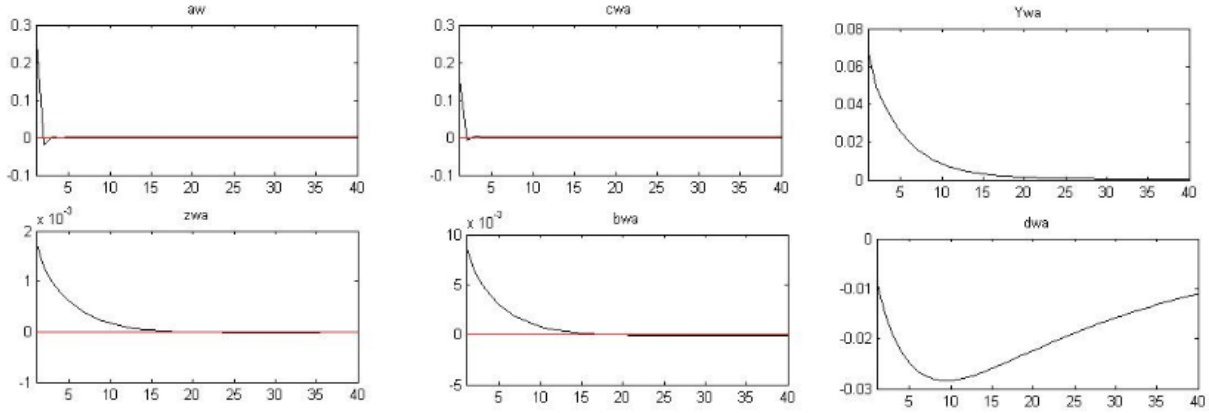


Table 2.- Main properties of the policies when reacting to a positive inflation shock

Monetary policy	●Under inflation targeting, lowers the variability of the output through a two-step approach: an increase in followed by a cut of the interest rates. Under a currency board regime, the policy has de-stabilizing effects on both inflation and the output, thereby implying a higher variability of both variables. ●The use of two instruments, namely the interest rate and policy intervention in the foreign exchange markets reduces the persistence of the output dynamics in Ghana compared with what happens in South Africa.
Fiscal policy	●Stabilizing effects on the public debt ratio in Ghana and in the WAEMU, but not in South Africa (policy strongly countercyclical) ●Under currency board, helps stabilizing inflation and output through a fiscal consolidation

3.3.3 Reactions to a negative shock to primary balance

South Africa and Ghana

The effects are shown in Figures 11 till 13. A negative shock to the primary balance boosts the economy by increasing the output. The increased output raises the inflation rate which is fought by an increase in the interest rate. This in turn reduces the volume of credits and therefore slows the output increase.

Moreover, the shock shifts the debt ratio upward and the latter is curbed by higher in primary surpluses or a policy of fiscal consolidation. The latter cancels the increase in production, and even decreases in the output and inflation rate are observed. In turn, the monetary authorities respond by interest rate cuts. The induced effects are those of an expansionary monetary policy, specifically higher credits and a real exchange rate appreciation leading the output and the inflation rate back to their equilibrium level.

A negative shock to the primary balance thus yields to policy reactions that differ from those induced by a negative aggregate demand shock. Here, fiscal policy leads to a depressive effect on production, which is more pronounced as the government's fiscal sustainability constraint is strong. For instance, we see that the coefficient that measures the response of the primary balance to expected changes in the debt ratio debt is very high in Ghana (0.82) compared to its value in South Africa (0.03). This motivates a two-step reaction of the monetary authorities, once to stabilize inflation by preventing price increases induced by the negative shock on the primary balance, then a second time to stabilize production and prevent it falling.

WAEMU

The impacts are graphed in Figures 14 and 15. In WAEMU, the shock also yields a higher debt ratio and increases production. This results in a decrease in inflation. Once again, to slow down the increase in the debt ratio, the government needs to increase its primary balance, which negatively impact the output growth and implies that the Central bank reacts by buying more assets in order to increase the liquidity in the economy and allow a higher amount of credits

distributed by the banking sector to slow down the induced decrease in the output till it goes back to its equilibrium level. As a result, monetary policy is oriented in the same direction as in South Africa and Ghana, being expansionary to counteract the negative effects on the activity of the fiscal sustainability constraint. The difference arises only in the instrument used, namely interest rates in one case, and the central bank's balance sheet in the second case.

Figure 11.- Impact of primary fiscal balance shock in % on the primary surplus : South Africa and Ghana

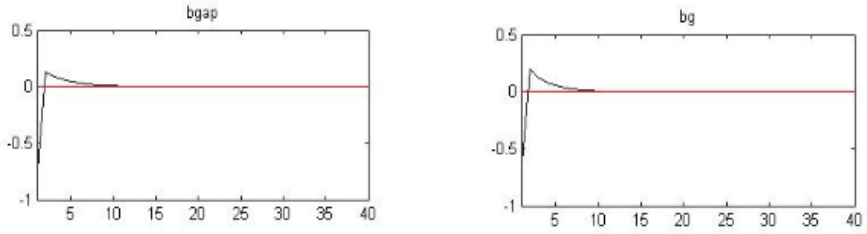


Figure 12.-Impact of a negative shock on primary balance on respectively inflation, interest rate, credit, debt, real exchange rate and output in % in South Africa.

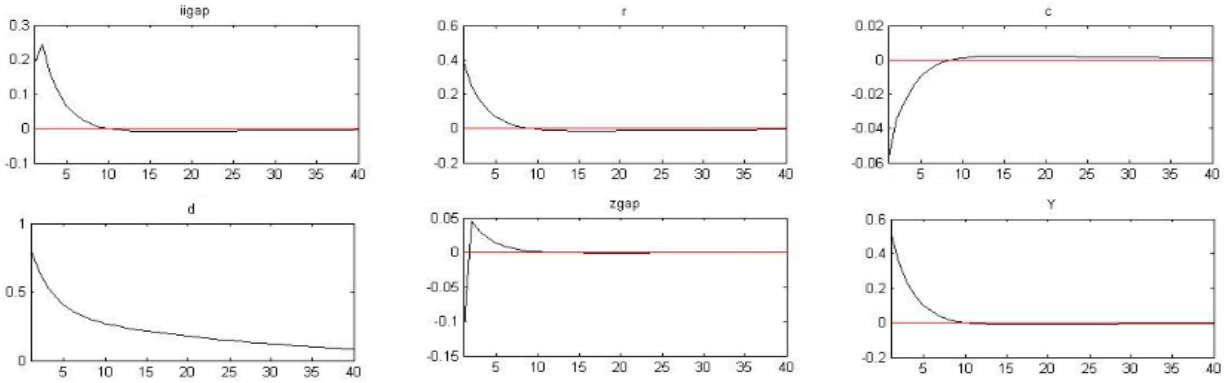
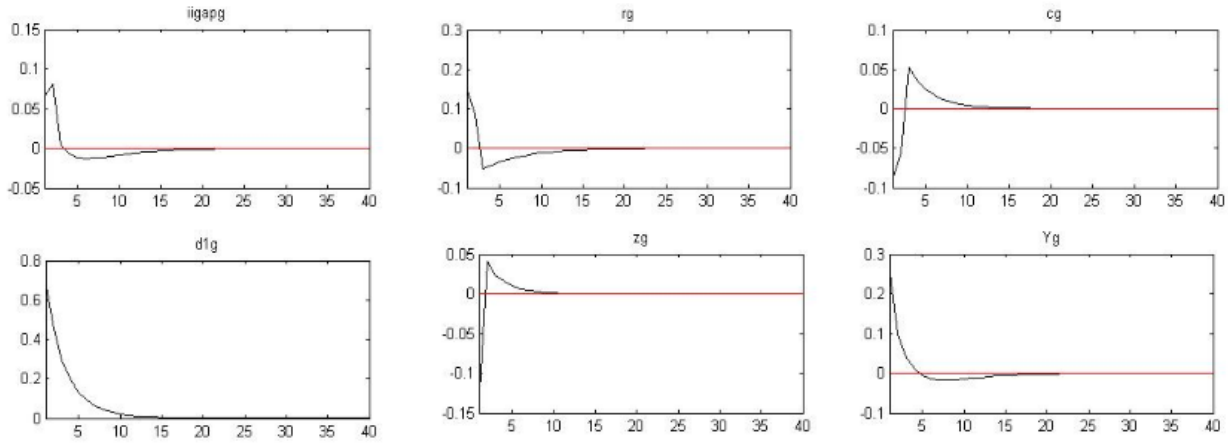


Figure 13.-Impact of a negative shock on primary balance on respectively inflation, interest rate, credit, debt, real exchange rate and output in % in Ghana



The properties of the policies are summarized in Table 3.

Table 3.- Main properties of the policies when reacting to a negative fiscal shock

Monetary policy	●No difference between inflation targeting and currency board regimes. The policy is expansionary to counteract the negative effect of fiscal consolidation on the output. ● In both regimes, monetary and fiscal policies work in opposite directions, thereby limiting the variability of inflation and of the output.
Fiscal policy	● The policy is restrictive in order to reduce the public debt ratio: stabilizing effects on both inflation and the output

Figure 14.- Impact of primary fiscal balance shock in % on the primary surplus : WAEMU

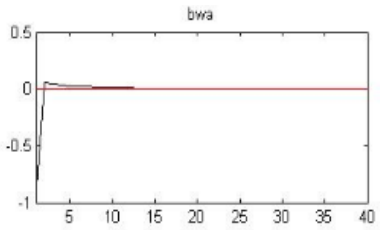
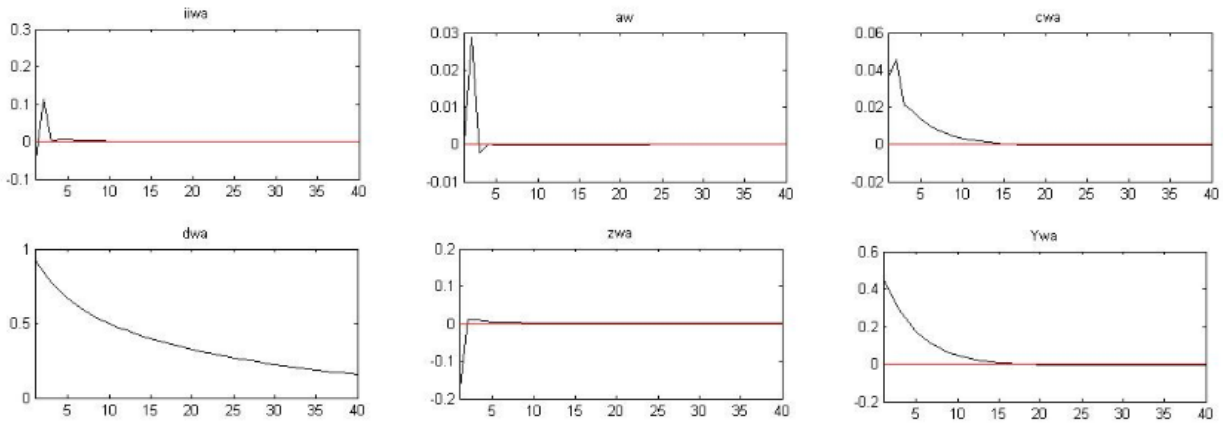


Figure 15.-Impact of a negative shock on primary balance on respectively inflation, interest rate, credit, debt, real exchange rate and output in % : WAEMU



4.-Conclusion

The tougher issue today in Africa is the choice among two nominal anchors: inflation targeting or exchange rate pegging. A widespread view among central bankers and academics is that the first policy makes a difference in regard to its ability to attenuate the volatility of the output and of inflation and to lead to a fall in inflation level. However, the example of the CFA zone countries suggests that pegging the domestic currency to that of a low inflation country also contributes to keeping inflation under control. Further, such a peg does not necessarily leaves the WAEMU countries opened to speculative attacks because of the “insurance” mechanism by the French Treasury. Our paper suggests that, when the policies are compared in terms of their ability to eliminate the negative effects of the shocks facing the countries, there is no clear evidence of a predominance of one regime over the other.

Our results are summarized in Table 4. They do indicate the inability of a currency board regime to perform well when used to fight negative demand shocks and positive shocks to inflation. Its efficiency in reducing the variability of inflation and output is small relative to its de-stabilizing effects because the changes in assets moves in the wrong direction to stabilize the effects of the shocks. The adjustments prove successful only if fiscal adjustment is employed as a substitute for monetary policy. Inflation targeting policy is more successful in this regard, playing in a straightforward way when the economy is hit by a positive supply shock: monetary policy has all the good properties (stabilizing effects, low variability, low persistence of the shock). There is, however, evidence of a poor performance when used to remove the effects of a negative demand shock: the effects of the latter tends to be persistent,

inflation and the output exhibit a high variability and it is also clear that the policy in costly in terms of public debt ratio.

The usefulness of both monetary regimes in an attempt to lean against a negative primary balance shock is justified by their advantage in countering the effects of a restrictive fiscal policy.

To sum up, both policies seem inappropriate to help the economies exiting from the effects of negative demand shocks (the adjustment relies mainly on fiscal policy), both are essential when negative shocks to primary balance occur (fiscal policy aggravates the negative effects of the shocks), while inflation targeting dominates the currency board regime as a strategy to cope with positive shocks to inflation.

Table 4.- Effects on output and inflation of inflation targeting and currency board

	Negative demand shock	Positive shock to inflation	Negative shock to primary balance
Inflation targeting	-Stabilizing effect -Higher volatility -High persistence of the shock -Costly in terms of public debt ratio	-Stabilizing effect -Low variability -Low persistence of the shock	-Stabilizing effects -Low variability -Low variability of the shock
Conclusion	Monetary and fiscal policies are complements (but at the cost of a higher debt ratio	Monetary policy alone would be enough	Expansionary monetary policy needed as a substitute for restrictive fiscal policy
Currency board	-De-stabilizing effects -Lower variability -Lower persistence of the shock -costly in terms of debt ratio	-De-stabilizing effects -High persistence of the shock -Low variability	-Stabilizing effects -Low variability -Low persistence of the shocks
Conclusion	Fiscal policy enough	Contractionary fiscal policy needed	Expansionary monetary policy needed as a substitute

			for restrictive fiscal policy

Appendix 1

Ghana and South Africa

The model is given by the following equations:

$$y_t - y_t^* = \beta_0 + \beta_1(E_t y_{t+1} - y_{t+1}^*) + (1-\beta_1)(y_{t-1} - y_{t-1}^*) + \beta_3(z_t - z_t^*) \\ -\beta_4(b_t - b_t^*) + \beta_5(C_t - C_t^*) + \beta_6(y_t^W - y_t^{W*}) + \varepsilon_t^y \quad (1)$$

$$C_t - C_t^* = \delta_0 - \delta_1(r_t - r_t^*) + \delta_2(E_t y_{t+1} - y_{t+1}^*) + \varepsilon_t^C \quad (2a)$$

$$b_t - b_t^* = \theta_0 + \theta_2(E_t d_{t+1} - d_{t+1}^*) + \theta_3 aid_t + \theta_4(y_t - y_t^*) + \theta_5(TOT_t) + \varepsilon_t^b \quad (3)$$

$$d_t = (1+\lambda)d_{t-1} - b_t, \quad (4)$$

$$\pi_t = m_0 + (1-m_1)\{\alpha_1 E_t \pi_{t+1} + \alpha_2 \pi_{t-1} + \alpha_3(y_t - y_t^*)\} + m_1(z_t - z_{t-1}) + \varepsilon_t^\pi \quad (5)$$

$$r_t - r_t^* = \rho_0 + \rho_1(E_t \pi_{t+1} - \pi_{t+1}^*) + \rho_2(E_t y_{t+1} - y_{t+1}^*) + \rho_3(z_{t-1} - z_{t-1}^*) + \varepsilon_t^r \quad (7a)$$

$$z_t = \omega_0 + \omega_1 OPEN_t + \omega_2 TOT_t + \omega_3 RPROD_t + \omega_4 b_t + \omega_5(r_t - r_t^F) + \varepsilon_t^z \quad (7b)$$

We define $\tilde{X}_t = X_t - X_t^*$:

$$\tilde{y}_t = \beta_0 + \beta_1 E_t[\tilde{y}_{t+1}] + (1-\beta_1)\tilde{y}_{t-1} + \beta_3 \tilde{z}_{t-1} - \beta_4 \tilde{b}_t + \beta_5 \tilde{c}_t + \beta_6 \tilde{y}_t{}^w + \varepsilon_t^y$$

$$\tilde{c}_t = \delta_0 - \delta_1 \tilde{r}_t + \delta_2 E_t[\tilde{y}_{t+1}] + \varepsilon_t^c$$

$$\tilde{b}_t = \theta_0 + \theta_2 E_t \tilde{d}_{t+1} + \theta_3 aid_t + \theta_4 \tilde{y}_t + \theta_5 TOT_t + \varepsilon_t^b$$

$$\tilde{d}_t = (1+\lambda)\tilde{d}_{t+1} - \tilde{b}_{t+1}$$

$$\tilde{\pi}_t = m_0 + (1-m_1)\{\alpha_1 E_t \tilde{\pi}_{t+1} + \alpha_2 \tilde{\pi}_{t-1} + \alpha_2 \tilde{y}_t\} + m_1 \Delta z_t + [(1-m_1)(\alpha_1+\alpha_2) - 1]\pi_t^* \\ + \varepsilon_t^\pi$$

$$\tilde{r}_t = \rho_0 + \rho_1 E_t \tilde{\pi}_{t+1} + \rho_2 E_t \tilde{y}_{t+1} + \rho_3 \tilde{z}_{t-1} + \varepsilon_t^r$$

$$\Delta z_t = \omega_0 + \omega_1 open_t + \omega_2 TOT_t + \omega_3 Rprod_t + \omega_4 \tilde{b}_t + \omega_5 (r_t - r_t^F) - z_t^* - \tilde{z}_{t-1} + \omega_4 b_t^* + \varepsilon_t^z$$

For Ghana and South Africa the model can be cast in the following form:

$$B_0 Y_t = A_0 + B_1 Y_{t-1} + \Delta X_t + C E_t Y_{t+1} + \zeta U_t \quad , \quad U_t = \Phi U_{t-1} + v_t$$

Where:

$$Y_t' = (\tilde{y}_t, \tilde{c}_t, \tilde{b}_t, \tilde{d}_t, \tilde{\pi}_t, \tilde{r}_t, \Delta z_t), \qquad E_t' = (\varepsilon_t^y, \varepsilon_t^c, \varepsilon_t^b, 0, \varepsilon_t^\pi, \varepsilon_t^r, \varepsilon_t^z)$$

$$X_t' = (\tilde{y}_t^w, aid_t, TOT_t, \pi_t^*, \tilde{z}_{t-1}, open_t, Rprod_t, b_t^*, r_t - r_t^F)$$

v_t is a 7x1 vector of i.i.d. innovations A_1, A_2, B are 7x7 matrices, c is a 7x10 matrix , A_0 and B_t are a 7x1 vectors

$$C = \begin{bmatrix} \beta_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \delta_2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \theta_2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & (1-m_1)\alpha_1 & 0 & m_1 \\ \rho_2 & 0 & 0 & 0 & \rho_1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$B_0 = \begin{bmatrix} 1 & -\beta_5 & \beta_4 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & \delta_1 & 0 \\ -\theta_4 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ -(1-m_1)\alpha_3 & 0 & 0 & 0 & 1 & 0 & -m_1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & -\omega_4 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A'_0 = (\beta_0, \delta_0, \theta_0, 0, m_0, \rho_0, \omega_0)$$

$$B_1 = \begin{bmatrix} 1-\beta_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & (1+\lambda) & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & (1-m_1)\alpha_2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$D=\begin{bmatrix}\beta_1 & 0 & 0 & 0 & \beta_3 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & \theta_3 & \theta_5 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & c_1 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & \rho_3 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & \omega_2 & 0 & -1 & \omega_1 & \omega_3 & \omega_5 & \omega_4 & -1\end{bmatrix} \quad c_1 = (1-m_1)(\alpha_1+\alpha_2)-1$$

$$\varphi=\begin{bmatrix}\varphi_y & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & \varphi_c & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & \varphi_b & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & \varphi_\pi & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & \varphi_r & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & \varphi_z\end{bmatrix}$$

P is found to be for Ghana (with the calibrated parameters):

$$P=\begin{bmatrix}1.9740 & 0 & 0 & 0.0190 & 0.0618 & 0 & 0\\ 4.2339 & 0 & 0 & 0.0715 & 0.1438 & 0 & 0\\ 0.6027 & 0 & 0 & 0.0324 & 0.0187 & 0 & 0\\ -0.6027 & 0 & 0 & 0.9376 & -0.0187 & 0 & 0\\ -6.9423 & 0 & 0 & -0.1392 & 0.0630 & 0 & 0\\ -4.7783 & 0 & 0 & -0.0925 & -0.1539 & 0 & 0\\ -3.5320 & 0 & 0 & -0.0724 & -0.1019 & 0 & 0\end{bmatrix}$$

For South Africa:

$$P=\begin{bmatrix}0.2307 & 0 & 0 & -0.0143 & -0.0124 & 0 & 0\\ -0.0038 & 0 & 0 & -0.0031 & -0.0357 & 0 & 0\\ 0.0735 & 0 & 0 & 0.0223 & -0.0039 & 0 & 0\\ -0.0735 & 0 & 0 & 0.9477 & 0.0039 & 0 & 0\\ 0.0734 & 0 & 0 & 0 & 0.3051 & 0 & 0\\ 0.0618 & 0 & 0 & -0.0112 & 0.0631 & 0 & 0\\ 0.0140 & 0 & 0 & 0.0042 & -0.0007 & 0 & 0\end{bmatrix}$$

For WAEMU, we have a similar system :

$$y_t - y_t^* = \beta_0 + \beta_1(E_t y_{t+1} - y_{t+1}^*) + (1-\beta_1)(y_{t-1} - y_{t-1}^*) + \beta_3(z_t - z_t^*) \\ -\beta_4(b_t - b_t^*) + \beta_5(C_t - C_t^*) + \beta_6(y_t^W - y_t^{W*}) + \varepsilon_t^y \qquad (1)$$

$$C_t - C_t^* = \delta_0 - \delta_1(a_t) + \delta_2(E_t y_{t+1} - y_{t+1}^*) + \varepsilon_t^C \qquad (2b)$$

$$b_t - b_t^* = \theta_0 + \theta_2(E_t d_{t+1} - d_{t+1}^*) + \theta_3 aid_t + \theta_4(y_t - y_t^*) + \theta_5(TOT_t) + \varepsilon_t^b \quad (3)$$

$$d_t = (1+\lambda)d_{t-1} - b_t, \quad (4)$$

$$\pi_t = m_0 + (1-m_1)\{\alpha_1 E_t \pi_{t+1} + \alpha_2 \pi_{t-1} + \alpha_3(y_t - y_t^*)\} + m_1(z_t - z_{t-1}) + \varepsilon_t^\pi \quad (5)$$

$$a_t = a_0 - \varphi_1 f_t + (1-\varphi_1)\{\varphi_2(y_t - y_{t-1}) + \varphi_3(r_t - r_{t-1}) + \varphi_4 h_t + \varphi_5 \pi_t\} + \varepsilon_t^a \quad (6b)$$

$$z_t = \omega_0 + \omega_1 OPEN_t + \omega_2 TOT_t + \omega_3 RPROD_t + \omega_4 b_t + \varepsilon_t^z \quad (6c)$$

We define $\tilde{X}_t = X_t - X_t^*$:

$$\tilde{y}_t = \beta_0 + \beta_1 E_t[\tilde{y}_{t+1}] + (1-\beta_1)\tilde{y}_{t-1} + \beta_3 \tilde{z}_{t-1} - \beta_4 \tilde{b}_t + \beta_5 \tilde{c}_t + \beta_6 \tilde{y}_t{}^w + \varepsilon_t^y$$

$$\tilde{c}_t = \delta_0 - \delta_1 \tilde{r}_t + \delta_2 E_t[\tilde{y}_{t+1}] + \varepsilon_t^c$$

$$\tilde{b}_t = \theta_0 + \theta_2 E_t \tilde{d}_{t+1} + \theta_3 aid_t + \theta_4 \tilde{y}_t + \theta_5 TOT_t + \varepsilon_t^b$$

$$\tilde{d}_t = (1+\lambda)\tilde{d}_{t+1} - \tilde{b}_{t+1}$$

$$\tilde{\pi}_t = m_0 + (1-m_1)\{\alpha_1 E_t \tilde{\pi}_{t+1} + \alpha_2 \tilde{\pi}_{t-1} + \alpha_2 \tilde{y}_t\} + m_1 \Delta z_t + [(1-m_1)(\alpha_1+\alpha_2) - 1]\pi_t^* + \varepsilon_t^\pi$$

$$\tilde{a}_t = a_0 - \varphi_1 f_t + (1-\varphi_1)\varphi_2 \tilde{y}_t - \varphi_2(1-\varphi_1)\tilde{y}_{t-1}$$

$$+(1-\varphi_1)\rho_3 \tilde{r}_t + (1-\varphi_1)\varphi_5 \tilde{\pi}_t + (1-\varphi_1)\varphi_4 h_t + (1-\varphi_1)\varphi_5 \pi_{t+}^* \varepsilon_t^a$$

$$\Delta z_t = \omega_0 + \omega_1 open_t + \omega_2 TOT_t + \omega_3 Rprod_t + \omega_4 \tilde{b}_t + \omega_4 b_t^* - z_t^* - \tilde{z}_{t-1} + \varepsilon_t^z$$

The model can be cast in the following form:

$B_0 Y_t = A_0 + C \quad E_t Y_{t+1} + \mathrm{B} Y_{t-1} + \mathrm{D} X_t + D E_t$,

Where:

$Y_t' = (\tilde{y}_t\ ,\ \tilde{c}_t\ ,\ \tilde{b}_t\ ,\ \tilde{d}_t\ ,\ \tilde{\pi}_t, \tilde{r}_t, \Delta z_t)$, $\qquad E_t' = (\varepsilon_t^y, \varepsilon_t^c, \varepsilon_t^b, 0, \varepsilon_t^\pi, \varepsilon_t^a, \varepsilon_t^z)$

$X_t' = (\tilde{y}_t^w, aid_t, TOT_t, \pi_t^*, \tilde{z}_{t-1}, open_t\ , Rprod_t\ ,\ b_t^*, f_t, h_t, \Delta r_t, z_t^*)$

The matrices A_0, B_0, B_1, C, D are defined as follows:

$$B_0=\begin{bmatrix} 1 & -\beta_5 & \beta_4 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & \delta_1 & 0 \\ -\theta_4 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ -(1-m_1)\alpha_3 & 0 & 0 & 0 & 1 & 0 & -m_1 \\ -(1-\varphi_1)\varphi_2 & 0 & 0 & 0 & -(1-\varphi_1)\varphi_5 & 1 & 0 \\ 0 & 0 & -\omega_4 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$C=\begin{bmatrix} \beta_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \delta_2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \theta_2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & (1-m_1)\alpha_1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$B_1=\begin{bmatrix} 1-\beta_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & (1+\lambda) & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & (1-m_1)\alpha_2 & 0 & 0 \\ -\varphi_2(1-\varphi_1) & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

D=

$$\begin{bmatrix} \beta_4 & 0 & 0 & 0 & \beta_3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \theta_3 & \theta_5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & c_1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & (1-\varphi_1)\varphi_5 & 0 & 0 & 0 & 0 & -\varphi_1 & (1-\varphi_1)\varphi_4 & (1-\varphi_1)\varphi_3 & 0 \\ 0 & 0 & \omega_2 & 0 & -1 & \omega_1 & \omega_3 & \omega_4 & 0 & 0 & 0 & -1 \end{bmatrix}$$

where $c_1 = (1-m_1)(\alpha_1+\alpha_2)-1$

$A'_0 = (\beta_0, \delta_0, \theta_0, 0, m_0, \rho_0, \omega_0)$

And Finally P was found to be (with the calibration of the parameters):

$$P=\begin{bmatrix} 0.9400 & 0 & 0 & -0.0078 & 0.0005 & 0 & 0 \\ 0.0887 & 0 & 0 & -0.0014 & 0.0013 & 0 & 0 \\ 0.1199 & 0 & 0 & 0.0082 & 0.0001 & 0 & 0 \\ -0.1199 & 0 & 0 & 0.9618 & -0.0001 & 0 & 0 \\ 0.0486 & 0 & 0 & 0.0006 & -0.0739 & 0 & 0 \\ -0.0005 & 0 & 0 & -0.0002 & -0.0020 & 0 & 0 \\ 0.0240 & 0 & 0 & 0.0016 & 0 & 0 & 0 \end{bmatrix}$$

Appendix 2

Table B1: Equilibrium values

	Ghana	South Africa	WAEMU
Real exchange rate index	96.81	91.63	100.39
Credit ratio as share of GDP (%)	28.04	79.98	18.41
Debt ratio as share of GDP (%)	70	50	70
Primary balance as share of GDP (%)	-4	-1.7	-2
λ	-0.06	-0.03	-0.03
Inflation (%)	5	6	2

Table B2: Calibration of the parameters

	Ghana	**South Africa**	**WAEMU**
Aggregate Demand Parameters			
β_1: Weight forecast output gap	0.1[16]	0.05 [12]	0.1[16]
β_2: lagged output gap	0.75[13,16]	0.70 [8]	0.75[16]

[12] Taken from Harjes and Ricci (2008).

[13] Taken from Alpanda et al. (2011).

[15] Taken from Fielding et al. (2012). For credit, we consider the elasticity of the growth rate with respect to money growth, and we take the average of the coefficients of the WAEMU countries. We consider the same value for Ghana and South Africa.

β_3: real exchange gap elasticity	0.1[16]	0.05[8]	1.3[14]
β_4: Fiscal gap elasticity	0.44[16]	0.55	0.7[16]
β_5: Credit gap elasticity	0.40[15]	0.40[15]	0.40[15]
β_6: World output gap	0.25[16]	0.20[8]	0.44[15]
Taylor Rule			
ρ^1*: taylor rule inflation*	2.5[16]	0.73[9]	–
ρ^2: taylor rule output gap	0.5[16]	0.62[9]	–
ρ^3: taylor rule real exchange rate	0.7[16]	0.04[9]	–
Currency board parameters			
φ^1*: net foreign asset ratio*	–	–	0.5[17]
φ^2: output gap	–	–	0.06[17]
φ^3: interest rate	–	–	0.3[17]
φ^4*: money multiplier*	–	–	0.15[17]
φ^5: Inflation	–	–	0.55[17]
Credit parameters			
δ^1*: interest rate/domestic asset*	0.9[17]	0.6[17]	0.51[17]
δ^2: output gap	0.06[17]	0.1[17]	0.32[17]
Standard Deviation of shocks			
σ_y: aggregate demand	0.27[17]	0.29[17]	0.24[17]
σ_c: Credit	0.269[17]	0.34[17]	0.63[17]
σ_b: fiscal balance	0.096[17]	0.009[17]	0.26[17]
σ_π: domestic inflation	0.26[17]	0.08[17]	0.17[17]
$\sigma_{r/a}$: Monetary policy	0.30[17]	0.26[17]	0.37[17]
σ_z: Real exchange rate	0.031[17]	0.043[17]	0.06[17]

[16] Taken from Dagher et al. (2010).

Aggregate supply parameters			
m_1:	0.3^{16}	0.28^{9}	0.5^{14}
α_2: past domestic inflation	0.9^{16}	0.37^{9}	-0.15^{16}
α_1: expected future inflation	0.1^{16}	0.63^{9}	0.40^{16}
α_3: output gap	0.3^{16}	0.30^{8}	0.06^{14}
Fiscal reaction function parameters			
θ_2: forecast debt ratio	0.6^{10}	0.03^{11}	0.01^{12}
θ_3: aid	-0.1^{10}	-0.1^{10}	-0.1^{14}
θ_4: output gap	0.17^{17}	0.33^{15}	0.13^{12}
θ_5:TOT	$0.85^{16,17}$	-0.45^{17}	-0.01^{17}
Real Exchange rate Parameters			
ω_1: openness	-0.07^{13}	0.19^{17}	-0.07^{13}
ω_2: TOT	0.31^{13}	0.55^{17}	0.31^{13}
ω_3: relative productivity	0.8^{13}	0.44^{17}	0.80^{13}
ω_4: Fiscal balance	-0.2^{13}	0.19^{17}	-0.20^{18}
ω_5:interest rate differential	0.025^{17}	0.08^{17}	-

Table B3 : Calibration of intercepts

	Ghana	South Africa	WAEMU
β_0	0.81061	-1.27588	1.35742
ρ_0	-0.938232	-0.0497876	2.96745

[14] Chosen from Lledo and Poplawski-Ribeiro (2011).

[15] Taken from Burger et al. (2012).

[16] Taken from Adedji and Williams (2007) and Fernandez et al. (2011).

[17] Calculation Based on available database, for shocks we estimated according to VAR process.

[18] Chosen from Roudet et al. (2007).

[14] See Dembo Toe (2010).

m_0	0.33462	0.361305	0.368294
θ_0	-19.7007	-6.35085	1.65974
δ_0	-0.102131	0.174531	1.85577
ω_0	2.4287	2.03559	2.05849

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