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# Monetary Union in West Africa and Asymmetric Shocks : A Dynamic Structural Factor Model Approach*

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**Abstract**

We analyse the costs of a monetary union in West Africa by means of asymmetric aggregate demand and aggegate supply shocks. Previous studies have estimated the shocks with the VAR model. We discuss the limits of this approach and apply a new technique based on the dynamic factor model. The results suggest the presence of economic costs for a monetary union in West Africa because aggregate supply shocks are poorly correlated or asymmetric across these countries. Aggregate demand shocks are more positively or less negatively correlated between West African countries. These conclusions imply some policy recommendations for the monetary union project in West Africa.

- Keywords: Asymmetric Shocks, Monetary Union, Factor Model.
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## 1 Introduction

Following the emergence of the euro as the single currency of the European Monetary Union, there has been a renewed and a growing interest in the monetary integration around the

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world[1]. One special case is the monetary union project in the Economic Community of the West African States (ECOWAS) area. ECOWAS is a regional group of 15 countries[2] and it already includes a monetary union. This monetary union only involves the former French colony members of ECOWAS. It is known as the West African Economic and Monetary Union[3] (WAEMU). On April 2000, ECOWAS adopted a strategy of a two-track approach to the implementation of a monetary union in the whole area. As a first step, the non-WAEMU members[4] of ECOWAS agreed to form a second monetary union, the West African Monetary Zone (WAMZ). And later on, WAEMU and WAMZ will merge to form a wider monetary union in the ECOWAS area.

When countries decide to participate in a monetary union they abandon their national currency and fix their nominal exchange rate with respect to each other. From then on, the monetary policy is managed by the common central bank with area-wide objectives. As a consequence, the country members of the union lose the control of their national monetary policy. They can no longer change the price of their currency, nor can they determine the quantity of their money anymore; moreover, they can no longer change the short-term interest rate. Only, factors (labour and capital) mobility and wage flexibility remain the main adjustment mechanisms as alternatives to the exchange rate. Therefore, if wages are rigid and factor mobility is limited, countries will find it harder to adjust to asymmetric shocks. The loss of the ability to independently operate national monetary and exchange rate policies, in the presence of asymmetric shocks, is referred as the costs of a monetary union in the Optimal Currency Areas (OCA) literature. Mundell (1961), Mckinnon (1963) and Kenen (1969) are the pioneers of the theory of OCA. A currency area is optimal if the benefits that a country receives for joining the union outweigh the costs. The potential benefits of a monetary union are expected to include the creation of a larger regional market and the enhancement of economic competitiveness. A monetary union is also expected to increase the intra-regional trade via lower transaction costs and the reduction of the exchange rate uncertainty (see De Grauwe, 2003).

In this paper, we analyze the correlation of aggregate demand and aggregate supply shocks across West African countries during the period 1966-2000. The shocks are extracted from the generalized dynamic factor model proposed by Forni et al. (2000 and 2004) and

[1] In 1947, the number of independent currencies in the world was 65 for 76 countries (Alesina et al., 2002). Today, there are 193 countries, which use 158 different currencies in international transactions. Consequently, the ratio of the number of currencies to the number of countries has decreased between 1947 and today. This ratio is expected to drop rapidly when one considers the proposed regional currency areas.

[2] ECOWAS members are Benin, Burkina faso, Cape Vert, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo. Mauritania was a founding member but it left the group later.

[3] The members of the WAEMU are Benin, Burkina Faso, Cote d'Ivoire, Guinea Bissau, Mali, Niger, Senegal, and Togo. Apart from Guinea Bissau, which is a Portuguese colony, WAEMU countries are French speakers. WAEMU is also part of the CFA zone which has the CFA franc as the common currency. Figure B1 in the Appendix B summarises the overlaping membership of WEAMU.

[4] WAMZ members are Gambia, Ghana, Guinea, Nigeria and Sierra Leone. Liberia and Cape Verde are the two remaining ECOWAS countries that are not involved in the monetary project. Liberia has declined to participate in WAMZ project. Cape Verde has its currency, the Cape Verde Escudo, pegged to the Euro with the support of Portugal. WAMZ countries are English speaking.

Forni and Lippi (2001). The dynamic factor model is a non-parametric tool to analyze a large time series data set in a cross-section dimension. It has been applied for predictions (Stock and Watson, 2002a and 2002b and Forni et al., 2002), for structural analysis (Giannone et al., 2002; Forni and Reichlin, 1998 and Forni et al. 2003) and for constructing economic indicators (Forni et al. 2001). In our specification, each variable of the economy is driven by two common shocks (aggregate demand and aggregate supply shocks) and the idiosyncratic shock. On the one hand, the common shocks affect all the variables in the economy. They have a strong correlation with these variables. On the other hand, idiosyncatic shocks are specific to each variable and they are poorly correlated with the rest of the variables. They can be interpreted as measurement errors or short-run disturbances (see Forni et al., 2000). To identify the structural shocks, we use the restriction, like in Blanchard and Quah (1989), that aggregate demand shocks have only a temporary effect on output.

Previous studies have mainly used the Vector Auto-Regressive (VAR) model to analyze asymmetric shocks in West Africa. Actually, these studies followed the standard technique applied to industrialized countries, pioneered by Bayoumi and Eichengreen (1992). For example, Fielding and Shield (2001) identify output and price shocks for the CFA franc zone countries and Kenya.. They use a 4-variable (output growth, inflation, money growth and foreign inflation) VAR model and find a high degree of correlation between inflation shocks of CFA franc members but not with Kenya. The correlation of output shocks is, however, not uniform. Some CFA franc countries (Benin, Burkina Faso, Senegal, Togo, Niger, Cameroon, Gabon, Central African Republic and Chad) exhibit a positive correlation contrary to the rest. Besides, CFA countries have negative output shocks correlating with Kenya. Fielding and Shield (2003) extend this study to WAMZ. They use a 3-variable (output growth, real exchange rate and money growth) VAR model and the terms of trade as an exogenous variable. The results suggest less real exchange rate volatilities for CFA countries and negative output shocks correlation, although the later result is not significant.

The problem with these studies[5] lies in the use of the VAR model. First of all, the VAR model assumes that the shocks and the impulse response function are fundamental,[6]

[5]There are other papers that apply different methods to analyse the similarity of shocks in West African countries. Masson and Pastillo (2001) find very low term of trade correlations across West African countries. They interpret this asymmetric shocks. Bayoumi and Ostry (1997) study output disturbances for Sub-Saharan African countries. They use an AR (2) model of real output per capita and find little real disturbance correlations across countries. More recently, Bénassy-Quéré and Coupet (2003) use the cluster analysis to test the Optimal Currency Area hypothesis for sub-Saharan Africa. Their conclusions suggest the rejection of this hypothesis. However, they identify the core of WAEMU based on several economic indicators. More interestingly, they show that WAEMU can be extended to other ECOWAS countries such Ghana, Gambia, Sierra Leone, but not Nigeria. A similar result for Nigeria has been found by Debrun et al. (2002). They apply a multi-country model and show that the monetary union project in ECOWAS would not be in the interest of the other countries unless this process is accompanied by an effective discipline over Nigeria's fiscal policies. Furthermore, Ogunkola (2002) analyses real exchange rate shocks for ECOWAS members. He finds a lower volatility for intra-CFA countries than any others. Nigeria displays the highest volatility.

[6]The fundamentalness critic is discussed in Lippi and Reichlin (1993 and 1994). A VAR representaion is fundamental if the shocks belong to the linear space span by the present and past of the variables included in the system. In this case the roots of the determinant of the MA representaion are outside the unit circle. When the roots of the determinant of the impulse response function lie inside the unit circle, the VAR is no

i.e. they are innovations to the variables included in the system. This might not be the case for the small VAR aforementioned. The critique here is that economic agents might use superior information set to the variables included in the VAR model such that the few variables included in the VAR may not be sufficient to explain the whole dimension of the economy. Second, the number of parameters estimated with the VAR model grows with the square of the number of variables included in the system. For example in a 5-variable VAR model with 2 lags, the numbers of parameters is 50 (excluding the constant term). This fact may lower the number of degrees of freedom of the estimation. Third, the number of shocks is equal to the number of variables included in the VAR such that a large number of restrictions is needed to achieve identification.

The main motivation of this paper is to apply a new method based on the dynamic structural factor model to compute aggregate demand and aggregate supply shocks for West African countries. The benefit of this approach is that it provides a better structural presentation of the macroeconomy than the VAR model. First, the factor model distinguishes measurement errors and other idiosyncratic disturbances in the data. Macroeconomic data are computed with errors. These errors can be very large in developing countries where data are subject to substantial revisions and are released with a long delay. Therefore, our consideration of measurement errors can improve the efficiency of the results. Second, the factor model allows to analyze a large information set and it exploits the covariance structure of the panel to extract a limited information set. This reduces the number of restrictions needed to identify the shocks. We use 54 variables for each country to compute only two structural shocks. This was not possible with the VAR model. Third, Forni et al. (2003) show that the factor model is superior to the VAR model because the fundamentalness assumption is less restrictive within the factor model framework.

The rest of the paper is organized as follows. In section 2, we present the correlation of output growth and inflation across countries. The next section is devoted to the methodology. We present the dynamic structural factor model and the estimation procedure. Section 4 gives empirical results. The last section provides a conclusion.

## 2 Correlation of Output Growth and Inflation

Different preferences about inflation and output growth of countries may make the introduction of a common currency costly. On the one hand, a fast-growing country will have to follow deflationary policies,[7] which constraint growth, if it forms a monetary union with a low-growing country. On the other hand, a high inflation country will increasingly lose

longer fundamental. In this case, the shocks belong to the linear space span by the past and future of the variables in the system. Therefore, the estimation of shocks and the impulse response function are biased because the future of the variables are not included in the system.

[7] A fast-growing country will need fast-growing imports, and owing exports to grow at the same rate as imports, this country has to make its exports more cheaper; otherwise there will be a large current account deficit. If this country were not in a monetary union, it could just depreciate its currency to increase exports.

its competitiveness[8] if it forms a monetary union with a lower inflation country. These points motivate our comparative analysis of inflation and output growth across West African countries.

To begin with, we plot the historical performance of output growth and inflation of WAEMU and WAMZ in Figure 1. Additional indicators are provided in Tables $B_1$, $B_2$ and $B_3$ in the Appendix B. The data are annual and span the period from 1966 to 2000. Real GDP is our measure of output and GDP deflator is our proxy for the price level. We compute aggregate inflation and output growth as the weighted sum of inflation and output growth of countries in each group. The weights are a 1 lag share of real GDP as suggested by Beyer et al. (2001). A lack of data forces us to exclude some countries. Our aggregate WAEMU involves Benin, Burkina Faso, Cote d'Ivoire, Niger, Senegal and Togo. The WAMZ countries considered are Nigeria, Gambia and Ghana. In the paper we will sometimes refer WAEMU countries as CFA countries or French speaking countries and the WAMZ ones as English speaking countries.

[ Figure 1 and Table 1 about here]

One fact from Figure 1 and Table 1 is that inflation is much lower in CFA countries. Moreover, English speaking countries have on average the highest volatility of both output growth and inflation. The relative low level of inflation in WAEMU have been explained by the peg of the CFA franc to the French franc before 1999 and now to the Euro (see Blaeney and Fielding, 2002).

Regarding output growth, there is not a clear difference between the two groups. There are some periods when the English speaking countries did better than the French speaking ones and vice-versa.

Next, we analyze the correlation of output growth and inflation across countries. Figures 2 and 3 display the correlations of output growth and inflation with the aggregate WAEMU and WAMZ, respectively. Tables 2 and 3 report the correlation matrices of output growth and inflation.

[ Figures 2 and 3 and Tables 2 and 3 about here]

WAEMU countries have a strong and positive inflation correlation with their aggregate. This is also true for output growth except for Benin and Togo, which have a negative and a low output growth correlation, respectively. Ghana and Nigeria, two WAMZ countries, are a bit closer to the French speaking countries. They have a weak and positive correlation of inflation and output growth with WAEMU, respectively. Gambia has both negative output growth and inflation correlation.

According to the correlation with WAMZ, the member countries also exhibit a positive correlation except for Gambia. However, the correlations here are less pronounced compared

[8] This follows from the standard PPP theorem.

to the WAEMU ones. Besides, French speaking countries have little or negative output growth and inflation correlation with the aggregate WAMZ. These results are also confirmed in the correlation matrices reported in Tables 2 and 3. Nigeria is approximately at the place where Cote d'Ivoire was when we compute the correlation with WAEMU. This may suggest that Cote d'Ivoire and Nigeria can be considered as the core of WAEMU and WAMZ, respectively. The result is not surprising given the high weights of Cote d'Ivoire and Nigeria in the computation of aggregate output growth and inflation of WAEMU and WAMZ, respectively. In the next section, we will then focus on the correlation between countries shocks with the shocks faced by Nigeria and Cote d'Ivoire.

The main conclusion of this section is that WAMZ countries have a relative higher level of inflation. This implies a cost of the loss of competitiveness for these countries if they form a monetary union with WAEMU members. They can reduce these costs by reducing their inflation. But this will not help because it will create another cost. A lower inflation means lower seigniorage. This will force them to increase taxation or let deficit budget increases. The question is whether the correlation of aggregate demand and supply shocks are similar to what we have observed here.

# 3 Methodology

In this section, we present the dynamic structural factor model. The estimation procedure is discussed as well. We conclude with a short description of the data set.

## 3.1 The Dynamic Structural Factor Model

We assume that the process $x_{it}$ is the sum of two unobservable components as follows:

$$x_{it} = \chi_{it} + \xi_{it}, \tag{1}$$

where, $x_{it}$, $i = 1, \ldots, n$, $(n \in \mathbb{N})$, $t = 0, \ldots, T$, $(T \in \mathbb{Z})$, is a stationary process with zero mean. $n$ represents the number of variables included in the panel and $T$ is the number of observations. $\chi_{it}$ is called the common component and $\xi_{it}$ is the idiosyncratic component. Next, we assume that the economy is driven by two common shocks such that the common component can be expressed as:

$$\chi_{it} = b(L)u_t = b_{i1}(L)u_{1t} + b_{i2}(L)u_{2t}, \tag{2}$$

where, the filters $b_{ij}(L)$ are one-sided polynomial of order $s$ in the lag operator $L$. $u_t = (u_{1t}, u_{2t})'$ represents a 2-dimentional vector of the common shocks. We call $u_{1t}$ and $u_{2t}$ aggregate supply shocks and aggregate demand shocks, respectively. The vector of shocks, $u_t$, is orthonormal white noise. $\xi_{it}$ is a zero-mean stationary process and orthogonal to $u_{jt-k}$ for any $i, j, t$, and $k$.

Equation 1 can be restated in matrix notation as:

$$\mathbf{x}_{nt} = \boldsymbol{\chi}_{nt} + \boldsymbol{\xi}_{nt} = B_n(L)u_t + \boldsymbol{\xi}_{nt}, \tag{3}$$

where, $\mathbf{x}_{nt} = (x_{1t} \dots x_{nt})'$; $\boldsymbol{\chi}_{nt} = (\chi_{1t} \cdots \chi_{nt})'$ and $\boldsymbol{\xi}_{nt} = (\xi_{1t} \cdots \xi_{nt})'$. $B_n(L) = B_0^n + B_1^n L + \dots + B_s^n L^s$ is a $n \times 2$ matrix, which has the $b_{ij}(L)$ as entries.

Equation 3 is the generalized dynamic factor model proposed by Forni et al. (2000) and Forni and Lippi (2001) where the 2 entries of $u_t$ represent the dynamic factors. Identification of the common and idiosyncratic components requires two additional assumptions that are given below. Before, we define some useful quantities.

Denote by $\boldsymbol{\Sigma}_n^{\mathbf{x}}(\theta)$, $\theta \in [-\pi\ \pi]$, the spectral density matrix of $\mathbf{x}_{nt}$ and $\mu_i^{\mathbf{X}}(\theta)$, $i = 1, 2, \dots, n$, its eigenvalues in decreasing order of magnitude. The $\mu_i^{\mathbf{X}}(\theta)$ are called dynamic eigenvalues[9]. Similarly, $\mu_i^{\boldsymbol{\chi}}(\theta)$ and $\mu_i^{\boldsymbol{\xi}}(\theta)$ represent the dynamic eigenvalues of the spectral density matrices of the common component, $\boldsymbol{\Sigma}_n^{\boldsymbol{\chi}}(\theta)$, and the idiosyncratic component, $\boldsymbol{\Sigma}_n^{\boldsymbol{\xi}}(\theta)$, respectively.

*Assumption* 1: The first dynamic eigenvalue of the spectral density matrix of the idiosyncratic component is uniformly bounded, i.e., there exists a real $\Lambda$ such that $\mu_1^{\boldsymbol{\xi}}(\theta) \preceq \Lambda$, $\forall$ $\theta \in [-\pi\ \pi]$. This implies that variations caused by idiosyncratic components are small and tend to zero as, $i$ tends to infinity.

*Assumption* 2: The first two largest dynamic eigenvalues of the spectral density matrix of the common component diverge almost everywhere (a.e.) in $[-\pi\ \pi]$, i.e., $\mu_j^{\boldsymbol{\chi}}(\theta) \longrightarrow \infty$ as $n \longrightarrow \infty$, a.e. in $[-\pi\ \pi]$, $j = 1, 2$. This means that each of the two dynamic factors is infinitely present in the cross-section units. Note that this assumption only concerns the first two largest dynamic eigenvalues of the common components because we implicitly assume 2 commons shocks. We will show later that the assumption of two common shocks is supported by our data.

Under these requirements, Forni et al. (2000) show that the first two largest eigenvalues of $\boldsymbol{\Sigma}_n^{\mathbf{x}}(\theta)$ diverge a.e. in $[-\pi\ \pi]$ whereas the third one is uniformly bounded. This guaranties the identification of the common and idiosyncratic components (see Forni and Lippi, 2001).

To identify each common shock, we use the transformation $v_t = Ru_t$, with $RR' = I_2$, where $I_2$ is a $2 \times 2$ identity matrix. The problem consists of choosing the appropriate rotation matrix $R$ that corresponds to our identification assumption. We will come back to this point later.

The static form representation of Equation 3 is:

$$\mathbf{x}_{nt} = A_n F_t + \boldsymbol{\xi}_{nt}, \tag{4}$$

where, $A_n = (a_1' \dots a_n')' = (B_0^n\ B_1^n\ \dots B_s^n)$ and $F_t = (u_{1t}\ u_{2t}\ u_{1t-1}\ u_{2t-1} \dots u_{1t-s}\ u_{2t-s})'$. The $r = 2(s+1)$ entries of $F_t$ are called static factors. From the expression of $F_t$, it follows by definition that:

[9] The term dynamic eigenvalue is used to make a difference with the eigenvalue of the variance covariance of $X_{nt}$. See Brillinger (1975).

$$F_t = CF_{t-1} + e_t, \tag{5}$$

where, $C = \begin{pmatrix} 0 & 0 \\ (2 \times 2s) & (2 \times 2) \\ I & 0 \\ (2s \times 2s) & (2s \times 2) \end{pmatrix}$; $e_t = \begin{pmatrix} u_t \\ 0 \\ (2s \times 1) \end{pmatrix}$ and $F_{t-1}$ is orthogonal to $e_t$.

The vector $F_t$ is only identified up to a pre-multiplication by a unitary matrix. So we cannot estimate it directly. We rather estimate[10] the common static factors space. This is the vector $G_t$ whose entries span the linear space as the entries of $F_t$. Suppose that $G_t = EF_t$, where $E$ is a non-singular matrix. Given the definition of $G_t$ and Equation 5 , it follows the VAR(1) representation:

$$G_t = DG_{t-1} + \epsilon_t, \tag{6}$$

where, $D = ECE^{-1}$ and $\epsilon_t = Ee_t$. The residual from the VAR(1) in Equation 6 can be expressed as:

$$\epsilon_t = E_2 u_t = E_2 R' R u_t = PMRu_t, \tag{7}$$

where, $E_2$ is the matrix formed by the first 2 columns of $E$. $M$ represents the diagonal matrix having on the diagonal the square roots of the first 2 largest eigenvalues of the covariance matrix of the residual, $\epsilon_t$. $P$ is the matrix whose columns are the eigenvectors corresponding to these eigenvalues. Replacing the residual $\epsilon_t$ by its expression in Equation 7 and inverting the VAR (1) gives:

$$G_t = (I_r - DL)^{-1} PMRu_t, \tag{8}$$

where $L$ is the lag operator and $I_r$ is a $r-$dimensional identity matrix. Substitute Equation 6 in Equation 4 and replacing $EF_t$ by $G_t$ gives:

$$\mathbf{x}_{nt} = Q_n G_t + \boldsymbol{\xi}_{nt} = Q_n (I_r + DL + D^2 L^2 + \ldots + D^s L^s) PMRu_t + \boldsymbol{\xi}_{nt}, \tag{9}$$

with $Q_n = A_n E$ and $R$ is a rotation matrix which is chosen according to our identification restriction. Note that this sum is finite because $\boldsymbol{\chi}_{nt}$ is orthogonal to $u_{t-k}$ for $k \succ s$. From Equation 9, we identify the impulse response function ($IRF$) as follows:

$$IRF = Q_n (I + DL + D^2 L^2 + \ldots + D^s L^s) PMR. \tag{10}$$

[10] We deal with the estimation issue in the next section.

### 3.2 Estimation

In this section we explain the different steps to estimate the unknowns parameters in Equation 10. These parameters are $Q_n$, $D$, $P$, $M$, and $R$.

Following Stock and Watson (2002a and 2002b), we estimate the static factors space, $G_t$, by the first $r$ principal components of $\mathbf{x}_{nt}$:

$$G_t = V'\mathbf{x}_{nt}, \tag{11}$$

where $V$ is a $n \times r$ matrix whose columns are the eigenvectors corresponding to the first $r$ largest eigenvalues of the variance-covariance matrix of $\mathbf{x}_{nt}$. The number of static factors, $r$, is determined by the information criteria proposed by Bai and Ng (2002). We find the values for $r$ ranging between 3 and 6. We choose a value 5 for every country to allow comparison of the results between countries.

Based on Equation 9 and on Stock and Watson (2002a and 2002b) again, we estimate $Q_n$ by OLS as:

$$Q_n = \sum_{t=1}^{T} \mathbf{x}_{nt} G_t' \left( \sum_{t=1}^{T} G_t G_t' \right)^{-1} = V, \tag{12}$$

where $T$ is the number of observations.

Having determined $G_t$, we estimate the VAR(1) in Equation 6 by OLS. This gives the value for $D$:

$$D = \sum_{t=2}^{T} G_t G_{t-1}' \left( \sum_{t=2}^{T} G_{t-1} G_{t-1}' \right)^{-1}. \tag{13}$$

Next, we compute the variance-covariance matrix of the residual $\epsilon_t$ in Equation 6 by:

$$\Gamma = \frac{1}{T-1} \sum_{t=2}^{T} G_t G_t' - D \left( \frac{1}{T-1} \sum_{t=2}^{T} G_{t-1} G_{t-1}' \right)^{-1} D'. \tag{14}$$

After that, we run the first 2 principal components on this matrix to estimate $P$ and $M$. $M$ is the diagonal matrix having on the diagonal the square roots of the first 2 largest eigenvalues of the covariance matrix of $\epsilon_t$ and $P$ is the matrix whose columns are the eigenvectors corresponding to these eigenvalues.

Based on Equation 7, we estimate $u_t$ by:

$$R' M^{-1} P' \epsilon_t \tag{15}$$

where $\epsilon_t = V'\mathbf{x}_{nt} - DV'\mathbf{x}_{nt-1}$ (see Equation 6).

Finally, the rotation matrix is represented by:

$$R = \begin{pmatrix} \sin(a) & \cos(a) \\ -\cos(a) & \sin(a) \end{pmatrix}, \tag{16}$$

where $a \in [0, \pi)$. The parameter $a$ is fixed such that the long-run effect of the demand shock on the output is zero. More specifically, the parameter $a$ minimizes the distance between zero and the accumulated impulse response function ( see Equation 10) of the output to aggregate demand shocks.

Using this framework we compute aggregate demand and aggregate supply shocks for each ECOWAS country. After that, we take the correlation of these shocks across countries. We test the significance of the correlation coefficients by the statistic:

$$z = \frac{\sqrt{n-3}}{2} \ln \left( \frac{1+r}{1-r} \right), \tag{17}$$

where, $r$ is the correlation coefficient. $ln$ represents the natural logarithm and $n$ is the number of years for which we have computed each shock. After considering the lag structure of the model we end up with 33 observations. Under the null hypothesis that $r$ is equal to zero, the statistic $z$ has a normal asymptotic distribution.

### 3.3 Data

The data used in the paper are at the annual basis. They span the period from 1966 to 2000. We use 54 series of different nature, including real, nominal and financial variables. Some indicators expressed as a percentage of GDP are used as well (see Appendix A).

The data come from the International Monetary Fund (International Financial Statistics), the World Bank ( the World Development Indicators) and the Penn World Table 6.1 (Heston et al. 2002).

We transform the original series to reach stationarity as required by our model. In most of the cases, the series are $I(1)$ such that we apply the first difference. The series are taken in deviation from the mean value and divided by the standard deviation. This renders comparison between series as they are now expressed in the same unit[11].

## 4 Supply and Demand Shocks across West African Countries

First of all, we check whether the assumption of two shocks is plausible in ECOWAS countries. For this end, we compute the percentage of the variance explained by two dynamic principal components. Table 4 reports the results.

We observe that two dynamic principal components capture on average more than 60% of the variance of the panel in each country (see column 2 in Table 4). These values are significant for standardized data and it implies a high co-movement between the series and the two shocks.

Now, we look at the shocks. Figure 4 displays the underlying aggregate demand and supply shocks for selected countries.

[11] Each serie has now zero mean and 1 standard deviation.

[ Figure 4 about here]

During the period studied, Cote d'Ivoire and Nigeria experienced similar demand and supply shocks on average. Cote d'Ivoire had a severe negative shock in 1994 corresponding to the CFA devaluation. Nigeria had a boom period in the late of the 1980s. This has to do with substantial growth during the structural reforms period.

Cote d'Ivoire had a recession in the end of the 1970s and beginning of the 1980s. This corresponds to the financial crisis in French speaking countries in Africa. The crisis has led to the bankruptcy of the financial system. Benin was one of the most affected. In 1989 all the commercial banks that were operating in the Beninese economy collapsed. The negative supply shock in Cote d'Ivoire in 1993 may be related to the loss of competitiveness in WAEMU countries. The positive supply shock of 1995 is the supply response to the devaluation of the CFA franc.

Let us look at the size of the shocks. This is measured by the standard deviation of the shocks. Table 5 summarizes the results. The larger the asymmetric shocks, the more difficult it will be for countries to maintain a fixed exchange rate. This is particularly true for supply shocks since demand shocks can be adjusted with domestic policies. The results show comparable size across West African countries. The size of the shocks reported here are much bigger than the ones found by Bayoumi and Eichengreen (1992) for industrialized countries. This is not the case when we compare the results with the work by Fidrmuc and Korhonen (2003). Many European countries had bigger demand shocks than West African countries. These are for example, the UK, Belgium, Finland, Germany, Denmark, Spain, Sweden and Bulgaria. On the contrary, West African countries experienced relatively larger supply shocks. What about the correlation of these shocks across countries?

Tables 6 and 7 report the correlation matrices of aggregate demand and supply the shocks across countries. Figures 5 and 6 display the correlation of shocks with Cote d'Ivoire and Nigeria, respectively. For comparison, we plot in the same graphs the results for European countries found by Fidrmuc and Korhonen (2003). The correlations for European countries are evaluated with Germany.

[Figures 5 and 6 and Tables 6 and 7 about here]

CFA countries, except for Togo and Niger, have positive demand shocks correlation with Cote d'Ivoire (see Figure 5). But the result is only significant for Senegal at 5% level (cf. Table 6). The magnitudes of their demand shocks correlation are smaller than those of their inflation correlation found earlier in Figure 2. Demand shocks correlation between WAEMU countries are comparable with those of European countries. Nigeria is the only WAMZ member having positive demand shocks correlating with Cote d'Ivoire. However, the correlation is weak and the result is not significant.

Supply shocks present a similar picture for WAEMU countries but the correlation are much bigger here for Benin and Burkina Faso. The results are also more significant for supply shocks than demand shocks for WAEMU countries.

Turn now to the results when we take the correlation with Nigeria. Except for Niger, Senegal and Gambia, all countries have positive demand shocks correlating with Nigeria (see Figure 6). The highest and significant correlation is found for Ghana. Supply shocks are asymmetric between Nigeria and other WAMZ countries. This is also the same between Nigeria and WAEMU countries. Niger is the only WAEMU member having positive supply shocks correlating with Nigeria, although the magnitude is small and the result is not significant.

To give a short conclusion of what we have observed here, demand shocks and supply shocks are similar between French speaking countries, except for Niger and Togo. The correlation between French speaking countries are comparable to those between European countries. This is the same for English speaking countries except for Gambia which displays asymmetric demand and supply shocks relative to Nigeria. Demand shocks are positively or less negatively correlated between all West African countries. Supply shocks are weakly positively correlated or more asymmetric than demand shocks between these countries. This result may reflect the different specialization in commodity goods in West African countries (cf. Table B3). Hence, if wages are rigid and factors mobility is limited in West Africa, a monetary union in the ECOWAS area will be highly costly. Our results also suggest that the French speaking countries monetary union in west Africa can be extended to Ghana. A similar result has been found by Bénassy-Quéré and Coupet (2003).

To check the robustness of our analysis, we look at the sign predictions of output and price in the aggregate demand and supply framework. A positive demand shock is supposed to increase the price level while a positive supply shock is expected to reduce it. Figure 7 reports the impulse response functions of output and price for selected countries.

[ Figure 7 about here]

The sign predictions are satisfied for all. However, there are some irregularities for Nigeria and Burkina Faso. For comparison, output reaches its optimum at roughly 10 years after a positive supply shock in Nigeria while it is about 20 years for Cote d'Ivoire and Burkina Faso. The long-run response is much bigger for Cote d'Ivoire. In addition there is some persistence in the impulse response functions for WAEMU countries.

Finally, we look at the adjustment speed between Cote d'Ivoire and Nigeria. We measure the adjustment speed as the ratio of the value of the accumulated impulse response function after some period to its long-run response value. A high value would indicate a large amount of adjustment. For comparison, we look at the output response to a positive supply shock. Only about 53% of the long-run level of the accumulated response is reached after 3 years for Cote d'Ivoire. This indicator is about 83% for Nigeria. Bayoumi and Eichengreen (1992) report 94% and 72%, respectively, for the US economy and European countries. After 10 years, the difference in the adjustment process is still significant between West African countries. Nigeria completes 100% against 85% for Cote d'Ivoire. These results clearly show a lower speed of adjustment of the output to a positive supply shock for Cote d'Ivoire compared to Nigeria. This difference in the speed of adjustment may reflect the difference in the exchange regime between the two countries. Fidrmuc and Korhonen (2003) find a similar result for France and Germany. After 4 quarters, the adjustment speed of the output to a positive supply shock is about 87% for Germany against 92% for France.

## 5 Discussion and Policy Recommendations

The analysis of the feasibility of a monetary union in West Africa is only completed once we also look at the benefits side. In a monetary union, countries have a fixed bilateral exchange rate. A fixed exchange rate reduces transactions and conversion costs. It also reduces bilateral exchange rate fluctuations. Therefore, the greater the amount of inter-regional trade, the higher the benefits of a monetary union. Masson and Pattillo (2001) estimate internal trade at 10% and 4.7% between 1997 and 1998 for WAEMU and WAMZ, respectively. Hugon (1999) provides an estimate of 12% for the WAEMU in 1998. These values are far from the estimation of 46% for EMU in the same year. The rudimentary state of the transport system may explain this low level of intra-ECOWAS trade. Then, the benefits for forming a monetary union in West Africa could be lower.

We do not have to worry a lot about this result for different reasons. First of all, the gravity model predicts that their intra-trade should be lower because of their small level of income per capita. This is why Foroutan and Pritchett (1993) show that the intra-African trade is comparable to the trade between low -and middle- income developing countries. Secondly, the trade statistics that are usually published, do not take into account informal trade thereby, introducing a bias in the analysis. For example, Lares (1998) estimates informal trade between Benin and Nigeria. It shows that the official statistics should be multiplied by 12 and 13 for imports and exports, respectively. ECOWAS has introduced a trade liberalization project to increase intra-regional trade. The objectives of this project are: to establish a custom union, to eliminate custom duties and taxes of equivalent effects, to remove non-tariff barriers and to establish common custom external tariffs. In any case, Alesina et al., (2002), among others, find that a monetary union has a positive effect on trade. In addition, Frankel and Rose (1998) show that an integration leads to more trade, which will result in high business cycle correlations.

The presence of asymmetric shocks for countries in a monetary union is not a problem itself if labour is highly mobile between countries. When asymmetric shocks happen to countries in a monetary union it makes some countries richer and others poorer. If labour forces are mobile between countries, people in the poorer countries can emigrate to the richer countries. This process continues until countries go back to their initial situation (Mundell, 1961). Labour data is difficult to obtain for ECOWAS countries. The World Bank (2000) estimates the foreign residents at 26% in Cote d'Ivoire in 1998, 14% in Gambia and 8% in Guinea. These values are significant. ECOWAS has also introduced a common passport in 2000, which is supposed to increase labour mobility.

The effects of asymmetric shocks between ECOWAS countries would be reduced if there is a real solidarity between countries. A centralization of the budgetary process that allows automatic transfers to countries hit by negatives shocks would reduce the effects of asymmetric shocks in the ECOWAS. In this respect, we encourage the establishment of the WAMZ Stabilization and Cooperation Fund (SCF) to provide financial assistance to member states that may experience temporary disequilibria. A similar institution exists in WAEMU. To make these institutions operational, countries should pay regularly their contributions.

Note, however, that fiscal transfers will not completely solve the problem of asymmetric shocks. They will reduce their effects to reach positive net welfare, given that there are some benefits for forming a currency area in West Africa. If shocks are permanent, wages flexibility and labour mobility will be necessary to adjust to asymmetric shocks in ECOWAS. A common passport introduced in ECOWAS would increase labour mobility across counties. But the effectiveness of this instrument is not clear. Recent problems in Cote d'Ivoire, just to give an example, are illustrative. Burkinabes were forced to leave Cote d'Ivoire. Therefore, we suggest a strong political commitment to different agreements. Lastly, we recommend achieving the trade liberalization project of ECOWAS in order to increase intra-regional trade. This will increase some benefits of a monetary in ECOWAS.

## 6 Conclusion

In this paper, we use the dynamic structural factor model to extract aggregate demand and aggregate supply shocks for West African countries. The correlations of the underlying shocks are evaluated across countries. The results show positive demand shocks correlation between French speaking countries, except for Togo and Niger. This is the same for English speaking countries except for Gambia which displays asymmetric demand shocks with Nigeria. Demand shocks are positively or less negatively correlated between all West African countries. Supply shocks are weakly correlated and more asymmetric than demand shocks between these countries reflecting the different specialization in commodity goods in West Africa countries. Our results also suggest that only Ghana has similar shocks with CFA countries in West Africa. These results imply some costs for a monetary union in West Africa.

In the paper we have concentrated on correlations of shocks between bilateral countries. We would like to improve the analysis by taken correlations of country specific shocks with the shocks faced by the aggregate of countries. This approach is more parsimonious because the common central bank will take an aggregate view in the decision making process.

The aim of this paper is not to give a definite answer to whether ECOWAS is an optimal currency area. We only analyse one dimension of this question, that is the costs of a monetary union in this area. We would have to deepen our work in the direction of a cost-benefit analysis to go further. We can apply a framework like in Aksoy et al. (2002) to access the impact of asymmetric shocks on the welfare function when a common monetary policy is implemented in West Africa. This framework is useful since it allows us to compute the loss or the gain of a country when a common monetary policy is implemented to a situation where a national optimal monetary policy is decided. We would also like to access the impact of different fiscal policies on the welfare function when a common monetary policy is implemented in West Africa.

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Figure 1: **Historical Output Growth and Inflation**

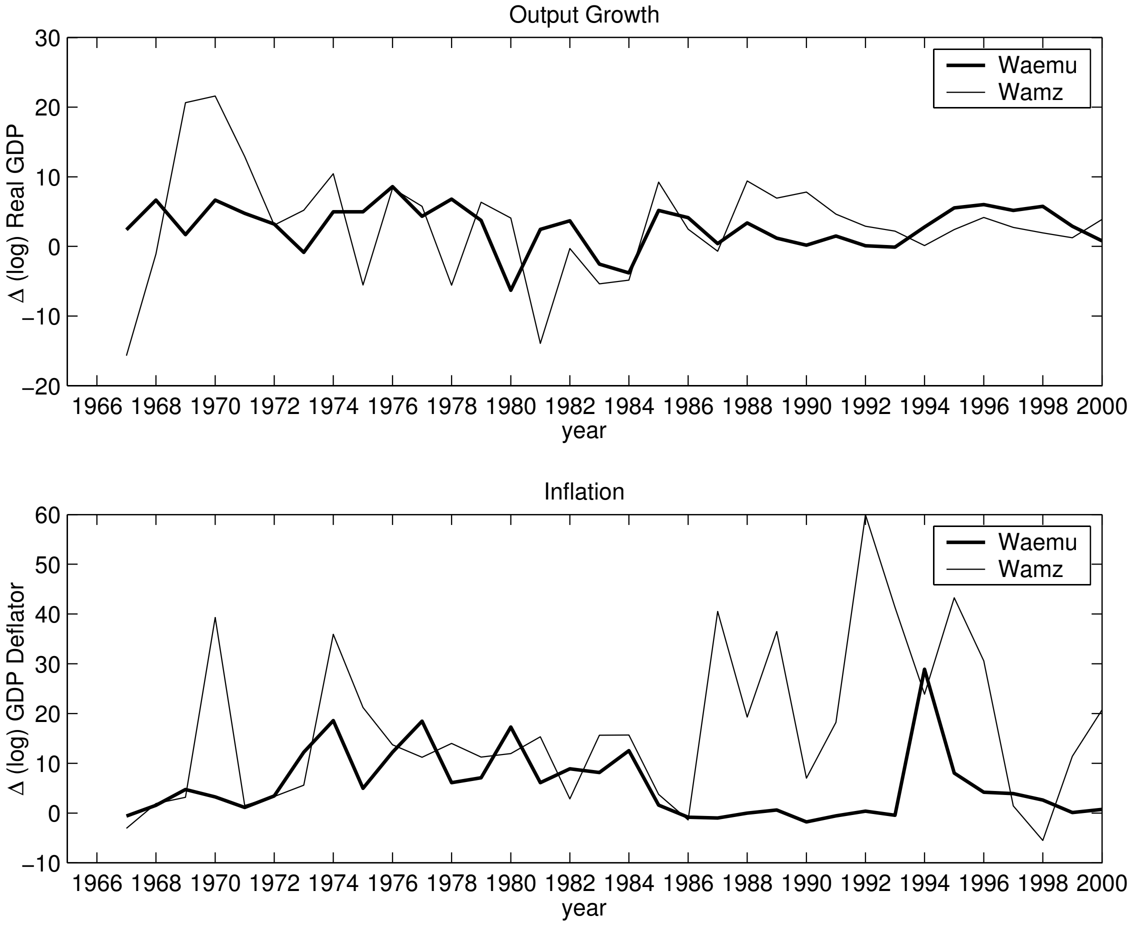


Figure 2: **Correlation of Output Growth and Inflation with the Aggregate WAEMU**

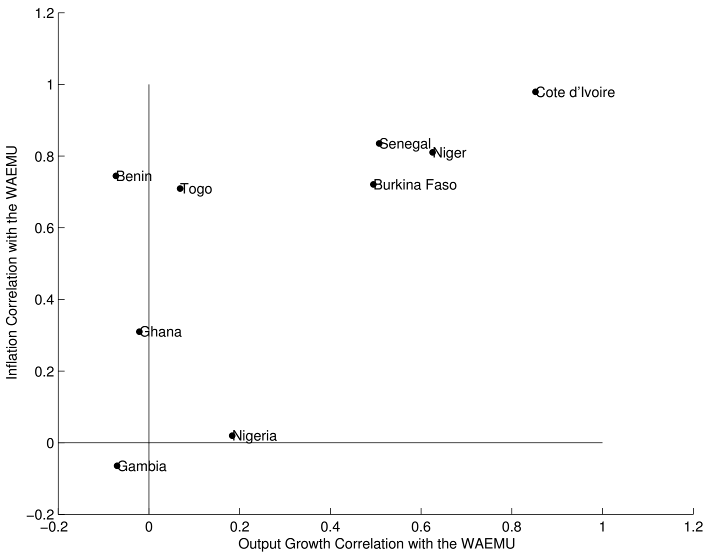



Figure 3: **Correlation of Output Growth and Inflation with the Aggregate WAMZ**

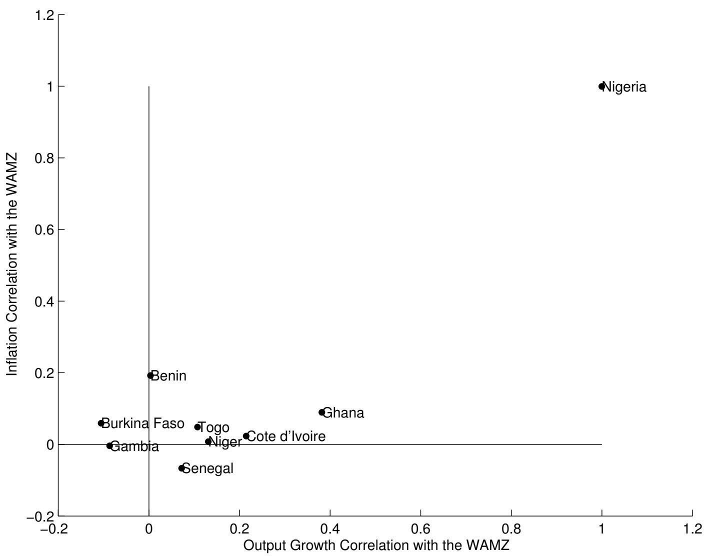


Figure 4: **Aggregate Demand and Supply Shocks in Selected Countries**

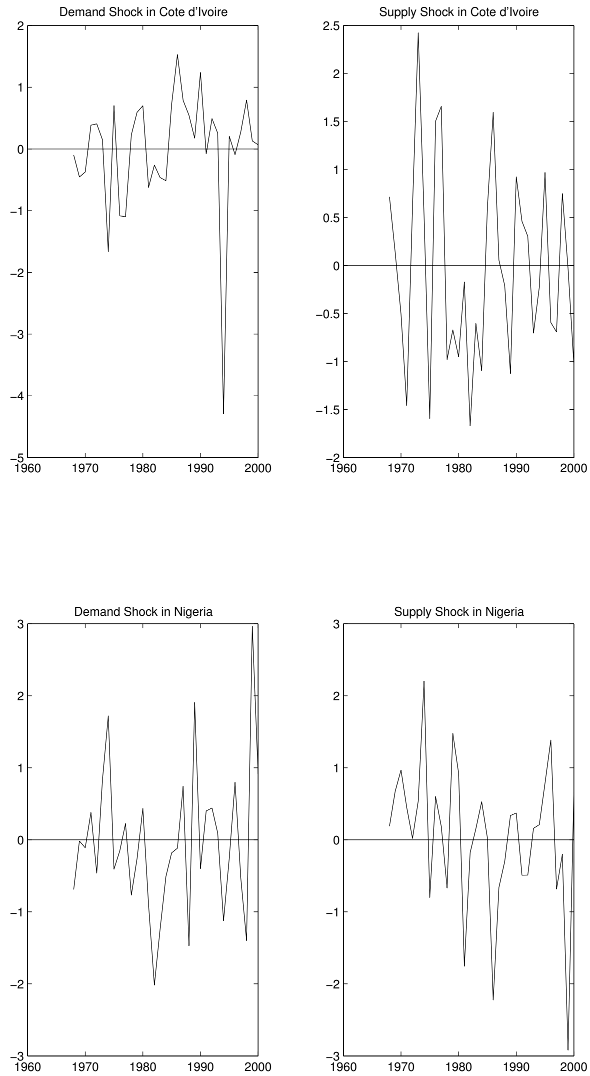
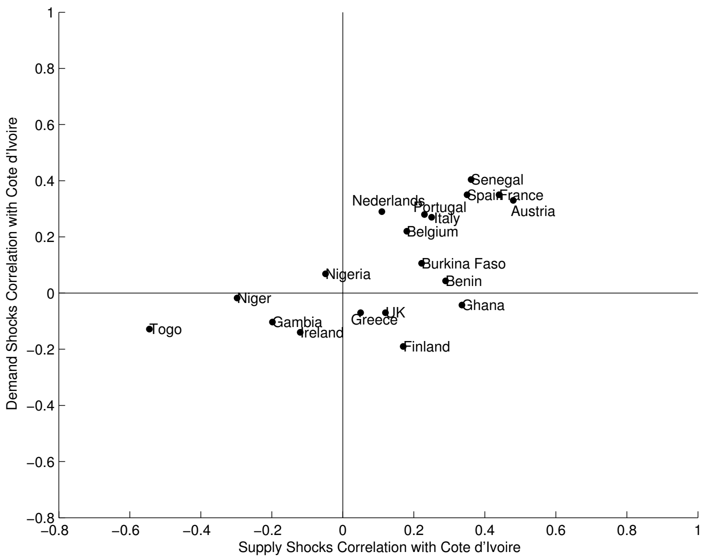


Figure 5: **Aggregate Demand and Supply Shocks Correlation with Cote d'Ivoire**




WAEMU members are Benin, Burkina Faso, Cote d'Ivoire, Niger, Senegal, and Togo. WAMZ members are Gambia, Ghana, and Nigeria. EU members are Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Nederlands, Portugal, Spain and the UK. The UK is a non-Euro member

Figure 6: **Aggregate Demand and Supply Shocks Correlation with Nigeria**

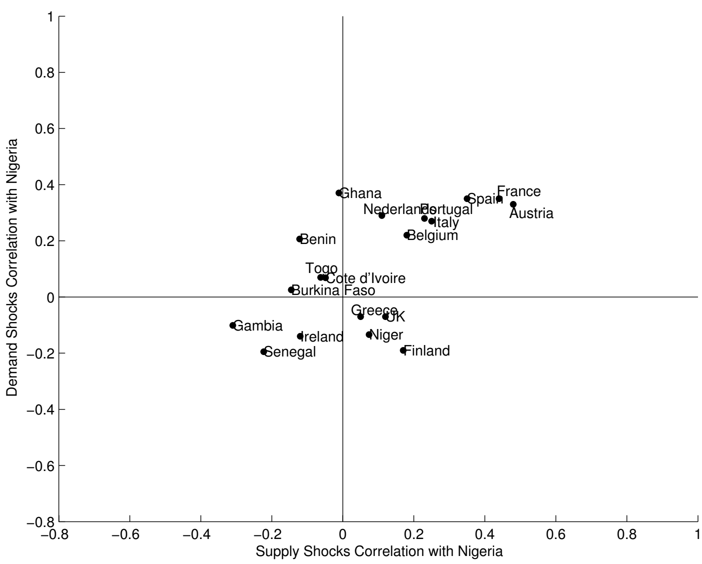



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Figure 7: **Impulse Response Function of Output in the WAEMU**

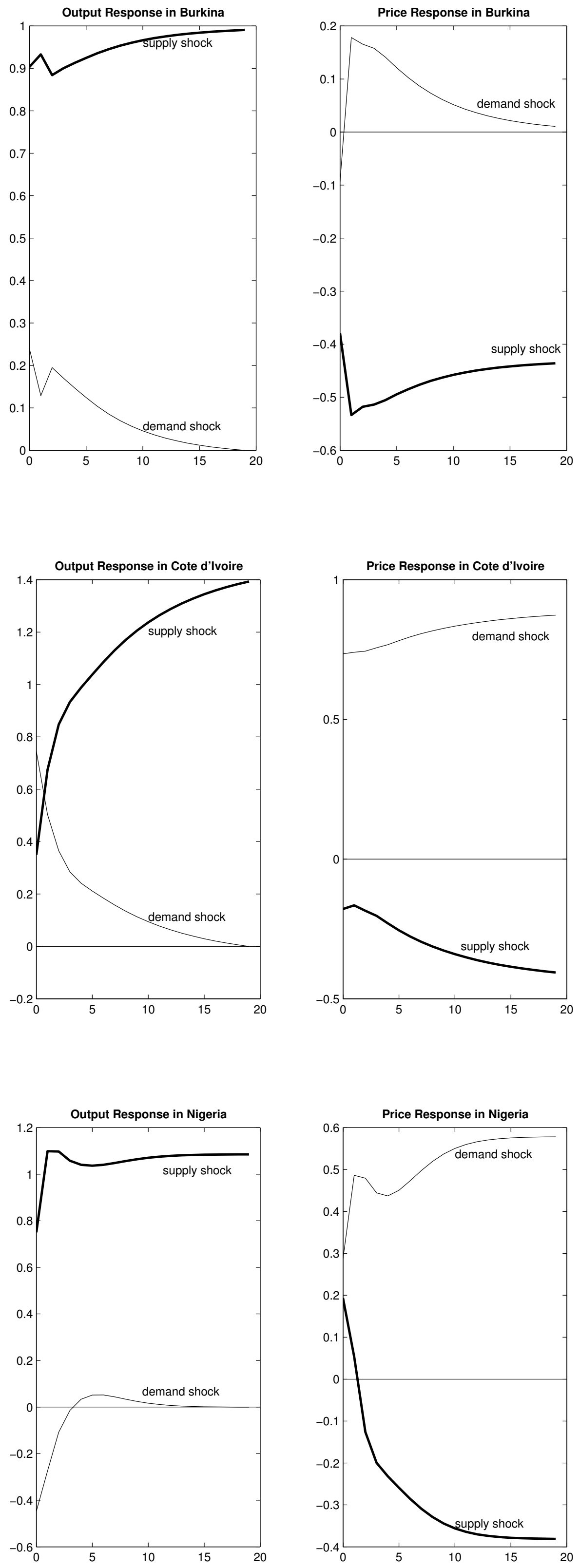

Table 1: **Inflation and Output Growth Developments**

| | Average Output Growth | Std. Dev. Output Growth | Inflation | Std. Dev. Inflation |
|---|---|---|---|---|
| Benin | 3.20 | 3.30 | 5.70 | 6.60 |
| Burkina | 3.75 | 3.32 | 4.49 | 5.62 |
| Cote I. | 3.51 | 4.98 | 6.12 | 9.16 |
| Gambia | 3.95 | 3.22 | 8.46 | 8.66 |
| Ghana | 2.51 | 4.73 | 26.28 | 16.64 |
| Niger | 0.83 | 6.67 | 5.10 | 8.82 |
| Nigeria | 3.18 | 7.98 | 16.88 | 16.29 |
| Senegal | 2.56 | 4.66 | 5.41 | 5.36 |
| Togo | 2.58 | 6.07 | 5.63 | 9.42 |
| Waemu | 2.83 | 3.22 | 5.66 | 7.05 |
| Wamz | 3.15 | 7.69 | 16.80 | 15.83 |

Table 2: **Correlation Matrix of Output Growth**

| | Benin | Burkina | Cote I. | Gambia | Ghana | Niger | Nigeria | Senegal | Togo | Waemu |
|---|---|---|---|---|---|---|---|---|---|---|
| Benin | 1 | | | | | | | | | |
| Burkina | 0.14 | 1 | | | | | | | | |
| Cote I. | 0.25 | 0.21 | 1 | | | | | | | |
| Gambia | -0.17 | -0.20 | 0.08 | 1 | | | | | | |
| Ghana | -0.02 | -0.06 | 0.03 | -0.21 | 1 | | | | | |
| Niger | 0.00 | 0.47 | 0.27 | -0.25 | 0.15 | 1 | | | | |
| Nigeria | -0.08 | -0.11 | 0.22 | -0.08 | 0.36 | 0.12 | 1 | | | |
| Senegal | 0.15 | 0.34 | 0.13 | -0.06 | -0.39 | 0.31 | 0.07 | 1 | | |
| Togo | -0.15 | -0.12 | 0.14 | -0.03 | 0.24 | 0.02 | 0.10 | -0.22 | 1 | |
| Waemu | -0.07 | 0.49 | 0.85 | -0.07 | -0.02 | 0.62 | 0.18 | 0.50 | 0.06 | 1 |
| Wamz | 0.00 | -0.10 | 0.21 | -0.09 | 0.38 | 0.13 | 0.99 | 0.07 | 0.10 | 0.18 |

Table 3: **Correlation Matrix of Inflation**

| | Benin | Burkina | Cote I. | Gambia | Ghana | Niger | Nigeria | Senegal | Togo | Waemu |
|---|---|---|---|---|---|---|---|---|---|---|
| Benin | 1 | | | | | | | | | |
| Burkina | 0.66 | 1 | | | | | | | | |
| Cote I | 0.68 | 0.63 | 1 | | | | | | | |
| Gambia | -0.22 | -0.04 | -0.7 | 1 | | | | | | |
| Ghana | 0.20 | 0.49 | 0.25 | 0.05 | 1 | | | | | |
| Niger | 0.58 | 0.57 | 0.74 | -0.29 | 0.28 | 1 | | | | |
| Nigeria | 0.18 | 0.04 | 0.01 | 0.00 | 0.07 | 0.00 | 1 | | | |
| Senegal | 0.66 | 0.61 | 0.76 | 0.20 | 0.30 | 0.57 | -0.07 | 1 | | |
| Togo | 0.47 | 0.40 | 0.70 | 0.13 | 0.16 | 0.42 | 0.04 | 0.63 | 1 | |
| Waemu | 0.74 | 0.72 | 0.97 | -0.06 | 0.30 | 0.81 | 0.02 | 0.83 | 0.70 | 1 |
| Wamz | 0.19 | 0.05 | 0.02 | 0.00 | 0.08 | 0.00 | 0.99 | -0.06 | 0.04 | 0.02 |

Table 4: **Percentage of Variance Explained by the DPCs**

| Number of DPCs | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Benin | 42.18 | 61.96 | 75.20 | 84.03 | 89.50 |
| Burkina Faso | 42.62 | 62.80 | 75.86 | 83.88 | 89.51 |
| Cote d'Ivoire | 44.01 | 64.14 | 77.45 | 85.30 | 90.46 |
| Gambia | 40.45 | 63.12 | 75.66 | 84.16 | 89.47 |
| Ghana | 43.63 | 62.90 | 76.24 | 84.32 | 89.61 |
| Niger | 39.67 | 59.56 | 74.14 | 82.93 | 88.71 |
| Nigeria | 45.05 | 65.12 | 77.77 | 85.62 | 90.72 |
| Senegal | 45.00 | 67.03 | 77.94 | 85.97 | 91.07 |
| Togo | 39.53 | 62.63 | 76.12 | 85.08 | 90.39 |

DPC=Dynamic Principal Component. The values in the table are averaged over 100 frequencies.

Table 5: **Standar Deviation of Demand and Supply Shocks**

| Countries | Supply Shocks | Demand Shocks |
|---|---|---|
| Benin | 1.0155 | 1.0152 |
| Burkina | 1.0154 | 1.0155 |
| Cote d'Ivoire | 1.0150 | 1.0153 |
| Gambia | 1.0155 | 1.0155 |
| Ghana | 1.0154 | 1.0152 |
| Niger | 1.0155 | 1.0143 |
| Nigeria | 1.0145 | 1.0149 |
| Senegal | 1.0151 | 1.0155 |
| Togo | 1.0155 | 1.0153 |

Table 6: **Correlation Matrix of Demand Shocks**

| | Benin | Burkina | Cote I. | Gambia | Ghana | Niger | Nigeria | Senegal | Togo |
|---|---|---|---|---|---|---|---|---|---|
| Benin | 1 | | | | | | | | |
| Burkina | -0.24 | 1 | | | | | | | |
| | (-1.39) | | | | | | | | |
| Cote I | 0.04 | 0.11 | 1 | | | | | | |
| | (0.23) | (0.58) | | | | | | | |
| Gambia | -0.18 | 0.30* | -0.10 | 1 | | | | | |
| | (-1.05) | (1.70) | (-0.56) | | | | | | |
| Ghana | 0.01 | 0.15 | -0.04 | 0.05 | 1 | | | | |
| | (0.10) | (0.86) | (-0.23) | (0.28) | | | | | |
| Niger | 0.08 | 0.01 | -0.01 | -0.07 | -0.04 | 1 | | | |
| | (0.49) | (0.07) | (-0.09) | (-0.38) | (-0.20) | | | | |
| Nigeria | 0.20 | 0.02 | 0.06 | -0.10 | 0.37** | -0.13 | 1 | | |
| | (1.14) | (0.13) | (0.37) | (-0.55) | (2.13) | (-0.73) | | | |
| Senegal | 0.07 | -0.19 | 0.40** | 0.02 | -0.30* | 0.03 | -0.19 | 1 | |
| | (0.43) | (-1.08) | (2.34) | (0.10) | (-1.70) | (0.18) | (-1.08) | | |
| Togo | -0.07 | -0.01 | -0.13 | 0.09 | 0.34** | 0.24 | 0.06 | -0.04 | 1 |
| | (-0.43) | (-0.10) | (-0.70) | (0.51) | (1.97) | (1.37) | (0.38) | (-0.22) | |

The number in brackets are Z-statistics. We apply a two-sides test. The critical values are 2.58; 1.96 and 1.64 respectively for 1%, 5% and 10% significance levels. ***=significative at 1%; **=significative at 5%; *=significative at 10%

Table 7: **Correlation Matrix of Supply Shocks**

| | Benin | Burkina | Cote I. | Gambia | Ghana | Niger | Nigeria | Senegal | Togo |
|---|---|---|---|---|---|---|---|---|---|
| Benin | 1 | | | | | | | | |
| Burkina | 0.86*** | 1 | | | | | | | |
| | (7.11) | | | | | | | | |
| Cote I | 0.28 | 0.22 | 1 | | | | | | |
| | (1.63) | (1.23) | | | | | | | |
| Gambia | -0.30 | -0.25 | -0.19 | 1 | | | | | |
| | (-1.74) | (-1.45) | (-1.10) | | | | | | |
| Ghana | 0.12 | 0.15 | 0.33* | -0.15 | 1 | | | | |
| | (0.70) | (0.85) | (1.91) | (-0.88) | | | | | |
| Niger | -0.88*** | -0.84*** | -0.29* | 0.38** | -0.02 | 1 | | | |
| | (-7.63) | (-6.86) | (-1.68) | (2.22) | (-0.10) | | | | |
| Nigeria | -0.12 | -0.14 | -0.04 | -0.30* | -0.01 | 0.07 | 1 | | |
| | (-0.67) | (-0.80) | (-0.26) | (-1.75) | (-0.06) | (0.41) | | | |
| Senegal | 0.78*** | 0.79*** | 0.36*** | -0.26 | 0.05 | -0.79*** | -0.22 | 1 | |
| | (5.85) | (5.92) | (2.70) | (-1.50) | (0.28) | (-6.00) | (-1.24) | | |
| Togo | -0.37** | -0.30* | -0.54*** | 0.26 | -0.29* | 0.39** | -0.06 | -0.55 | 1 |
| | (-2.18) | (-1.72) | (-3.34) | (1.50) | (-1.66) | (2.30) | (-0.34) | (-3.42) | |

The number in brackets are Z-statistics. We apply a two-sides test. The critical values are 2.58; 1.96 and 1.64 respectively for 1%, 5% and 10% significance levels. ***=significative at 1%; **=significative at 5%; *=significative at 10%

# A Appendix Data Description

| N° | Variables | Source | Transformation |
|---|---|---|---|
| 1 | GDP (constant US$) | World Bank | DLOG |
| 2 | GDP deflator (base year varies by country) | World Bank | DLOG |
| 3 | GDP per capita (constant US$) | World Bank | DLOG |
| 4 | Consumer price index (1995 = 100) | World Bank | DLOG |
| 5 | Official exchange rate (LCU per US$, period average) | World Bank | DLOG |
| 6 | Crop production index (1989-91 = 100) | World Bank | DLOG |
| 7 | Exports as a capacity to import (constant US$) | World Bank | DLOG |
| 8 | Final consumption expenditure (constant US$) | World Bank | DLOG |
| 9 | Food production index (1989-91 = 100) | World Bank | DLOG |
| 10 | Labor force, total | World Bank | DLOG |
| 11 | Money (current US$) | World Bank | DLOG |
| 12 | Official development assistance and official aid (current US$) | World Bank | DLOG |
| 13 | Quasi money (current US$) | World Bank | DLOG |
| 14 | Foreign Assets$ | IMF | DLOG |
| 15 | Central Government Deposits$ | IMF | DLOG |
| 16 | Claims on Central Government$ | IMF | DLOG |
| 17 | Claims on Private Sector$ | IMF | DLOG |
| 18 | Demand Deposits$ | IMF | DLOG |
| 19 | Foreign liabilities | IMF | DLOG |
| 20 | Gross domestic income (constant US$) | World Bankk | DLOG |
| 21 | Gross value added at factor cost (constant US$) | World Bank | DLOG |
| 22 | Household final consumption expenditure (constant US$) | World Bank | DLOG |
| 23 | price level of gdp | Penn World Table | DLOG |
| 24 | price level of consumption | Penn World Table | DLOG |
| 25 | price level of cunsumption | Penn World Table | DLOG |
| 26 | price level of investment | Penn World Table | DLOG |
| 27 | Age dependency ratio (dependents to working-age population) | World Bank | D |
| 28 | Agricultural machinery, tractors per 100 hectares of arable land | World Bank | D |
| 29 | Agriculture, value added (% of GDP) | World Bank | D |

| | Variables | Origine | Transformation |
|---|---|---|---|
| 30 | Livestock production index (1989-91 = 100) | World Bank | DLOG |
| 31 | General gov. final cons. expenditure (constant $) | World Bank | DLOG |
| 32 | Net taxes on products (constant $) | World Bank | GLOG |
| 33 | TET index | World Bank | DLOG |
| 34 | Land use, area under cereal production (hectares) | World Bank | DLOG |
| 35 | Cereal yield (kg per hectare) | World Bank | DLOG |
| 36 | Time and Savings and foreign currency Deposits$ | IMF | DLOG |
| 37 | Gross capital formation (constant$) | World Bank | DLOG |
| 38 | Aid per capita (current US$) | World Bank | D |
| 39 | comsumption share in real gdp per capita | Penn World Table | D |
| 40 | government comsumption share in real gdp per capita | Penn World Table | D |
| 41 | investment share in real gdp per capita | Penn World Table | D |
| 42 | Rural population (% of total population) | World Bank | D |
| 43 | Services, etc., value added (% of GDP) | World Bank | D |
| 44 | Liquid liabilities (M3) as % of GDP | World Bank | D |
| 45 | Money and quasi money (M2) as % of GIR | World Bank | D |
| 46 | Population density (people per sq km) | World Bank | DLOG |
| 47 | Imports of goods and services (% of GDP) | World Bank | D |
| 48 | Industry, value added (% of GDP) | World Bank | D |
| 49 | Labor force, female (% of total labor force) | World Bank | D |
| 50 | Gross national expenditure (% of GDP) | World Bank | D |
| 51 | Aid (% of gross capital formation) | World Bank | D |
| 52 | Bank liquid reserves to bank assets ratio | World Bank | D |
| 53 | Domestic credit to private sector (% of GDP) | World Bank | D |
| 54 | Exports of goods and services (% of GDP) | World Bank | D |

Abreviation: DLOG=first difference of log variable. D=irst difference

# Appendix B

**Figure B1: The Membership of the ECOWAS and the CFA Zone**

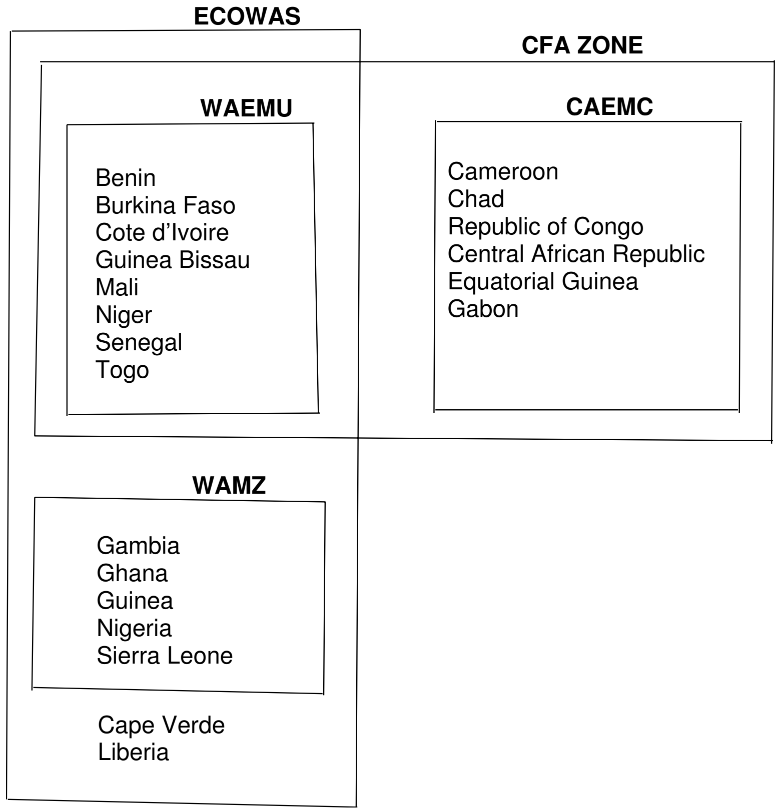

Table B1: **Selected Indicators for the WAEMU in 2001**

| | Benin | Burkina Faso | Cote d'Ivoire | Niger | Senegal | Togo | WAEMU |
|---|---|---|---|---|---|---|---|
| Population[1] | 6.62 | 12.2 | 16.7 | 11.64 | 9.9 | 4.77 | 75.09 |
| Land area[2] | 110.6 | 273.6 | 318.0 | 1,266.2 | 192.5 | 54.4 | 3,464.2 |
| Intraregional trade | | | | | | | |
| Export in % | 6.6 | 7.4 | 15.2 | 3.4 | 11.7 | 33.0 | |
| Import in % | 5.5 | 31.8 | 1.1 | 22.1 | 3.8 | 8.7 | |
| Share in % | | | | | | | |
| GDP[3] in 2000 | 8.31 | 12.66 | 44.85 | 9.23 | 22.19 | 2.71 | 100.0 |
| Net domestic assets | 4.1 | 8.4 | 48.8 | 3.4 | 21.2 | 5.9 | 100.0 |
| Net foreign assets | 30.4 | 9.4 | 25.1 | 2.0 | 12.5 | 4.2 | 100.0 |
| Fiscal balance[4] | -4.2 | -12.6 | 0.4 | -7.4 | -3.9 | -2.5 | -5.0 |

Source: IMF (2003). 1=in million. The data come from the United Nations Populated Fund; 2= in 1000 sq.km; 3=the share of the 2 remaining countries of the WAEMU are less than 1%. 4=in % of the GDP and it is measured with exclusion of grants.

Table B2: **Selected Indicators for the WAMZ in 2001**

| | Gambia | Nigeria | Ghana | WAMZ |
|---|---|---|---|---|
| Population (millions) | 1.37 | 120 | 20.175 | 158 |
| Land area (1000 of sq km) | 10 | 910.77 | 227.54 | |
| Share in % | | | | |
| GDP[1] in 2000 | 9.9 | 89.9 | 0.09 | 100.0 |
| Fiscal balance[2] as % of GDP | -11.1 | -4.7 | -7.4 | - |

Source: IMF (2003). 1=in the total of the 3 countries here. 2=excluded grants

Table B3: **Main Commodity Goods Exported and Exchange Rate Regimes**

| | Commodities | Curreny and Exchange rate Regime |
|---|---|---|
| Benin | cocoa, coffee, cotton, grandnuts, oil-palm, acajou | CFA peg[a] to euro |
| Burkina Faso | cotton, grandnuts. | CFA peg to euro |
| Cote d'Ivoire | cocoa, coffee, cotton, oil palm, rubber. | CFA peg to euro |
| Niger | uranium, cotton, groundnuts, groundnut oil, tobacco. | CFA peg to euro |
| Senegal | cotton, groundnuts, groundnuts-oil, phosphate, sisal, sugar. | CFA peg to euro |
| Togo | phosphate,cocoa, coffee, cotton, groundnuts. | CFA peg to euro |
| Nigeria | oil, oil-palm, rubber, cocoa. | Naira, managed float[b] |
| Ghana | bauxite, cocoa, coffee, gold, manganese, oil-palm. | Cedi, independant float |
| Gambia | groundnuts, groundnuts-oil, oil-palm. | Dalassi, independant float |

Source:Masson and Pattillo(2001) and IMF. a=the CFA was peg to the French franc before 1999. b=with no preanounced path for the exchange rate