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The Characteristics of Macroeconomic Shocks in the CFA Franc Zone

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Abstract

In this paper we fit a VECM in output and prices to data from ten countries of the CFA Franc Zone. This model allows for various cross-country interactions in both the short run and the long run. The VECM parameters are used to estimate persistence profiles of different kinds, in order to identify the degree of homogeneity in the way in which the countries respond to macroeconomic shocks. In this way we can shed light on questions about the likely size of the costs incurred from these countries' membership of a monetary union.

Keywords: CFA, VECM, monetary union, Africa

JEL classification: C53, F42, O11

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1 Introduction

Over the last forty years most economies in Sub-Saharan Africa have been characterised by exchange rate instability, financial fragility and high inflation. The continent as a whole is the furthest from achieving the UNDP's Millennium Development Goals, and seems to be diverging from rather than converging on the industrialized world (Easterly and Levine, 1997; World Bank, 2003). Many Sub-Saharan African countries are economically very small, and it is possible that one factor handicapping African economic development is the absence of opportunities to exploit economies of scale in production and trade. For this reason, the promotion of macroeconomic integration in Sub-Saharan Africa is, if anything, even more urgent than elsewhere in the world.

One possible route to greater macroeconomic integration is the formation of monetary unions. In fact, there is a part of Africa – the African Financial Community (CFA) – in which a monetary union has existed for over half a century. At present, the CFA comprises 14 different countries formed into two monetary unions, the West African Economic and Monetary Union (UEMOA) and the Central African Economic and Monetary Community, CEMAC). In each of these two areas there is a single currency and a single central bank setting its own interest rate and credit creation targets.[1] These monetary unions trace their existence back to the monetary institutions of French colonial Africa. The two central banks (the BCEAO and the BEAC) date from 1955, seven years before the end of French rule, and most of the current member states have never had a national currency. The two CFA currencies were pegged against the French Franc at a fixed rate, until France adopted the Euro, the currency to which the CFA currencies are now pegged. There has been a single devaluation of the two currencies against the French Franc, in January 1994.

There is a body of evidence suggesting that membership of the CFA has generated

[1]Although UIP with France appears to hold in the very long run (Shortland and Stasavage, 2003), interest rates in each of the two monetary unions do differ from those in France (and from each other) in the short run. The French Treasury is responsible for maintaining the exchange rate pegs, by offering an infinitely elastic supply of Euros for CFA Francs, as long as the CFA countries adhere to certain rules about credit creation. So the two central banks have the freedom to vary their base rate in order to pursue short-run macroeconomic objectives.

substantial benefits for many of the member states in terms of monetary and financial stability and regional integration (Stasavage, 1996; Fielding and Shields, 2003). However, the two current monetary groupings are a function of historical rather than economic factors: they represent the two halves of French territorial possessions in tropical Africa, divided by the former British colony of Nigeria (see Figure 1). Both monetary unions comprise a wide range of economies: some are semi-industrialised and – by African standards – relatively developed (for example Côte d'Ivoire and Senegal). Four are petroleum exporters: Cameroon (though its export base is more diversified than that of the following countries), Congo Republic, Equatorial Guinea and Gabon. Some are low-income landlocked countries on the edge of the Sahara (for example Mali and Chad). There is a concern that the existing groupings entail welfare losses because a single monetary policy is applied to a diverse range of countries. Not all countries can be expected to respond in the same way to a given policy innovation, so (for a given desired macroeconomic outcome) a single policy does not represent a First Best. In such a case there are potential welfare gains from re-grouping the countries according to an economic rather than an historical rationale.

In order to address this concern, it is necessary to quantify the degree of macroeconomic heterogeneity that prevails across the CFA. Summary economic statistics, for example those presented in Table 1, indicate the potential for a large amount of heterogeneity in terms of factors such as per capita income and the structure of production. But little if any work has been done to quantify the macroeconomic consequences of the diversity illustrated by the table. One reason for this is that macroeconomic data for the poorest countries in the region are very limited, so it is infeasible to construct a structural macroeconometric model that encompasses the whole of the CFA.

[Figure 1 and Table 1 here]

In this paper we navigate a way round this difficulty by fitting a VECM (Vector Error Correction Model) of annual output growth and inflation in CFA member states that does not embody any restrictions to identify structural parameters. Instead, we draw out the information implicit in the fitted model by constructing persistence profiles for innovations in output and prices in each of the countries. These profiles permit us to investigate the degree of heterogeneity in the way each of the economies responds to macroeconomic shocks, and to see if there are identifiable sub-groups of countries across which there is a reasonable degree of homogeneity. Among such a group of countries the costs of a single currency would be relatively low, and the case for a monetary union much stronger. Our application of this methodology to the CFA illustrates a way in which empirical macroeconomic analysis can be used to address questions about the costs and benefits of a single currency, even when data are relatively scarce.

2 The Modelling Framework

2.1 Overview

There are two established approaches to the estimation of regional shocks across a monetary area and their consequences. The first (exemplified by Funke and Hall, 1998) has focussed on the identification of aggregate supply and demand shocks in each region, using long-run restrictions in the style of Blanchard and Quah (1989). Because the interpretation of these structural innovations is the subject of some controversy (Levtchenkova et al., 1998), other authors (for example Giacometti and Pinelli, 1999) have chosen not to impose a particular set of theoretical long-run restrictions on their model. Instead they explore the dynamics of prices and output in each region through impulse response analysis. However, the application of impulse response analysis is not theoretically innocuous. The impulses to which the system's response is measured are orthogonalisations of the estimated reduced form innovations. These orthogonalisations (for example, Choleski decomposition) are not invariant to the ordering of the variables in the system. Implicit in the ordering is a theory about how the variables interact: in effect, a set of short-run restrictions.

We wish to avoid such restrictions, since our intention is to provide insights into national differences and similarities in the evolution of observed variables rather than in the structural model underlying them. Our analysis of the dynamics is conducted by constructing measures of persistence and persistence profiles, as described below.

The overall modelling approach is based on a VAR framework in national output growth and inflation. This framework provides a flexible method for characterising the evolution over time of national output growth and inflation, as well as readily accommodating relatively complicated forms of international interactions and feedback.

Our model will include measures of output growth and inflation for the different nations of the CFA. We begin by considering a general model of output growth and inflation for i=1, 2,...,m nations. Assuming that output growth and inflation are stationary with deterministic means, then it is always possible to obtain an MA representation of national output growth and inflation in the following form (see Wold, 1983):

$$\Delta \mathbf{z}_t = \boldsymbol{\mu} + \mathbf{A}(L)\boldsymbol{\varepsilon}_t \tag{1}$$

In this expression $\Delta \mathbf{z}_t = (\Delta \mathbf{y}_t, \Delta \mathbf{p}_t)'$ represents a stacked ($2m$ x 1) vector where $\Delta \mathbf{y}_t = (\Delta y_{1t}, \Delta y_{2t}, ..., \Delta y_{mt})'$ is a (m x 1) vector containing values on output growth in each of the m nations in time t, $\Delta \mathbf{p}_t = (\Delta p_{1t}, \Delta p_{2t}, ..., \Delta p_{mt})'$ is a (m x 1) vector containing values on inflation in each of the m nations in time t and Δ is the difference operator. $\boldsymbol{\mu} = (\boldsymbol{\mu}^y, \boldsymbol{\mu}^p)'$ is a ($2m$ x 1) vector, where $\boldsymbol{\mu}^y = (\mu_1^y, \mu_2^y....\mu_m^y)'$ and $\boldsymbol{\mu}^p = (\mu_1^p, \mu_2^p....\mu_m^p)'$ are both (m x 1) vectors and contain the mean values of output growth and inflation, respectively, in nations $i = 1, \ldots, m$. Similarly, $\boldsymbol{\varepsilon}_t = (\varepsilon_{it}^y, \varepsilon_{it}^p)'$ for $i = 1, \ldots, m$ is a ($2m$ x 1) vector of mean zero, serially uncorrelated innovations experienced by output growth (ε_{it}^y) and inflation (ε_{it}^p) in nation i at time t, with a covariance matrix Ω. In this multivariate model, $\mathbf{A}(L)$ is a matrix polynomial given by

$$\mathbf{A}(L) = \sum_{k=0}^{\infty} \mathbf{A}_k L^k, \qquad \mathbf{A}_0 = \mathbf{I}_{2m}, \tag{2}$$

and the (i, j)-th element of $\mathbf{A}(L)$ is the lag polynomial $a_{ij}(L)$. Hence, for instance, in addition to the effects of current and past values of innovations on $\Delta \mathbf{z}_t$ in nation i itself, output growth (inflation) in nation i may also be affected by past values of shocks to nation j to output growth or inflation. Moreover, there may be a systematic association between the occurrence of shocks in nation i and those taking place elsewhere (captured by the non-zero off-diagonal elements of Ω).

Expression (1) has a fundamental moving average representation, and, in general, this can be approximated by a finite order VAR model of the form

$$\mathbf{B}(\mathbf{L})\Delta\mathbf{z}_t=\Delta\mathbf{z}_t+\mathbf{B}_1\Delta\mathbf{z}_{t-1}+\mathbf{B}_2\Delta\mathbf{z}_{t-2}+.....+\mathbf{B}_q\Delta\mathbf{z}_{t-q}=\boldsymbol{\mu}^*+\boldsymbol{\varepsilon}_t, \tag{3}$$

where $\mathbf{B}_s$, $(s = 1, 2, \ldots .q)$ are $(2m \text{ x } 2m)$ matrices of coefficients, and the (i, j)-th element of $\mathbf{B}_s$, denoted b_{yipjs}, relates to the coefficient on inflation (denoted by p) in nation j, lagged by s periods, in the equation explaining output growth (denoted by y) in nation i. In this finite order VAR model, output growth in nation i is explained by q lagged values of output growth in nation i, q lagged values of inflation in nation i, plus q lagged values of output growth and inflation in all other nations, and a random innovation, ε^y_{it}; i.e.

$$\Delta y_{it} = \mu_i^{y^*}+\sum_{s=1}^{q} b_{yiyis}\Delta y_{i,t-s}+\sum_{s=1}^{q} b_{yipis}\Delta p_{i,t-s}+\sum_{s=1}^{q}\sum_{j\neq i} b_{yiyjs}\Delta y_{j,t-s}+\sum_{s=1}^{q}\sum_{j\neq i} b_{yipjs}\Delta p_{j,t-s}+\varepsilon^y_{it}. \tag{4}$$

This type of model has a very large number of parameters. For example, if $q = 2$ and $m = 10$, the number of terms the right hand side of expression (4) equals 40, excluding the intercept and error terms. Such a model is likely to be over-parameterised, and its application to small macroeconomic time-series is unlikely to produce robust results. However, one plausible simplification of the model is to restrict the international feedback effects so that all foreign price or income changes have the same impact on country i's income (or prices). In this paper, we fit a model that includes an aggregate income effect for the whole CFA. For the aggregate price effects, we use a slightly more flexible specification, distinguishing between a price aggregate for country i's monetary union partners and a price aggregate for the countries of the other monetary union. (A similar disaggregation of the aggregate income expression turns out not to improve the fit of the model.) For any one country, the model can be represented as:

$$\Delta y_{it} = \mu_i^{y^*} + \sum_{s=1}^{q} b_{yiyis}\Delta y_{i,t-s} + \sum_{s=1}^{q} c_{yis}\Delta\overline{y}_{-i,t-s} + \sum_{s=1}^{q} d_{yis}\Delta\overline{p}^A_{t-s} + \sum_{s=1}^{q} f_{yis}\Delta\overline{p}^B_{t-s} + \varepsilon^y_{it}, \tag{5}$$

for the output growth equations and

$$\Delta p_{it} = \mu_i^{p^*} + \sum_{s=1}^{q} b_{pipis} \Delta p_{i,t-s} + \sum_{s=1}^{q} c_{pis} \Delta \overline{p}^A_{-i,t-s} + \sum_{s=1}^{q} d_{pis} \Delta \overline{p}^B_{t-s} + \sum_{s=1}^{q} f_{pis} \Delta y_{t-s} + \varepsilon^p_{it}, \quad (6)$$

for the inflation equations. In expressions (5) and (6),

$$\Delta \overline{y}_{-i,t} = \frac{1}{m-1} \sum_{h \neq i} \Delta y_{ht} \qquad \text{and} \qquad \Delta \overline{p}^A_{-i,t-s} = \frac{1}{m_0 - 1} \sum_{k \neq i} \Delta p_{kt}, \quad (7)$$

where the first $k = 1, \ldots, m0$ countries are members of monetary union A, the union to which country i adheres, and

$$\Delta \overline{y}_t = \frac{1}{m} \sum_i \Delta y_{it} \qquad \text{and} \qquad \Delta \overline{p}^A_t = \frac{1}{m_0} \sum_k \Delta p_{kt} \qquad \text{and} \qquad \Delta \overline{p}^B_t = \frac{1}{m - m_0} \sum_l \Delta p_{lt}, \quad (8)$$

where the $l = m0+1, \ldots, m$ countries are members of union B, the other monetary union.

The model represented by equations (5) - (6) imposes the following restrictions:

1. Lagged output growth in countries other than i has a uniform effect on growth in i
2. Lagged inflation in countries other than i (but belonging to the same monetary union) has a uniform effect on inflation in i; the effect of inflation in countries of the other monetary union is also uniform.
3. Lagged output growth in countries other than i has a uniform effect on inflation in i.
4. Lagged inflation in countries belonging to the same monetary union has a uniform effect on output growth in i; the effect of inflation in countries of the other monetary union is also uniform.

Although such a model restricts the possible interactions that exist between different nations, it will be a good approximation of the true DGP as long as there is not a great deal of heterogeneity in international feedback effects. Note also that there is no restriction on the structure of the correlation of contemporaneous shocks to different nations, so there is still scope for substantial international heterogeneity within the estimated model.

If important interactions exist between the levels of $\mathbf{z}_t$, the existing modelling framework can be readily adapted to allow for the presence of cointegrating relationships in the form of restrictions on the MA representation in (1). The error-correction form of (3) can be expressed as

$$\Delta\mathbf{z}_t = \boldsymbol{\mu}^* + \sum_{s=1}^{q} \boldsymbol{\Gamma}_s \boldsymbol{\Delta}\mathbf{z}_{t-s} - \boldsymbol{\Pi}\mathbf{z}_{t-q-1} + \boldsymbol{\varepsilon}_t \tag{9}$$

where $\boldsymbol{\Pi}$ is a $(2m \text{ x } 2m)$ reduced rank matrix determining the extent to which the system is cointegrated. Again, for empirical purposes, we restrict (9) and give the following form for output growth in nation i at time t:

$$\begin{aligned} \Delta y_{it} \quad = \quad & \mu_i^{y^*} + \sum_{s=1}^{q} b_{yiyis}\Delta y_{i,t-s} + \sum_{s=1}^{q} c_{yis}\Delta\overline{y}_{-i,t-s} + \sum_{s=1}^{q} d_{yis}\Delta\overline{p}_{t-s}^{A} + \sum_{s=1}^{q} f_{yis}\Delta\overline{p}_{t-s}^{B} \\ & + \lambda_{yi}\left(y_{i,t-1} - \overline{y}_{-i,t-1}\right) + \lambda_{pi}\left(p_{it-1} - \overline{p}_{-i,t-1}^{A}\right) \\ & + \lambda_{zi}\left(\overline{p}_{i,t-1}^{A} - \overline{p}_{i,t-1}^{B}\right) + \lambda_i\left(y_{it-1} - p_{i,t-1}\right) + \varepsilon_{it}^{y}, \end{aligned} \tag{10}$$

and an analogous expression can be written for the inflation. In expression (10), $\overline{y}_{-i,t}$ represents the (equal-weighted) aggregate of (log) output outside i and $\overline{p}_{-i,t}^{A}$ represents the (equal-weighted) aggregate of (log) prices outside i but in the same monetary union. $\overline{p}_{it}^{A}$ and $\overline{p}_{it}^{B}$ are similar aggregates for all of the countries in i's union (including i) and for all of the countries in the other union.[2] Hence, in its most general form, the model allows for the possibility for the same long-run relationship across all m nations between output levels, the same long-run relationship amongst price levels across all nations, and for price and output series in nation i to be cointegrated.[3]

2.2 Measuring the persistence of shocks

The trans-national, multivariate VECM model presented above provides a flexible framework within which an analysis of output and price determination can be carried out. Of particular interest are the long-run responses of the variables in $\mathbf{z}_t$ to shocks, and the dynamics of adjustment to the long run. Pesaran et al. (1993), Lee and Pesaran (1993)

[2]A specification using average import weighted aggegrates yielded almost identical results and did not improve the fit of the model.

[3]This would be the case, if, for instance, all the series were driven, equiproportionately, by the same (stochastic) trend, such that the series do not diverge in the long run.

and Lee and Shields (1998) provide the means for identifying the effects of specified types of shock, and for distinguishing between the effects of shocks common to all nations and those associated with individual nations. We can investigate the evolution of individual variables in response to shocks, without resorting to a priori restrictions, by using persistence profiles (see Lee, Pesaran and Pierse, 1992, henceforth LPP). We will next provide a brief description of the measurement of the impact of shocks, showing how they may be used to construct measures of interest.

If a series is non-stationary, then the effects of a shock to the series is permanent and the size of the permanent effect of the shock is termed the 'persistence' of the shock. In LPP, a measure of persistence is suggested which can be applied to a trans-national model, and is based on the change in the conditional variance of $\mathbf{z}_t$ at the infinite horizon. If $\mathbf{z}_t$ is stationary, then eventually the series will return to its mean level with certainty, so the change in the conditional variance of predictions of $\mathbf{z}_t$ will tend to zero. Conversely, if $\mathbf{z}_t$ is $I(1)$, the conditional variance of predicted future $\mathbf{z}_t$ continues to grow as the forecast horizon extends. Hence the extent of the permanent effect of a shock is reflected by the size of the growth in the conditional variance at the infinite horizon.

Specifically, referring to the multivariate, trans-national model described in expressions (1) - (3), if $\mathbf{e}_t$ is a $(2m$ x $1)$ selection vector with unity in its r-th element, and zeros elsewhere, then the persistence of a shock to output $(1 \leq r \leq m)$ or prices $(m+1 \leq r \leq 2m)$ in nation i is given by:

$$Q(\mathbf{z}_i^1) = \left(\frac{\mathbf{e}_r' \mathbf{A}\left(1\right) \mathbf{\Omega} \mathbf{A}\left(1\right)' \mathbf{e}_r}{\mathbf{e}_r' \mathbf{A}_0 \mathbf{\Omega} \mathbf{A}_0' \mathbf{e}_r} \right)^{\frac{1}{2}}, \tag{11}$$

where $\mathbf{z}_i^1 = \left(y_i^1, p_i^1\right)$, $\mathbf{A}_0 = \mathbf{I}_{2m}$. $Q\left(y_i^1\right)$ and $Q\left(p_i^1\right)$ are to be interpreted as measuring the permanent effect in nation i of the shock to output (or prices) that results from an innovation causing output (or prices) in that nation to rise by one percent on impact. The persistence measures incorporate all of the interactions between variables in the system, insofar as they affect output (or prices) in nation i at the infinite horizon. Just as the asymptotic persistence measure given in equation (11) is of potential importance in understanding the response of the CFA economies to shocks, so also is the path to the asymptote. This time profile of the response to shocks ("persistence profile") is calculated as in equation (11), but replacing $\mathbf{A}(1)$ (which represents the infinite horizon entity) with the corresponding n-th horizon matrix, $\mathbf{A}(L) = \sum_{k=0}^{n} \mathbf{A}_k L^k$.[4] Both the asymptotic measure and persistence profiles will be discussed in the following section.

In a similar vein, we can calculate a measure of the permanent effect on nation i's output (or prices) of a unit shock to output (prices) in the whole monetary union by using the selection vector $\mathbf{w}_y$ (or $\mathbf{w}_p$). This is a $2m$ x 1 selection vector with ones in the first m (in the case of prices, the first $m+1$ to $2m$) elements, and zeros elsewhere. The persistent effect on nation i's output, when a shock causes economy-wide output to rise by one percent on impact is given by:

$$Q(y_i^2) = \left(\frac{\mathbf{e}_r' \mathbf{A}\left(1\right) \mathbf{\Omega} \mathbf{A}\left(1\right)' \mathbf{e}_r}{\mathbf{w}_y' \mathbf{A}_0 \mathbf{\Omega} \mathbf{A}_0' \mathbf{w}_y} \right)^{\frac{1}{2}}, \tag{12}$$

where the value of r $(1 \leq r \leq m)$ determines the selection of the output of a particular nation. An analogous expression can be given for the persistent effects of a unit shock to economy-wide inflation on national prices $(Q(p_i^2))$ by using $\mathbf{w}_p$ in place of $\mathbf{w}_y$ in expression (12) with $m+1 \leq r \leq 2m$.

It is possible to construct various decompositions of these persistence measures. Consider first decomposing the vector of shocks to each variable in each nation into three orthogonal components: a part due to a union-wide output shock, a part due to a union-wide price shock plus an idiosyncratic component. More formally,

$$\boldsymbol{\varepsilon}_t = \overline{\varepsilon}_t^y \mathbf{w}_y + \overline{\varepsilon}_t^p \mathbf{w}_p + \boldsymbol{\varepsilon}_t^d, \tag{13}$$

where $\overline{\varepsilon}_t^y$ and $\overline{\varepsilon}_t^p$ represent the union-wide output and price shocks and $\boldsymbol{\varepsilon}_t^d$ is the $2m$ x 1 vector of idiosyncratic innovations. Now consider a typical ε_t, that is, one causing output in all nations to rise by one percent on impact. For each nation i, it is possible to construct a persistence profile for output corresponding to the common-output-shock component of this ε_t. This persistence measure will be denoted $Q(y_i^3)$. $Q(y_i^3)$ can be thought of as one component of $Q(y_i^2)$, the other main components being the output persistence measure corresponding to common shocks to prices (which we will call $Q(y_i^{3p})$), and that

[4] See Lee and Pesaran (1993), Lee (1998), Lee and Shields (1998) for further details of how persistence profiles can be derived.

corresponding to the idiosyncratic innovation $\boldsymbol{\varepsilon}_t^d$ (which we will call $Q(y_i^{3x})$).[5]

An analogous exercise can be performed with price persistence profiles. Consider a typical ε_t causing prices in all nations to rise by one percent on impact. For each nation i, it is possible to construct a persistence profile for prices corresponding to the common-price-shock component of this ε_t. This persistence measure will be denoted $Q(p_i^3)$. $Q(p_i^3)$ can be thought of as one component of $Q(p_i^2)$, the other main components being the price persistence measure corresponding to common shocks to output ($Q(p_i^{3y})$), and that corresponding to the idiosyncratic innovation $\boldsymbol{\varepsilon}_t^d$ ($Q(p_i^{3x})$).

Formally, if $\mathbf{\Omega}^y = E\left(\overline{\varepsilon}_t^{y^2}\right)\mathbf{w}_y\mathbf{w}_y'$, $\mathbf{\Omega}^p = E\left(\overline{\varepsilon}_t^{p^2}\right)\mathbf{w}_p\mathbf{w}_p'$ and $\mathbf{\Omega}^d = E\left(\varepsilon_t^d\varepsilon_t^{d\prime}\right)$, the two additional persistence measures are defined as:

$$Q(y_i^3) = \left(\frac{\mathbf{e}_r'\mathbf{A}\left(1\right)\mathbf{\Omega}^y\mathbf{A}\left(1\right)'\mathbf{e}_r}{\mathbf{w}_y'\mathbf{A}_0\mathbf{\Omega}\mathbf{A}_0'\mathbf{w}_y}\right)^{\frac{1}{2}} \quad \text{and} \quad Q(p_i^3) = \left(\frac{\mathbf{e}_r'\mathbf{A}\left(1\right)\mathbf{\Omega}^p\mathbf{A}\left(1\right)'\mathbf{e}_r}{\mathbf{w}_p'\mathbf{A}_0\mathbf{\Omega}\mathbf{A}_0'\mathbf{w}_p}\right)^{\frac{1}{2}} \tag{14}$$

where $1 \leq r \leq m$ and $m+1 \leq r \leq 2m$ for $Q(y_i^3)$ and $Q(p_i^3)$, respectively. In a similar way, we can construct persistence measures for output and prices corresponding to the idiosyncratic component of ε_t, $\boldsymbol{\varepsilon}_t^d$.

In summary, we have three types of persistence measure for output growth (and inflation). Estimates of these three measures will be presented in the following section:

1. $Q(y_i^1)$ (or $Q(p_i^1)$): a measure of how output (or prices) in each nation evolves in response to a typical shock to output (or prices) in that nation.

2. $Q(y_i^2)$ (or $Q(p_i^2)$): a measure of how output (or prices) in each nation evolves in response to a typical union-wide shock to output (or prices).

3. $Q(y_i^3)$ (or $Q(p_i^3)$): a measure of how output (or prices) in each nation evolves in response to the common-output-shock component (or common-prices-shock component) of a typical union-wide shock to output (or prices). Corresponding to this measure is a measure of persistence in response to the nationally idiosyncratic component.

[5] The three components do not sum exactly to because this expression also incorporates some covariance terms.

All three measures are of potential importance in understanding how the CFA economies respond to economic shocks. The first measure provides a basic indication of how similar or dissimilar the dynamics of output and prices are across CFA nations. Similar values for persistence measures indicate a degree of homogeneity in the dynamics of each nation, although they do not indicate how similar shocks are across nations. For this reason the second two measures are also of potential interest.

The second persistence measure is of potential use in assessing the relative sizes of typical shocks to each country, and the consequences of differences in these sizes. If in some countries shocks are larger on average, then their $Q(y_i^2)$ measure will be relatively large at short horizons. If these relatively large shocks are attenuated by cross-country convergence over the longer term, then the $Q(y_i^2)$ measures at longer horizons will exhibit less heterogeneity. Even if prices are co-integrated across nations, so that there is no heterogeneity at the infinite horizon, there might nevertheless be heterogeneity in the paths to the asymptote. The larger the magnitude of such heterogeneity, the greater will be the degree of international price distortions resulting from the shock.

The usefulness of the second measure of persistence is predicated on knowledge about the degree of correlation of innovations on impact. The third measure of persistence complements the second, since it is based on that component of innovations in output (or prices) that is common to all nations. If persistence measures corresponding to the common innovations are large relative to the persistence measures corresponding to the idiosyncratic innovations then we can expect a larger degree of homogeneity in the movement of output and prices across nations, ceteris paribus. If the persistence measures corresponding to the idiosyncratic innovations are relatively large, then we can expect a greater degree of heterogeneity. The potential costs of sharing a single currency are likely to depend on how large this heterogeneity is.

Implicit in the construction of the $Q(y_i^2)$ and $Q(y_i^3)$ figures is a normalisation: they are based on a shock that creates a unit change in CFA-wide output on impact. On this basis, we can make observations about the relative costs for different countries of sharing a single currency, and whether these costs might be lower or higher in a world where the monetary unions had a different membership. We do not make any comments about the absolute costs of sharing a single currency: in the absence of any knowledge about the relevant policymakers' utility functions, it is not possible to create a sensible metric for such an assessment.

3 Estimating Measures of Persistence

In this section we present our estimates of the three persistence measures discussed in Section 2, using the national real GDP and GDP deflator data from the World Bank World Development Indicators. These measures are based on a VECM model of annual price inflation and GDP growth in ten CFA countries for the period 1967-2000. These are, in the UEMOA: Burkina Faso, Côte d'Ivoire, Mali, Senegal and Togo; and in the CEMAC: Cameroon, Central African Republic, Congo Republic, Gabon and Chad. The relevant data for the other fours CFA countries (Benin, Equatorial Guinea, Guinea-Bissau and Niger) were either not reported at all, or else were unreliable, for some of the sample period.

3.1 Time-series properties of the data and estimation of the VECM model

The first stage of our empirical analysis is to test for the order of integration of our price and output series, using the standard panel unit root test of Im et al. (2003). We stack the regional output series and the regional price series and perform just two unit root tests, and under the assumption that all the output series and all the price series will be of the same order of integration, the test statistics have a standard normal distribution. (We think that the panel unit root tests are more appropriate here than univariate tests: we do not believe that the CFA countries are so heterogeneous as to manifest different orders of integration of prices and output. But in any case, the application of a battery of univariate unit root tests, available on request, does not alter our conclusions about the order of integration of the series.) The panel unit root test statistics are reported in Table 2. The table indicates the logarithms of both prices and output to be difference stationary, so the modelling framework in difference form outlined in the previous section is appropriate to our data. Figures 2-5 illustrate the output growth and inflation series that we use.

[Figures 2-5 and Table 2 here]

We also test for the four types of cointegration implicit in equation (10) above: cointegration between prices and GDP within one country, cointegration between national prices and the price aggregate in the appropriate monetary union, inter-union price cointegration, and cointegration between national GDP and the CFA average. In testing for cointegration between price and output in country i, residuals from an Engle-Granger regression are taken and standard unit root tests applied to the residuals. With regard to testing for cointegration existing between the same variable across countries, we again make use of the panel unit-root tests of Im et al (2003). In this case, residuals from regressions over all countries of the country i variable on a union-wide aggregate of the same variable exluding country i are stacked and the standard panel unit root test is applied. Details of the cointegration results are provided in the Appendix in Table A2. Briefly, we find that:

1. For no country is GDP cointegrated with prices.

2. For no country is GDP cointegrated with average CFA GDP.

3. For all countries prices are cointegrated with the union-wide aggregate, with a loading insignificantly different from [1, -1]. In other words, there is PPP in levels with a fixed wedge.

4. UEMOA prices are cointegrated with CEMAC prices.

So the estimated VECM is a restricted version of equation (10) in which λ_{yi} and λ_i are set to zero. The cointegration of national prices means that, by construction, persistence measures for CFA-wide price shocks will converge asymptotically. However, the persistence profiles for national prices might still exhibit substantial heterogeneity, since the convergence is consistent with regional heterogeneity in short run price dynamics. The absence of cointegration in regional GDP means that heterogeneity in persistence profiles is a possibility in both the short and the long term.

Table A1 in the Appendix provides the detailed regression results. This set of regressions takes the form of equation (10), with two deterministic components: an intercept and a dummy variable for the post-devaluation period (1994-2000). The time-series for inflation in Figures 4-5 show that 1994 saw an atypically large shock to prices in many of the CFA countries. The persistence profiles discussed below are based on estimated innovations other than the 1994 devaluation.

The unrestricted regressions contain many parameters that are individually statistically insignificant: with so many nuisance parameters, the power of diagnostic tests is very low and the standard errors on persistence measure very high. So Table A1 reports a restricted version of the regression equations in which very small and statistically insignificant coefficients are set to zero.[6] The persistence profiles are based on this set of regressions.[7] The table shows many individual interactions between output and prices in the different members of the CFA. In almost all cases inflation responds to the λ_{pi} error-correction term in equation (10). In other words, prices in a country respond to any divergence from PPP with the other members of its monetary union. In several of the CEMAC countries (but not in any of the UEMOA countries) the λ_{zi} error-correction term is significant. In other words, the long-run PPP that holds between the two monetary unions appears to be a consequence of CEMAC convergence on UEMOA prices. In this sense, the CEMAC area follows the UEMOA area. For all countries the devaluation dummy (DUM94) has a significant effect in the price equation.

[6]Formally, the specification search rule, whilst ensuring the stability of the system, excludes coefficients with t-ratios with absolute values less than one only if the F-test for the joint exclusion of restrictions is satisfied.

[7]The variables omitted from the restricted regression are not jointly significant, and the restricted regression is to be preferred on the basis of the Akaike Information Criterion. The diagnostic statistics reported in Table A1 suggest the absence of residual autocorrelation and heteroskedasticity in the regressions. In one or two cases the null of residual normality can be rejected, but the omission of the offending residual outliers does not substantially alter our results.

3.2 Estimates of regional persistence in output

Figures 6-7 illustrate persistence profiles for output for each of the ten countries. Figure 6 shows the $Q(y_i^1)$ measures, which show, for each country, the consequences of a typical shock to the system causing output in that country to rise by one unit on impact. Figure 7 shows the $Q\left(y^2\right)$ measures, which show, for each country, the consequences of a typical shock causing output across all ten countries to rise by one unit on impact. The corresponding asymptotic persistence measures are listed in Table 3 with their respective standard errors.

Figure 6 shows a wide range of responses to a unit shock to output. In all cases, the initial shock is multiplied in the long run; this is partly due to the positive response of $\Delta\overline{\mathbf{y}}$ to lagged in many of the countries (Mali, Senegal, Togo, Cameroon, CAR, Chad). However, the range of estimated multiplier effects is very great, both in the short run and asymptotically: in Senegal, a unit shock leads to an eventual increase of 1.02; at the other extreme, a unit shock in Congo Republic leads to an eventual increase of 4.49.[8] There is no obvious pattern suggesting that a certain degree of persistence pertains to a certain type of economy.

This is not true when we move to Figure 7, which shows the persistence profiles for a typical shock leading to an aggregate increase in output of one unit across the CFA. The four largest shocks on impact are in CEMAC countries (all the CEMAC countries except CAR); these are also four out of the five countries with the largest figures at the infinite horizon.[9] In other words, the 'average' shock causing an aggregate increase in output across the CFA is associated with relatively large initial output changes – on average –

[8] At the infinite horizon standard errors are rather high, making it difficult to assess which asymptotic effects are significantly different from each other. However, the standard errors on the effects at a shorter horizon are somewhat smaller. For instance, in the cases of Mali, Togo, Congo Republic and Chad, the standard errors on impact are smaller by a factor of approximately twenty, whilst for CAR, Gabon, Bukina Faso, Côte d'Ivoire and Cameroon, they range roughly from respectively being a sixth to a twelfth of the infinite horizon standard errors, and for Senegal, approximately three times smaller.

[9] Togo from the UEMOA joins the group of high persistence profile countries at longer horizons. Its typical initial shock is almost as large as for the CEMAC countries, and its multiplier effect is the second largest of the ten.

in the petroleum-exporting countries (Cameroon, Congo Republic and Gabon), plus one of their small CEMAC partners (Chad). Put another way, all of the CEMAC countries except CAR are typically subject to larger shocks than their UEMOA neighbours. Cross-country differences in levels of persistence are not great enough to change this picture substantially when we look at the impact of a typical shock in later years.

The $Q(y_i^2)$ measures indicate that output shocks in the petroleum exporters are typically larger on impact than in other countries, and have a larger long-run effect. The $Q(y_i^3)$ figures in Table 3 indicate that a very large part of these shocks is owing to country-specific specific effects. In other words, the idiosyncratic component of $Q(y_i^2)$, i.e. $Q(y_i^{3x})$, is large relative to the components reflecting common shocks, i.e. $Q(y_i^{3y})$ and $Q(y_i^{3p})$. This means that in the CEMAC area shocks to output (and the resulting output growth) are both relatively large and heterogeneous. If output stabilisation is regarded as an important policy goal, and if monetary policy can be harnessed effectively to pursue this goal, then the CEMAC countries may face relatively large costs from sharing a single currency. Moreover the UEMOA countries, where shocks are much smaller (if no less heterogeneous), stand to gain from using a different currency from their petroleum-exporting neighbours. The one country for which there is a rationale for switching between monetary areas is the non-petroleum-exporting CAR, whose persistence profiles are closer to those of the UEMOA than of the CEMAC.[10]

[Figures 6-9 here]

3.3 Estimates of regional persistence in prices

Figures 8-9 illustrate persistence profiles for prices for each of the ten countries. Figure 8 shows the $Q(p_i^1)$ measures, which show, for each country, the consequences of a typical shock to the system causing prices in that country to rise by one unit on impact. Figure 9 shows the $Q(p_i^2)$ measures, which show, for each country, the consequences of a

[10] If Cameroon, Congo Republic and Gabon all export petroleum, why are their output shocks not very highly correlated? Gabon exports a wide range of minerals other than petroleum (for example, manganese), and, in Cameroon, the share of petroleum exports in GDP is rather smaller than in the other countries.

typical shock causing prices across all ten countries to rise by one unit on impact. The corresponding asymptotic persistence measures are listed in Table 3 with their respective standard errors.[11]

Figure 8 and Table 3 show that the $Q(p_i^1)$ price persistence measures are just as heterogeneous as the equivalent measures for output. In some cases (the two most oil-dependent countries, Congo Republic and Gabon) there is a very low level of persistence, and a unit shock to prices is somewhat attenuated in the long run. In the other countries there is a long run multiplier effect ranging from a factor of 1.55 in Togo and Côte d'Ivoire to a factor of 4.00 in Mali.

As Figure 9 shows, this disparity does not lead to any heterogeneity in the $Q(p_i^2)$ measures in the very long run, because prices across all of the countries are cointegrated. However, the convergence is *very* slow, and the heterogeneity in the size of the shocks on impact is substantial. A typical shock leading to a unit increase in aggregate prices on impact is associated with a price increase of 0.35 in Congo Republic and of 0.33 in Gabon; in all the other countries, the figure is less than 0.2. Even at the four-year horizon, the persistence measures for Congo Republic and Gabon are 0.31 and 0.28 respectively, the next highest figure being 0.21 (Côte d'Ivoire). In other words, price shocks are typically very much larger in the two most oil-dependent countries, and long-run price convergence is not fast enough to eradicate this difference at any time horizon likely to be of interest to a policymaker.

Table 3 includes information about the $Q(p_i^3)$ components of $Q(p_i^2)$. Price cointegration means that these figures are the same for all countries at the infinite horizon, though the stylised facts discussed here are also generally true of the $Q(p_i^3)$ measures for different countries at finite horizons. $Q(p_i^{3x})$ is roughly as large as $Q(p_i^{3p})$ at the infinite horizon, and $Q(p_i^{3y})$ is very much smaller. In other words, the fraction of $Q(p_i^2)$ (that is, the

[11] Again, as in the case of the output profiles, the persistence profiles are estimated relatively more precisely at the short horizon compared to the infinite horizon. For instance, for Chad, Senegal, Bukina Faso and Mali, the short horizon standard errors are respectively in the range of being roughly nine to sixteen times smaller relative to their long-run counterparts, whilst for the Congo Republic, CAR, Côte d'Ivoire, Gabon, Togo and Cameroon, the respective range is approximately between two to six times smaller.

asymptotic effect of a typical shock causing aggregate prices to rise by one unit on impact across the CFA) that is accounted for by the response to a common price shock is about as large as the fraction accounted for by the response to an idiosyncratic shock. Given the relative homogeneity of the $Q(p_i^2)$ persistence profiles for the eight CFA countries excluding Congo Republic and Gabon (see Figure 9), this means that a policymaker concerned primarily with price stabilisation is much more likely to meet her objectives with a monetary area that excludes the two large petroleum exporters.

Overall, the picture for the price persistence profiles is very similar to that for output persistence profiles. The heterogeneity and persistence of shocks is generally lower for the UEMOA countries than for the CEMAC countries, and therefore presents fewer problems in reaching hypothetical stabilisation objectives. The profile for some CEMAC countries (just CAR in the case of output shocks, but also Cameroon and Chad in the case of price shocks) is close to that for the typical UEMOA country. So the difficulty of meeting output / price stabilisation objectives in the UEMOA would not be substantially greater if these countries shared the UEMOA currency. However, the two big CEMAC petroleum exporters, Congo Republic and Gabon, are always the exception. Price and output shocks in these two countries are typically larger than elsewhere, and these shocks have a high degree of persistence.

4 Summary and Conclusion

We have fitted a VECM model of output and prices in ten CFA countries, in order to explore the characteristics of inflation and output growth dynamics in the region. The dynamics are characterised in terms of persistence profiles, an approach that avoids the imposition of questionable identifying restrictions in a data set including some very low income countries about which little is known from a macroeconomic perspective. In this way we can make some observations about the relative degree of macroeconomic heterogeneity in the two monetary unions that make up the CFA, about relative difficulty of achieving price and output stabilisation objectives under the current configuration of countries, and about the relative merits of alternative configurations.

A common pattern that emerges in our results is that there is less heterogeneity in the macroeconomic dynamics of the UEMOA countries than there is among the CEMAC members, and so the costs of adhering to a single currency are likely to be lower, ceteris paribus. To some extent, the heterogeneity to be found among the CEMAC countries is a consequence of the presence of two economies – Congo Republic and Gabon – that are heavily dependent on mineral exports, particularly petroleum. In some ways, the macroeconomic dynamics of some of the other CEMAC members are closer to those of the UEMOA. This is even true to some extent of Cameroon, which is a petroleum exporter but has a more diversified export base.

If the CFA adopted a single currency in place of the existing two, the presence of large petroleum exporters would probably make the achievement of stabilisation objectives in the current members of the UEMOA more difficult. These results are likely to reinforce the reluctance of the UEMOA to respond positively to the stated aim of the non-CFA members of ECOWAS – including Nigeria – to form a monetary union across the ECOWAS area.

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Table 1: Summary Statistics for Ten CFA Countries

	Gross National Income ($bn)	per capita GNI ($1000)	agriculture value added / GDP	industry value added / GDP
Burkina Faso	2.4	0.21	0.35	0.17
Cote d'Ivoire	9.6	0.60	0.29	0.22
Mali	2.5	0.24	0.46	0.17
Senegal	4.7	0.49	0.18	0.27
Togo	1.3	0.29	0.38	0.22
Cameroon	8.6	0.58	0.44	0.20
CAR	1.0	0.28	0.55	0.20
Congo	1.7	0.57	0.05	0.71
Gabon	3.9	3.19	0.06	0.53
Chad	1.5	0.20	0.39	0.14

Table 2: Panel Unit Root Test Results

variable	t-bar stat.	variable	t-bar stat.
y	-0.583	p	+3.10
Δy	**-12.80**	Δp	**-7.77**

Notes: Figures in bold indicate rejection of the null that the series are I(1) against the alternative that they are I(0) at the 5% level. The test is based on Im et al. (2003), with no deterministic trend in the ADF regressions.

Table 3: Asymptotic Effects of Different Shocks to the System

	Effect of a shock causing initial output (prices) to rise by one unit in country i				*Effect of a shock causing an initial zone-wide rise in output (prices) of one unit*			
	Q(y^1)	s.e.	Q(p^1)	s.e.	Q(y^2)	s.e.	Q(p^2)	s.e.
Burkina Faso	2.2145	1.2664	2.6144	1.1697	0.2920	0.1670	0.2902	0.1298
Côte d'Ivoire	3.1904	1.4713	1.5507	0.6938	0.5403	0.2492	0.2902	0.1298
Mali	1.8072	1.7018	4.0043	1.7915	0.3914	0.3686	0.2902	0.1298
Senegal	1.0245	0.6308	3.3226	1.4865	0.2096	0.1291	0.2902	0.1298
Togo	3.9580	2.7251	1.5487	0.6929	0.9636	0.6634	0.2902	0.1298
Cameroon	2.9417	1.5606	2.8006	1.2530	0.7229	0.3835	0.2902	0.1298
CAR	1.4901	1.4392	2.0786	0.9300	0.2683	0.2591	0.2902	0.1298
Congo Republic	4.4883	5.5914	0.8255	0.3693	1.1049	1.3764	0.2902	0.1298
Gabon	3.0896	4.1652	0.8802	0.3938	1.5869	2.1393	0.2902	0.1298
Chad	3.0721	3.3620	1.8067	0.8083	1.2398	1.3568	0.2902	0.1298

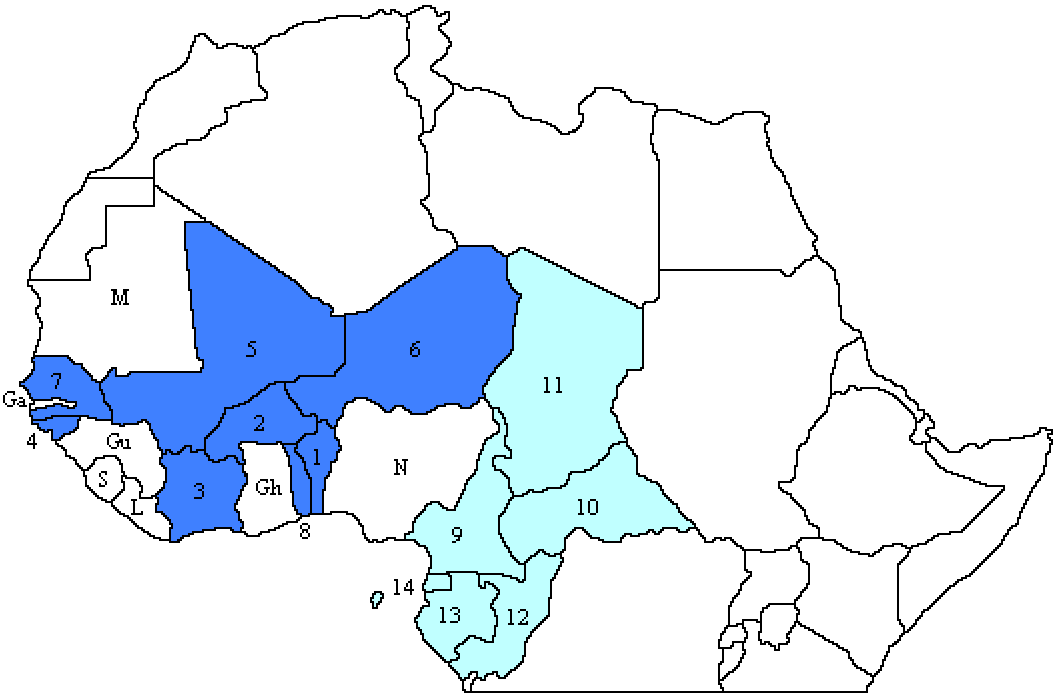
	*Decomposition of the effects of a shock causing an initial zone-wide rise in output**					
	Q(y^3) share	s.e.	Q(y^{3p}) share	s.e.	Q(y^{3x}) share	s.e.
Burkina Faso	0.0654	0.0447	0.0275	0.0447	0.2766	0.1663
Côte d'Ivoire	0.1583	0.0600	0.0074	0.0600	0.5156	0.2379
Mali	0.1711	0.0646	0.0491	0.0646	0.3495	0.3958
Senegal	0.0939	0.0329	0.0258	0.0329	0.1756	0.1384
Togo	0.1356	0.1643	0.4778	0.1643	0.9135	0.6246
Cameroon	0.2260	0.1051	0.2794	0.1051	0.6702	0.2677
CAR	0.1239	0.0510	0.0261	0.0510	0.2348	0.2929
Congo Republic	0.3139	0.2185	0.4587	0.2185	1.3002	1.5544
Gabon	0.1689	0.2911	0.0961	0.2911	1.5540	2.0968
Chad	0.0221	0.2215	0.1327	0.2215	1.2880	1.4371

	*Decomposition of the effects of a shock causing an initial zone-wide rise in prices**					
	Q(p^3) share	s.e.	Q(p^{3y}) share	s.e.	Q(p^{3x}) share	s.e.
all	0.2280	0.0395	0.0379	0.0395	0.2066	0.0792

* The shares in each row do not sum exactly to the total effect Q(z^2) because of non-zero covariance terms.

Figure 1: The CFA Franc Zone and its Neighbors

The dark shaded area is the UEMOA; the light shaded area is the CEMAC.



1 = Benin; 2 = Burkina Faso; 3 = Côte d'Ivoire; 4 = Guinea-Bissau; 5 = Mali; 6 = Niger; 7 = Senegal; 8 = Togo; 9 = Cameroon; 10 = CAR; 11 = Chad; 12 = Congo Republic; 13 = Gabon; 14 = Equatorial Guinea; Ga = Gambia; Gh = Ghana; Gu = Guinea-Conakry; L = Liberia; M = Mauritania; N = Nigeria; S = Sierra Leone

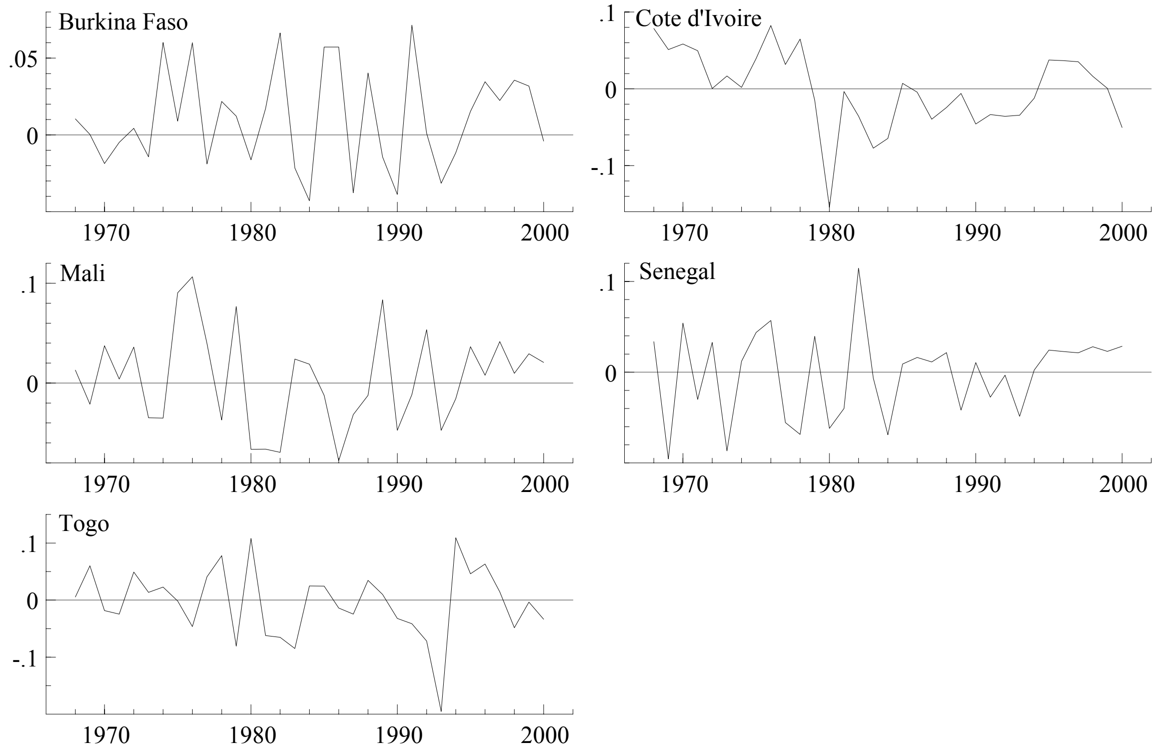


Figure 2: Annual GDP growth in five UEMOA countries

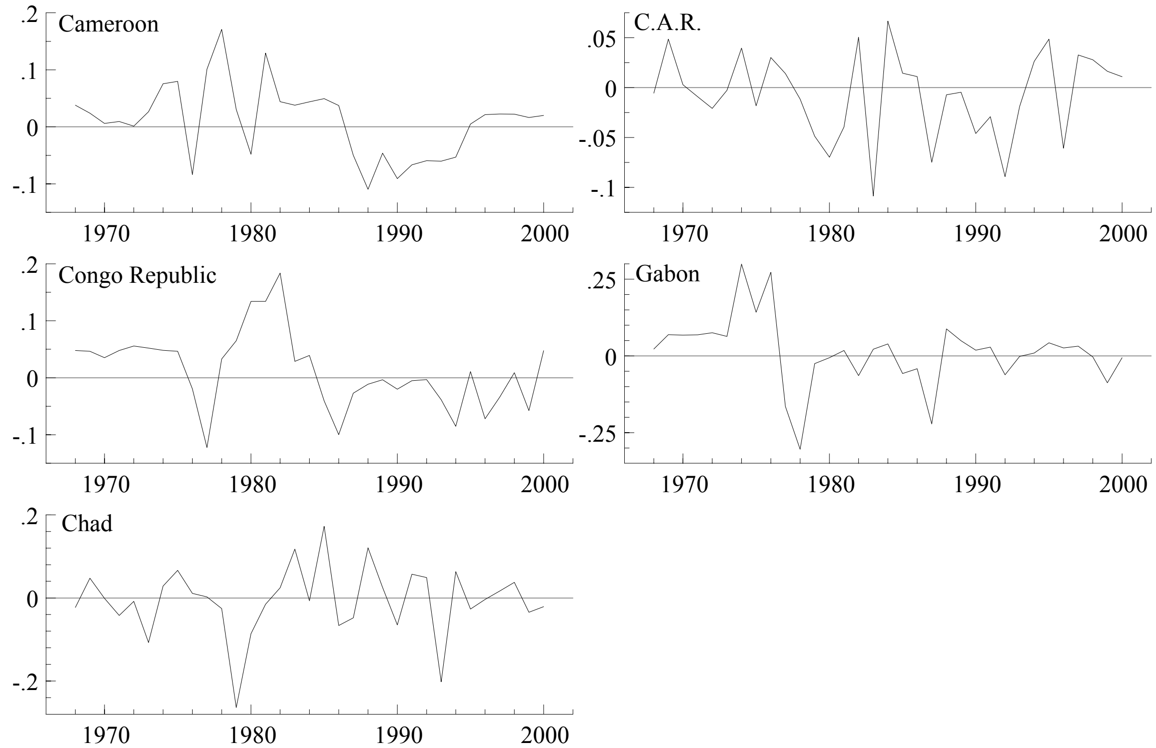


Figure 3: Annual GDP growth in five CEMAC countries

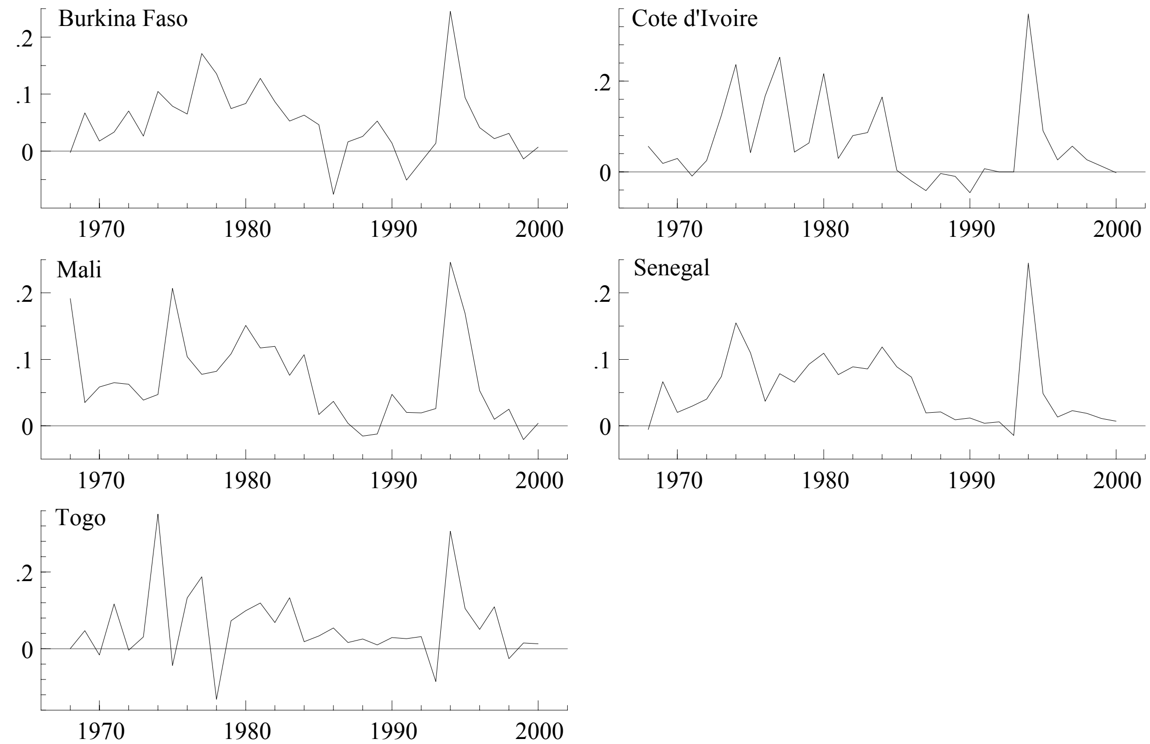


Figure 4: Annual inflation in five UEMOA countries

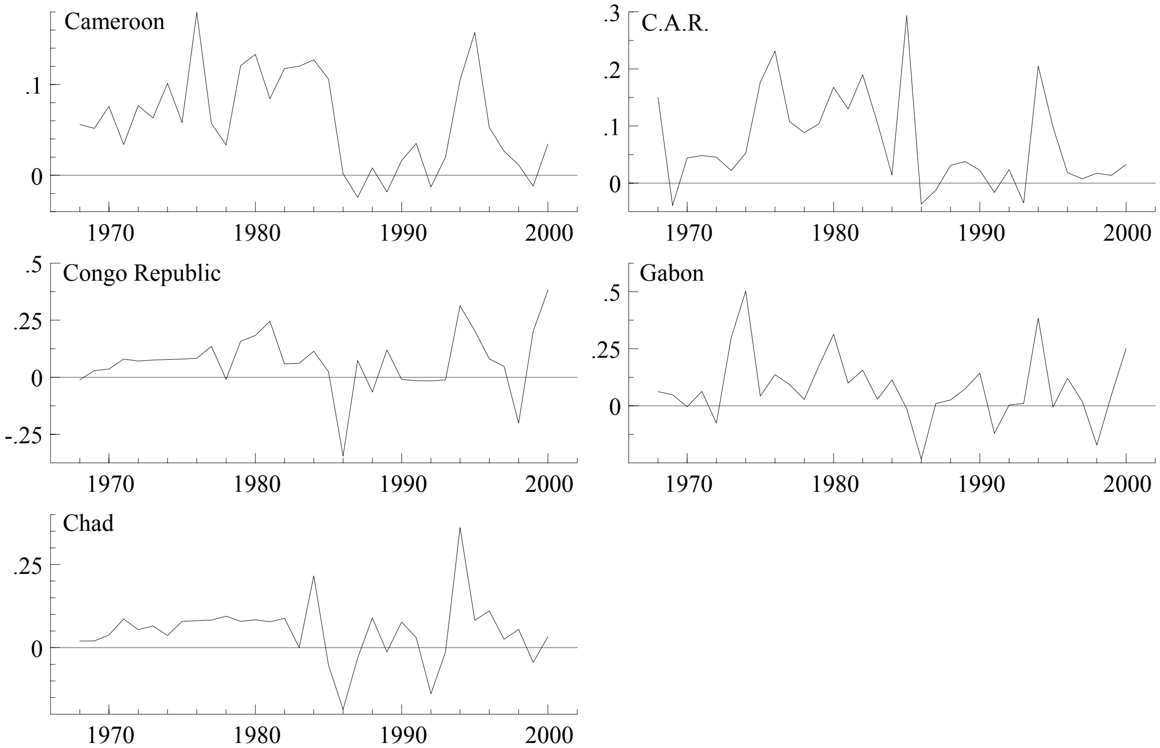


Figure 5: Annual inflation in five CEMAC countries

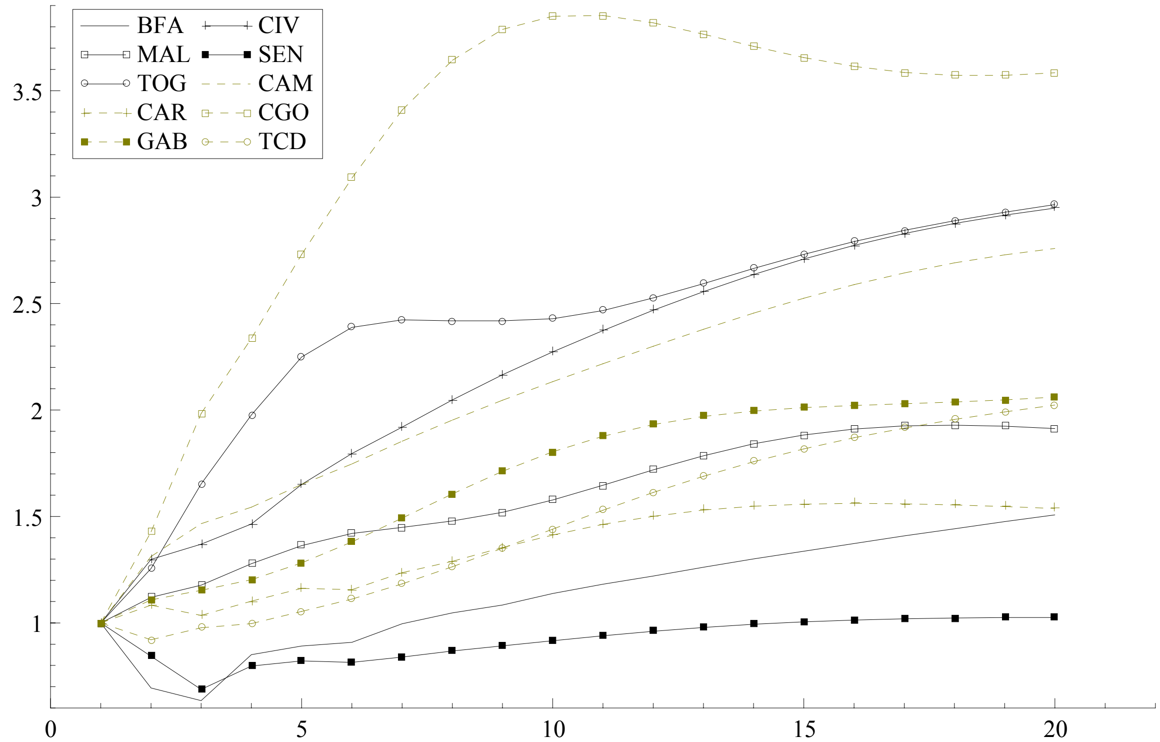


Figure 6: Effect of a shock causing initial output to rise by one unit in country *i* (Q(y^1))

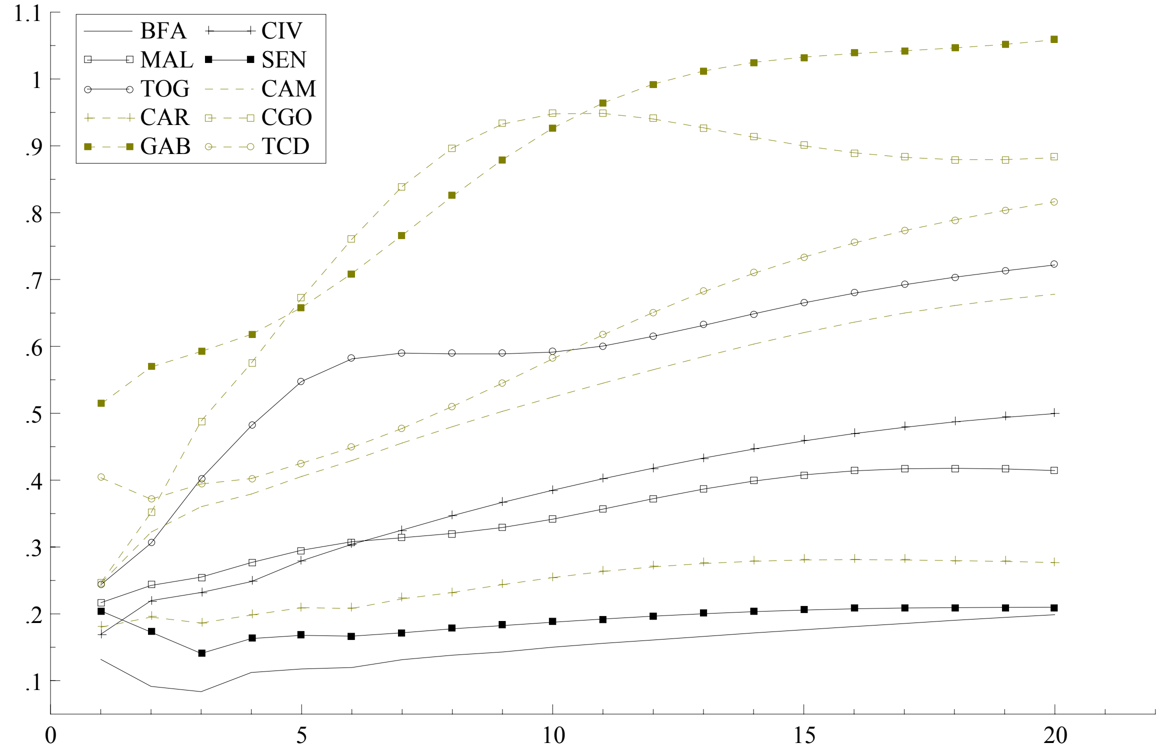


Figure 7: Effect of a shock causing an initial zone-wide rise in output of one unit (Q(y^2))

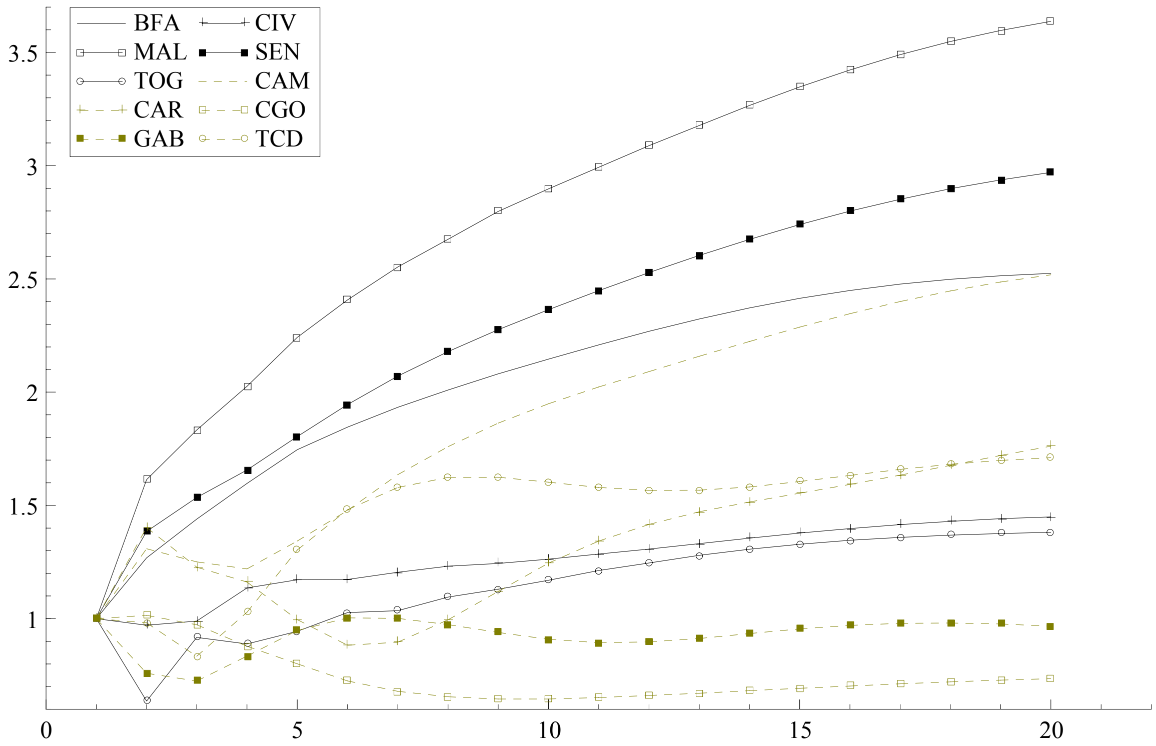


Figure 8: Effect of a shock causing initial prices to rise by one unit in country *i* (Q(p^1))

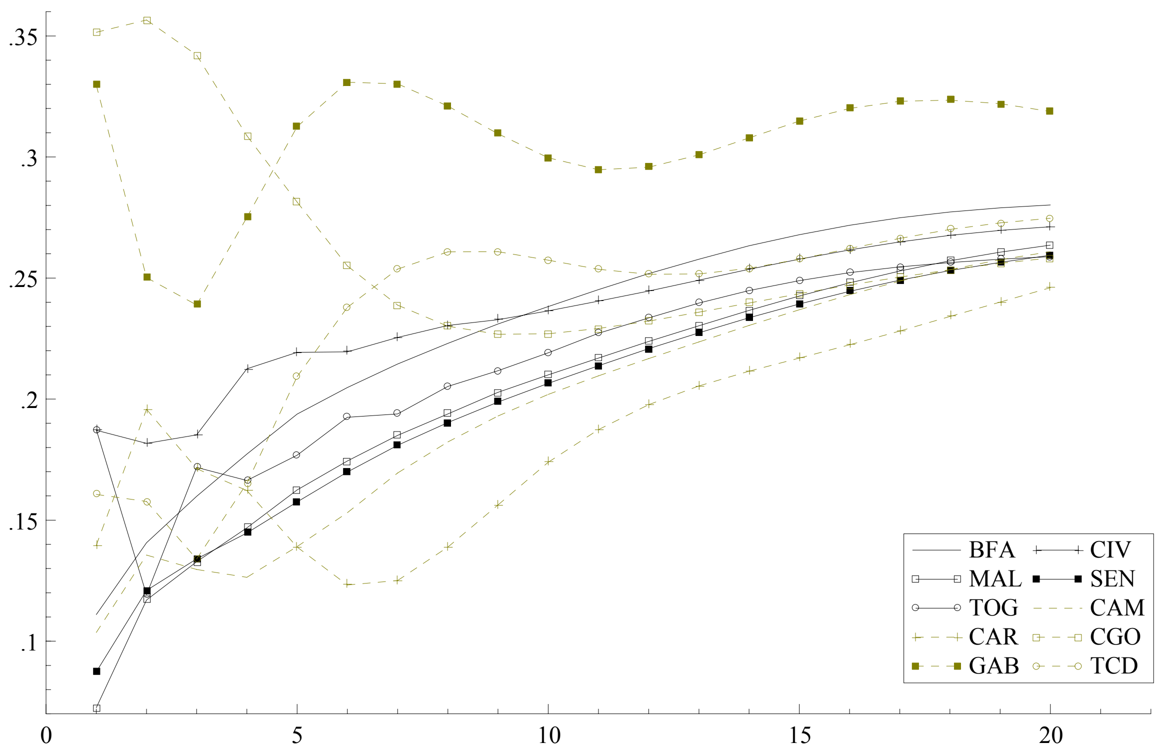


Figure 9: Effect of a shock causing an initial zone-wide rise in prices of one unit (Q(p^2))

Appendix Table A1: The Fitted Regression Equations

Dependent Variable = Δy_{it}

Regressors	BFA	CIV	MLI	SEN	TGO	CAM	CAR	CON	GAB	TCD
intercept	0.0590	0.0136	-0.0052	0.0205	-0.0510	-0.0140	-0.0119	0.0574	-0.0237	0.0178
	(4.6275)	(1.0730)	(-0.3841)	(1.3044)	(-2.2173)	(-0.8005)	(-0.7443)	(2.9211)	(-0.8211)	(0.6975)
Δy_{i-1}	-0.4388		-0.2927	-0.2927	0.2011	0.2011	-0.3630		0.1123	-0.1697
	(-2.6180)		(-1.5498)	(-1.5498)	(1.1941)	(1.1941)	(-1.8442)		(0.6278)	(-0.8239)
Δy_{i-2}	-0.3777		-0.2376	-0.2376				0.1929		
	(-2.1923)		(-1.3867)	(-1.3867)				(1.0838)		
Δy_{-1}		0.8235	0.4448	0.4448			0.7384	-1.1894		0.7339
		(2.7794)	(1.4885)	(1.4885)			(1.8538)	(-2.9467)		(0.9126)
Δy_{-2}					0.5725	0.5725	0.3784	-0.8081		
					(1.6544)	(1.6544)	(1.2276)	(-2.1701)		
Δp^{UEMOA}_{-1}					0.3946					
					(2.4727)					
Δp^{UEMOA}_{-2}	0.1736									
	(2.0018)									
Δp^{CEMAC}_{-1}						0.4197	0.2454		0.3117	0.2481
						(3.3500)	(2.1265)		(1.2081)	(1.1585)
Δp^{CEMAC}_{-2}							-0.2456			
							(-1.8797)			
$p_i\text{-}p^{UEMOA}_{-1}$	-0.1483		0.0785	-0.0820	-0.3827			0.1882	-0.2287	-0.1683
	(-2.3497)		(0.7708)	(-0.7745)	(-2.2305)			(1 .8308)	(-2.4713)	(-1.9964)
p^{UEMOA}-		-0.2289	0.2269		0.5499	-0.1493	-0.1890			
p^{CEMAC}_{-1}		(-3.0634)	(1.4863)		(2.4256)	(-1.2431)	(-1.2465)			
DUM94	-0.0306	-0.0052			0.1792		0.0885	-0.1615		
	(-1.0063)	(-0.3841)			(3.1509)		(1.8453)	(-2.6965)		
R^2	0.3900	0.5078	0.2682	0.1892	0.4148	0.0521	0.3240	0.5074	0.2834	0.1650
Σ	0.0286	0.0359	0.0451	0.0448	0.0527	0.94	0.0407	0.0533	0.1069	0.0856
LMAC p	0.01	0.14	0.06	0.14	0.28	0.32	0.94	0.70	0.45	0.58
FF p	0.68	0.38	0.79	0.91	0.05	0.80	0.14	0.75	0.25	0.73
Normality p	0.19	1.00	0.31	0.27	0.73	0.97	0.84	0.27	0.99	0.88
Heterosk. p	0.31	0.57	0.30	0.02	0.54	0.4616	0.76	0.41	0.07	0.08

Dependent Variable = Δp_{it}

Regressors	BFA	CIV	MLI	SEN	TGO	CAM	CAR	CON	GAB	TCD
intercept	0.0001	0.0135	0.0201	0.0005	0.0090	0.0239	0.0283	0.0549	0.0010	-0.0154
	(0.0081)	(0.4676)	(1.9745)	(0.0340)	(0.2762)	(2.1716)	(1.3521)	(1.1666)	(0.0216)	(-0.5989)
$\Delta p_{i\text{-}1}$				0.4251	-0.8468		-0.3784			
				(3.3541)	(-3.3738)		(-2.0969)			
$\Delta p_{i\text{-}2}$		-0.3020			-0.4159					-0.2154
		(-1.0174)			(-2.2480)					(-1.1439)
$\Delta y_{\text{-}1}$					1.1705				-1.1800	-0.9376
					(1.6639)				(-1.0656)	(-1.5419)
$\Delta y_{\text{-}2}$	0.4026		-0.1767	0.2882	0.7743		-0.5993			0.6730
	(1.3565)		(-0.8632)	(1.1722)	(1.1843)		(-1.2230)			(1.3116)
$\Delta p^{UEMOA}_{\text{-}1}$	0.5229	0.4996	0.6148		1.1431					
	(4.2554)	(1.8589)	(7.6053)		(3.1312)					
$\Delta p^{UEMOA}_{\text{-}2}$		0.7726								
		(1.6080)								
$\Delta p^{CEMAC}_{\text{-}1}$						0.3789	0.5361	0.3774		0.3244
						(4.2672)	(3.2798)	(1.0870)		(1.8254)
$\Delta p^{CEMAC}_{\text{-}2}$									0.5842	0.4002
									(1.4055)	(1.7470)
$p_i\text{-}p^{UEMOA}_{\text{-}1}$		-0.2299	-0.2937	-0.1789	-0.2773	-0.2381	-0.2701	-0.0791	-0.1319	
		(-1.6734)	(-4.8003)	(-2.0442)	(-1.2180)	(-2.1200)	(-3.7880)	(-0.3909)	(-0.8768)	
$p^{UEMOA}\text{-}$						0.2252	-0.3073		1.1286	0.5742
$p^{CEMAC}_{\text{-}1}$						(1.2654)	(-1.4979)		(1.9392)	(2.3339)
DUM94	0.2522	0.3337	0.2507	0.2494	0.2837	0.0935	0.1996	0.2613	0.2921	0.2817
	(5.5564)	(4.1695)	(8.2783)	(6.6983)	(3.0719)	(2.2111)	(3.2833)	(1.8420)	(1.9522)	(3.5330)
R^2	0.6031	0.5059	0.8394	0.6696	0.5245	0.5483	0.6333	0.1470	0.4083	0.6365
Σ	0.0425	0.0745	0.0283	0.0341	0.0779	0.0404	0.0568	0.1345	0.1313	0.0668
LMAC p	0.94	0.16	0.29	0.96	0.35	0.32	0.40	0.14	0.05	0.63
FF p	0.24	0.46	0.63	0.58	0.14	0.72	0.61	0.73	0.43	1.00
Normality p	0.23	0.97	0.10	0.97	1.00	0.63	0.90	1.00	0.19	1.00
Heterosk. p	0.43	0.20	0.12	0.30	0.12	0.18	0.69	0.45	0.74	0.46

Notes: In each part of the table 'LMAC p' is the p-value from an LM test for first-order residual autocorrelation, figures *greater* than 0.95 indicating rejection of the null of no autocorrelation at the 5% level. 'FF p' corresponds to a RESET test for the validity of the functional form. 'Normality p' corresponds to a Jarque-Bera test for residual normality. 'Heterosk. p' corresponds to a test for heteroskedasticity.

Appendix Table A2: Cointegration Test Results

Cointegration between output and price in country *i*	
Country	ADF Test Statistic
BFA	-0.87
CIV	-3.08
MLI	-1.35
SEN	-1.35
TGO	-3.65
CAM	-1.52
CAR	-2.33
CON	-1.06
GAB	-2.21
TCD	-1.53
Panel Tests for Cointegration	
	t-bar Test Statistic
Cointegration between output in country *i* and average CFA output	-0.79
Cointegration between prices in country *i* and average CFA prices	**-3.04**

Notes: The upper part of the table gives ADF test statistics based on a regression of the Engle-Granger residuals as described in the text, and contain a constant term. The lower part of the table gives the *t*-bar Test Statistic based on Im et al. (2003) with no deterministic trend in the ADF regressions. Figures in bold indicate rejection of the null that the series are I(1) against the alternative that they are I(0) at the 5% level.