United Nations University
WIDER
World Institute for Development Economics Research

Research Paper No. 2004/17

The Impact of Monetary Union on Macroeconomic Integration

Evidence from West Africa

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February 2004

Abstract

In this paper we use data from 17 African nations in order to investigate the hypothesis that monetary union – represented in this case by the CFA Franc Zone – augments the extent of macroeconomic integration. The paper covers a number of dimensions of integration including the volume of bilateral trade, real exchange rate volatility and the magnitude of cross-country business cycle correlation.

Keywords: monetary union, Africa, trade, business cycles

JEL classification: E39, F15, F49, O11

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This study has been prepared within the UNU-WIDER project on 'Long-Term Development in the CFA-zone Countries of Sub-Saharan Africa', directed by David Fielding.

UNU-WIDER gratefully acknowledges the financial contribution to the project by the Finnish Ministry for Foreign Affairs.

UNU-WIDER also acknowledges the financial contributions to the research programme by the governments of Denmark (Royal Ministry of Foreign Affairs), Norway (Royal Ministry of Foreign Affairs), Sweden (Swedish International Development Cooperation Agency – Sida) and the United Kingdom (Department for International Development).

ISSN 1810-2611 ISBN 92-9190-596-8 (internet version)

UNU World Institute for Development Economics Research (UNU-WIDER)
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Camera-ready typescript prepared by Janis Vehmaan-Kreula at UNU-WIDER
Printed at UNU-WIDER, Helsinki

1 Introduction

Over the last 40 years most economies in sub-Saharan Africa (SSA) have been characterized 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 SSA 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 SSA 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 Union of Central African States (UDEAC). In each of these two areas there is a single currency and a single central bank.

Many African governments are now entertaining the possibility of emulating or attaching themselves to this zone. Most recently, as documented by Bawumia (2002), the Lomé meeting of ECOWAS heads of state in 1999 set out detailed plans for regional monetary integration among both francophone and anglophone states in West Africa. The ultimate aim envisaged in these plans is a merging of the UEMOA with a yet to be created anglophone monetary union, by as early as 2004. The Gambia, Ghana, Guinea-Conakry, Nigeria and Sierra Leone have agreed to create a Second Monetary Zone by July 2005. The institutional characteristics of this zone reflect some of the existing features of the UEMOA: an independent common central bank, no monetary financing for the public sector, pooled forex reserves and a stabilization fund to cushion temporary balance of payments shocks.

A widening of monetary union in West Africa could entail two benefits for the new member states. First (and beyond the scope of this paper), the autonomy of a trans-national central bank could make low inflation a time-consistent monetary policy goal. Second, the common currency could lead to a greater degree of macroeconomic integration, for reasons outlined below. Some aspects of integration, such as increased trade volumes or lower relative price variability, can reasonably be expected to increase welfare directly. Others, such as a greater degree of business cycle correlation, will mitigate the potential welfare losses resulting from a single monetary policy described by Mundell (1961).

In the light of these policy developments, we will assess the extent to which the existing monetary unions in West Africa and Equatorial Africa have already facilitated a greater degree of macroeconomic integration than could otherwise be expected, conditional on the geographical proximity and production structure of the member states. We focus on this small part of the world for two reasons. First, previous authors have looked at the correlation between exchange rate regimes and macroeconomic integration, but typically in the context of global data sets in which the effects estimated represent global averages. These averages might not reflect the experience of the poorest parts of the globe. Second, in our data set we are confident, for reasons given below, that selection for membership of the monetary unions has so far been exogenous to the countries' economic characteristics. (This assumption is much more questionable in global data sets.) So it is reasonable to interpret any difference in the extent of integration within the CFA from the regional average as a product of the CFA institutions themselves. The estimated difference will give us some idea of the magnitude of the increased integration that a wider monetary union might bring.

The following section has two purposes: first to survey the ways in which a monetary union might lead to greater macroeconomic integration, and second to relate these mechanisms to the institutional characteristics of the existing CFA. This will provide a basis for constructing a model to test the impact that the CFA has had on macroeconomic integration over the last 30 years.

2 Monetary union and macroeconomic integration in theory and practice

2.1 Theoretical background

The existing literature suggests at least three aspects of international economic integration that could in principle be affected by membership of a monetary union. A common theme that emerges is that the benefits of a fixed bilateral exchange rate are augmented by full monetary union.

(i) The absence of unanticipated shocks to bilateral nominal exchange rates will reduce the risks involved in international trade. The value of exports (or the cost of imports) in terms of local currency will be easier to predict. There already exists a literature documenting the impact of nominal exchange rate risk on trade; see for example Thursby and Thursby (1987).[1] A monetary union precludes any nominal exchange rate fluctuations, and should facilitate more trade. Moreover, the use of a common currency will eliminate currency transactions costs in international trade (De Grauwe 2000), so trade volumes ought to increase. This second effect is specific to full monetary union, as opposed to an ordinary fixed exchange rate regime.

(ii) Fixed exchange rates can reduce real exchange rate volatility. If there is any inertia in domestic commodity prices, shocks to the nominal exchange rate will lead to deviations from purchasing power parity. This is a key element of the exchange rate overshooting models that evolved out of Dornbusch (1976). Moreover, a full monetary union could lead to even lower real exchange rate volatility than a fixed exchange rate system. Engel and Rogers (2001) identify a number of factors that determine the degree of real exchange rate volatility between pairs of countries.[2] Nominal exchange rate volatility and physical distance turn out to be important factors, but there is also a substantial 'pure' border effect. Controlling for all other factors, the ratio of prices in two regions is more volatile if the regions are located

1 However, it is important to acknowledge that in a general equilibrium setting fixed exchange rates do not *necessarily* lead to more trade. See Bacchetta and van Wincoop (2000).

2 Related papers on this theme include Lothian and Taylor (1996) and Papell (1997).

in different countries. Engel and Rogers suggest a number of explanations for this effect. Some of these, including the currency transactions costs mentioned above, but also factors such as international heterogeneity in marketing and distribution systems, the scope for international price discrimination, or 'informal' trade barriers, might be reduced if the countries shared a common currency.[3]

(iii) As a consequence of increased trade, the degree of business cycle synchronicity between two countries in a monetary union might be higher, because aggregate demand shocks in one country have more of an impact on the other than they would otherwise; or it might be lower, because increased trade corresponds to increased specialization in types of production subject to different productivity shocks. But an increased volume of bilateral trade is not the only way in which a common currency could affect business cycle synchronicity. For example, if multinational firms have less scope for price discrimination between members of a monetary union (because price differences are more transparent and because the elimination of currency transactions costs facilitates arbitrage in goods), then international productivity shocks are likely to be passed on to local markets in a more uniform way. Papers looking at the relationship between business cycle synchronicity an exchange rate regimes include Artis and Zhang (1995), Christodoulakis *et al.* (1995), Fatas (1996) and Boone (1997).

In this paper, we will examine the three dimensions of integration noted above: trade intensity, real exchange rate volatility and business cycle synchronicity. The data set we will use comprises most of the countries of the CFA Franc Zone, plus most of their immediate neighbours with floating exchange rates or adjustable pegs. As we explain below, this gives us the opportunity to examine the effects both of fixed exchange rates *per se* and of full monetary union.

2.2 The CFA Franc zone: institutional background

The CFA evolved from the monetary institutions of the last phase of French colonial Africa. Figure 1 shows a map of the CFA region. The two monetary areas have different currencies. The UEMOA uses currency issued by the Central Bank of West African States (BCEAO); the UDEAC uses currency issued by the Bank of Central African States (BEAC). Somewhat confusingly, both currencies are commonly called the CFA Franc.

The countries that make up the CFA, and their basic economic structure, are summarized in Table 1. The boundaries between the different monetary areas have a geographical and historical basis, and each of the two monetary unions (the UEMOA and UDEAC regions) comprises a wide range of economies, as indicated by the descriptive statistics in Table 2. The UEMOA region includes both semi-industrialized economies with a high export-GDP ratio (such as Côte d'Ivoire and Senegal) and also some of the world's poorest and underdeveloped countries (such as Burkina Faso and Mali). The UDEAC region includes both countries that are equally underdeveloped

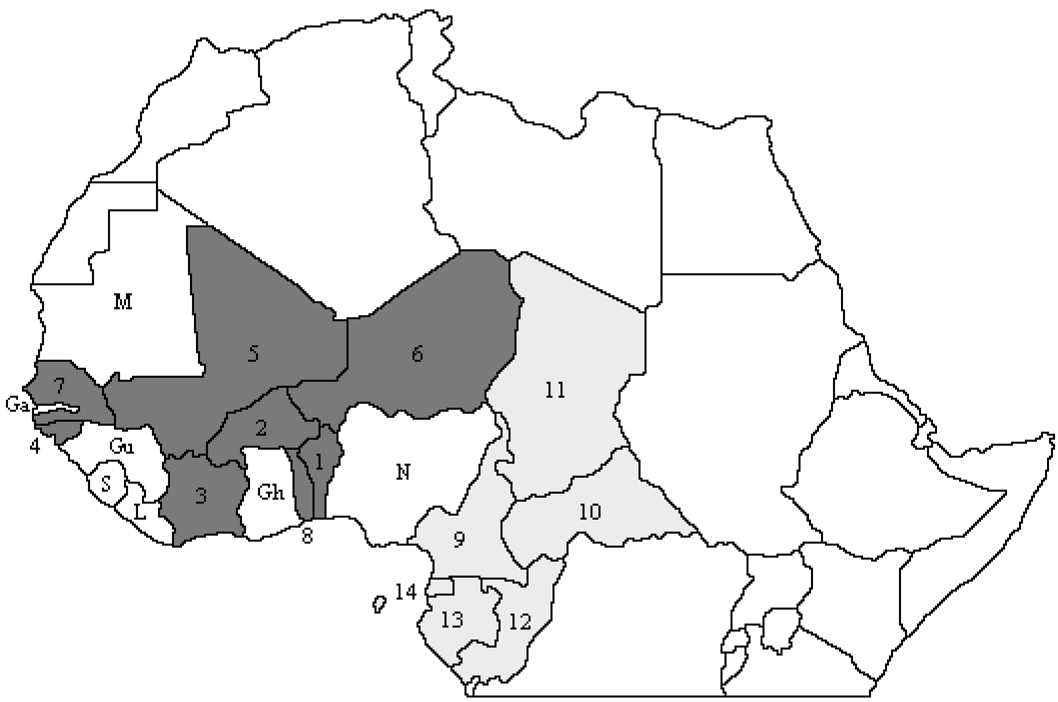
3 For example, traders' lives will be made easier if they only have to hold one type of currency with which to bribe customs officials.

(Chad, Central African Republic and Equatorial Guinea) and relatively high-income petroleum exporters (Cameroon, Congo Republic and Gabon).

Each of the two currencies is exchangeable for the French Franc at a rate of 100:1 (and now at the equivalent Euro rate). The French Treasury is obliged to exchange CFA Francs for Euros at this fixed rate,[4] and there are rules limiting CFA government borrowing that are intended to prevent the African countries from abusing France's guarantee of convertibility. However, France is not part of the CFA, and the only legal tender in each CFA country is the currency issued by its central bank. Foreign currency (including other CFA currency) is not used as a unit of account or medium of exchange. Commercial banks do not typically offer customers foreign currency deposit facilities, and foreign currency deposits are a negligibly small fraction of total deposits. The exchange of one CFA currency for another (or of CFA Francs for Euros) must be conducted through the central bank and, is subject to taxation, so intra-CFA currency transactions costs are not negligible (Vizy 1989).

Figure 1
The CFA franc zone and its neighbours

The dark shaded area is the UEMOA; the light shaded area is the UDEAC



1 = Benin; 2 = Burkina Faso; 3 = Côte d'Ivoire; 4 = Guinea-Bissau; 5 = Mali; 6 = Niger;

7 = Senegal; 8 = Togo; 9 = Cameroon; 10 = C.A.R.; 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

4 In effect, France pegs the Euro to the CFA currencies. Monetary policy in the CFA is constrained not by the need to maintain an exchange rate peg, but by (very lax) rules limiting domestic credit creation.

Table 1
Monetary groupings in the CFA

Countries in italics are excluded from the econometric analysis because of inadequate data.

UEMOA	UDEAC
Benin	Cameroon
Burkina Faso	C.A.R.
Côte d'Ivoire	Chad
Guinea-Bissau	Congo Republic
Mali	*Equatorial Guinea*
Niger	Gabon
Senegal	
Togo	

Table 2
Summary statistics for CFA countries and their neighbours

	Gross national income (US$bn)	Per capita GNI (US$1000)	Agriculture value added/GDP	Industry value added/GDP
ben	2.3	0.37	0.38	0.14
bfa	2.4	0.21	0.35	0.17
cam	8.6	0.58	0.44	0.20
car	1.0	0.28	0.55	0.20
civ	9.6	0.60	0.29	0.22
cgo	1.7	0.57	0.05	0.71
gab	3.9	3.19	0.06	0.53
mal	2.5	0.24	0.46	0.17
ner	1.9	0.18	0.39	0.18
sen	4.7	0.49	0.18	0.27
tcd	1.5	0.20	0.39	0.14
tgo	1.3	0.29	0.38	0.22
gam	0.4	0.34	0.38	0.13
gha	6.6	0.34	0.35	0.25
mau	1.0	0.37	0.22	0.31
nga	32.7	0.26	0.30	0.46
Sle	0.6	0.13	0.47	0.30

The composition of the two monetary unions is a consequence of the French colonial organization, and is therefore exogenous to contemporary economic characteristics. The current grouping into two currency areas dates from 1955 (seven years before full political independence, at which point the countries were self-governing French overseas territories), and arises from the distinction between French West Africa and French Equatorial Africa in the colonial period. As can be seen from the map, this division is based on the physical geography of the region. The only point of physical contact between the UEMOA and the UDEAC is the Chad-Niger border, which lies in the Sahara Desert far from any major centers of population. Further south, the two areas are separated by Nigeria, a former British colony that has no part in the CFA. The CFA comprises those SSA countries occupied by France at the end of the First World War.[5] There have been just two exits from the CFA, neither of which is likely to have been correlated with the countries' economic characteristics. In 1958, at the institution of the Fifth French Republic, all overseas territories participated in a referendum on the new constitution. Guinea-Conakry, which happened to have a socialist government at the time, was the only colony to reject this constitution, and severed all political and financial links with France. In 1973, after full independence, Mauritania (the only Arab country in the area) also exited the CFA, preferring to pursue an identity as a North African Arab state.[6] There have also been just two entries: Equatorial Guinea and Guinea-Bissau. These countries were, respectively, Spanish and Portugese colonies; they are surrounded by, respectively, UDEAC and UEMOA nations, and joined the appropriate monetary union in 1985 and 1997. The only other countries surrounded by the CFA (Gambia, Ghana, Liberia, Nigeria and Sierra Leone) are all anglophone. All but Liberia were British colonies, and up until now it has been made clear that they are not welcome to join the francophone monetary area.

So, if we look across the region depicted in Figure 1, we can see (i) pairs of countries sharing a single country (any two members of the UEMOA, or any two members of the UDEAC), (ii) pairs of countries with different currencies but a bilateral exchange rate that has been fixed for many decades (pairs made up of one UEMOA country and one UDEAC country), and (iii) pairs of countries for which the bilateral exchange rate has been variable (pairs in which at least one country is outside the CFA). The division between the two monetary unions within the CFA, and therefore the distinction between (i) and (ii), has been exogenous to economic characteristics. So also has membership of the CFA as a whole. If we assume (not implausibly) that the countries left outside the CFA with their own individual currencies have not been endowed with the political institutions necessary for a hard exchange rate peg to be a viable option, then the distinction between (i-ii) and (iii) has also been exogenous. So, using data from these countries relating to the three dimensions of integration outlined above, we have the opportunity to examine both the effects of a fixed exchange rate and the effects of a single currency on macroeconomic integration between pairs of countries in West Africa and Equatorial Africa.[7]

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5 Excepting Djibouti, which is thousands of kilometres away in the Horn of Africa.

6 Over the period covered by the empirical model in the next section, these two countries have lain outside the CFA.

7 We ought to comment briefly on the reasons for restricting our geographical scope to just one part of Africa. First, the immediate policy relevance of our results is to the ECOWAS the CFA (two

3 Testing the impact of the CFA on macroeconomic integration

In this section we focus on those 12 of the 14 members of the CFA for which adequate macroeconomic data are available: Benin (designated *ben* in the tables), Côte d'Ivoire (*civ*), Mali (*mli*), Niger (*ner*), Senegal (*sen*) and Togo (*tgo*) in the BCEAO area and Cameroon (*cam*), Central African Republic (*car*), Chad (*tcd*), Congo Republic (*cgo*) and Gabon (*gab*) in the BEAC region.[8] We will examine various aspects of macroeconomic integration among these countries and their non-CFA neighbours. There are five non-CFA countries in West Africa for which adequate data exist: Gambia (*gam*), Ghana (*gha*), Mauritania (*mau*), Nigeria (*nga*) and Sierra Leone (*sle*).[9] Four of these are ECOWAS countries that might form part of an expanded monetary union in the very near future. The fifth (Mauritania) is a former CFA member that might well rejoin the UEMOA at a later date.

One aim will be to identify the extent to which CFA membership has entailed a greater degree of integration (variously defined) than could otherwise have been expected. However, we will also make a distinction between the impact of common CFA membership and the impact of membership of the same monetary area (the UEMOA or the UDEAC). If sharing a common currency delivers an additional degree of integration over-and-above that arising from the common currency peg, then we should see a greater degree of integration within each of the two monetary unions than we do across the UEMOA-UDEAC border, conditional on other, exogenous economic characteristics.

Our basic methodology is similar to that of Rose and Engel (2000), but with different dependent variables and a different data set. The extent of macroeconomic integration between two countries might depend on a variety of factors other than their currency institutions. So our approach is to construct a fixed-effects regression for different measures of integration in any two countries i and j, conditional on both a common currency dummy (ifs_{ij}) for country pairs within the UEMOA or within the UDEAC, a CFA membership dummy (ifz_{ij}) for pairs made up of any two CFA members (including UEMOA-UDEAC pairs), and a set of exogenous conditioning variables.

In the empirical section that follows we will employ several different measures of integration. The first is the total value of bilateral trade between two countries, in US Dollars (T_{ij}). The T_{ij} figures used are taken from IMF *DOTS*, using data for 1981-2000. This corresponds to integration concept (i) in Section 2. T_{ij} ought to be higher in countries between which there is a nominal exchange rate peg, and perhaps even higher in those sharing the same currency. Since trade data are available for each individual year, it is in principle possible to construct a panel data set of bilateral trade flows.

overlapping sets of countries), where the creation of a single monetary union is more than a remote possibility. Second, the distance between countries turns out to be an important factor for some of our integration measures. Within that part of Africa to which we restrict ourselves, distance effects are approximately linear. We suspect that this would not be true with a wider geographical scope, and our model already contains several non-linear effects. Including more countries would necessitate a more general functional form and – with limited data – more fragile results.

8 The two countries lacking adequate data are Guinea-Bissau in the UEMOA region and Equatorial Guinea in the UDEAC region. National Accounts data for these countries exist for only a short time.

9 The non-CFA countries in Figure 1 for which data are missing are Guinea-Conakry and Liberia.

However, there is likely to be a substantial degree of cross-sectional heterogeneity in such a panel, which will lead to biases of the kind discussed by Pesaran and Smith (1995). Since we are interested primarily in the determinants of the cross-sectional variation in the data, we will follow Pesaran and Smith and aggregate the trade flow data over time. In doing so, we will also allow for the possibility that the impact of CFA membership on trade was different in the 1980s from in the 1990s. The 1980s were a period of relatively high trade and foreign currency restrictions in SSA (excepting trade within the CFA); but in the 1990s, most countries' trade regimes became very much more liberal. In the 1980s, CFA membership might have stimulated higher trade just because it acted as a restraint on distortionary trade policies. In the 1990s, with a reduction of regional trade barriers under the auspices of ECOWAS, this effect is likely to have been very much diminished, and any effect of the CFA on trade flows is more plausibly interpreted in terms of the factors outlined in (i-iii) above. So we will work with two dependent variables: T_{ij} for the period 1981-1990 and T_{ij} for the period 1991-2000.

The second, in the spirit of Engel and Rogers (2001), is a measure based on the real exchange rate. We will look at the extent to which prices in two countries are correlated. This corresponds to integration concept (ii) in Section 2. However, our focus will not be on an unconditional measure of real exchange rate correlation. In the short run, prices could vary in response to a wide variety of macroeconomic factors. For example, in the CFA the two different central banks can each pursue an active monetary policy. Interest parity with France does not hold in the short run, and the differential between each central bank's base rate and that of the European Central Bank varies over time; so does the differential between the interest rates in the two parts of the CFA. The Euro-CFA Franc peg is guaranteed by the French Treasury, so short-run monetary policy in the CFA is not constrained by the need to maintain the peg. Idiosyncratic innovations in monetary policy could generate price deviations. Two countries in different currency areas might exhibit a large degree of heterogeneity in the movement of their real exchange rates not because using different currencies creates underlying structural asymmetries, but just because the two monetary authorities are following different policies. Conditioning out the monetary shocks might give a more informative indicator of the degree of underlying macroeconomic integration. Similarly, two countries might exhibit a high degree of real exchange rate correlation just because their terms of trade or productivity shocks are highly correlated, rather than because of anything to do with the factors outlined in concept (ii) in the previous section.

For this reason we will look at the degree of conditional real exchange rate correlation between i and j. Our measure of correlation will be corr(u_i^p, u_j^p); u_i^p is an innovation constructed from the regression:

$$\begin{bmatrix} \Delta p_{it} \\ \Delta y_{it} \\ \Delta m_{it} \end{bmatrix} = \beta(L) \begin{bmatrix} \Delta p_{it-1} \\ \Delta y_{it-1} \\ \Delta m_{it-1} \end{bmatrix} + \alpha(L)\Delta x_{it} + \begin{bmatrix} u_{it}^{p} \\ u_{it}^{y} \\ u_{it}^{m} \end{bmatrix} \qquad (1)$$

where p_{it} is the log ratio of domestic prices (measured by the GDP deflator) to import prices (measured by the imports deflator in the National Accounts) for country i in year t. y_{it} is the log of real GDP, m_{it} the log of nominal M1 and x_{it} the log of the terms of trade (measured using export and import deflators in the National Accounts).[10] $\beta(.)$ is a 3×3 and $\alpha(.)$ a 1×3 matrix of lag polynomial operators. The annual data used to construct the variables in the VAR are described in Appendix 1.

This VAR is also used to construct the third measure of integration: the degree of business cycle synchronicity, corresponding to concept (iii) in Section 2. Here we are concerned with the measurement of the extent to which aggregate supply and aggregate demand shocks in one country are passed on to another. Again, we wish to condition on monetary policy: in the long run, money is neutral, but in the short run money shocks can impact on output. So the output shock correlations are measured as corr(u_i^y, u_j^y).

These two correlation measures capture the degree of similarity in observed movements in the real exchange rate and in output at time *t*, conditional on their own past values, on the past values of M1 (which is probably endogenous to *p* and *y*) and on current and past movements in the terms of trade (which is exogenous in a small open economy). However, they do not quite represent correlations in shocks to the real exchange rate and to aggregate output. Equation (1) represents a reduced-form system that corresponds to a structural system in which contemporaneous movements in *p*, *y* and *m* interact with each other. The u_i^p and u_i^m are mixtures of structural shocks to *p* and *y* (and to *m*) in this system. So an alternative way of measuring real exchange rate and output correlations is to impose an identification structure on equation (1) so as to extract the structural shocks ε_i^p and ε_i^y, and then to measure the correlations corr(ε_i^p, ε_j^p) and corr(ε_i^y, ε_j^y).

The identification structure we impose is based on the econometric methodology of Blanchard and Quah (1989), though with a different set of theory-based restrictions from those they use. Let $Z_{it} = [\Delta p_{it}\ \Delta y_{it}\ \Delta m_{it}]'$ and $u_{it} = [u_{it}^p\ u_{it}^y\ u_{it}^m]'$. Then equation (1) can be re-written as a moving-average process:

$$Z_{it} - a(L)\Delta x_{it} = (I - \beta(L))^{-1} u_{it} \tag{2}$$

We can compare equation (2) with a moving-average representation of a putative structural model of the form:

$$Z_{it} - a(L)\Delta x_{it} = \gamma(L)\varepsilon_{it} \tag{3}$$

where ε_{it} is a 1×3 vector of innovations to each of the structural equations. Identification the structural model requires the recovery of the 3×3 matrix $\gamma(0)$:

$$u_{it} = \gamma(0)\varepsilon_{it} \tag{4}$$

For this we need $3^2 = 9$ restrictions. Assuming that the three elements of ε_{it} are orthogonal and using a normalization, so that each has a unit variance, gives us 3(3+1)/2 = 6 restrictions, with Var(ε_{it}) = *I*. The last three restrictions come from the

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10 For the CFA countries, M1 is measured as checking deposits at banks located in a certain country, plus currency issued in that country. Currency issued is a proxy for currency in circulation, but the limited data on *billets deplacés* (notes issued in one country that end up in another) suggest that this is a reasonable approximation.

assumption that $\chi(L)$ is lower-triangular. In other words, we assume that in the long run, conditional on the terms of trade, the growth of the real exchange rate is independent of output and money growth, and output is independent of money growth. The real exchange rate restrictions can be motivated by the assumption that relative PPP holds (at least in growth rates) in the long run, for which there is African evidence in Lowrey (1995). The final restriction is based on the assumption that aggregate supply growth is independent of monetary shocks in the long run.

Altogether, then, we have five integration measures: T_{ij}, u_{ij}^p, u_{ij}^y, ε_{ij}^p and ε_{ij}^y. The following sections discuss how we investigate the possibility that these measures are dependent on whether two countries have a fixed exchange rate or share the same currency, conditional on geographical and economic characteristics.

4 The impact of the CFA on trade

Our first set of estimates relates to trade intensity, T_{ij}. The T_{ij} measure (the total bilateral trade volume in US Dollars) is constructed for two periods: 1981-90 and 1991-2000. The basic form of our trade intensity regression in each case is:

$$T_{ij} = f(D_i, D_j, ifs_{ij}, ifz_{ij}, X_{ij}, u_{ij}) \tag{5}$$

where u_{ij} is a residual, and X_{ij} a vector of conditioning variables. D_i is a dummy variable for the i^{th} country. It turns out that country-specific effects have a large part to play in predicting trade intensity, and it might not necessarily be the case that the economic characteristics contained in the *X*-vector fully capture these effects. In other words, we will allow for unobserved country-specific characteristics to affect the size of T_{ij}. These characteristics might incorporate a range of factors. For example, Rose and van Wincoop (2001) and Anderson and van Wincoop (2001) suggest that it is important to take account of the magnitude of each country's barriers to trade with all its trading partners. This is a factor that is difficult to measure in our sample of countries with very limited fiscal data.

The *X*-vector comprises a number of economic characteristics. To the extent that integration is a function of the volume of bilateral trade flows, the explanatory variables in 'gravity' models of international trade will enter into *X*:

(i) The log-product of the two countries' total GDP (in US Dollars): $y_i \cdot y_j$

(ii) The log-product of their populations: $p_i \cdot p_j$

(iii) A dummy variable for whether the countries share a land border: ifb_{ij}

(iv) The logarithm of the Great Circle distance between their capital cities (in radians): $dist_{ij}$

(v) A dummy variable for whether the two countries have a maritime coastline: ifc_{ij}

Figures for (i-iii) are taken from the World Bank *World Development Indicators*. However, these conditioning variables might also affect the magnitude of macroeconomic integration for other reasons. For example, larger or more developed countries might be less susceptible to speculative behaviour that induces unanticipated deviations in the real exchange rate; so real exchange rate volatility might be lower. In this paper, we do not attempt to identify the channels through which the conditioning variables impact on our macroeconomic integration measures.

There are two reasons for suspecting that estimation of the parameters of a linear form of equation (5) by least-squares will be inappropriate. First, many of the T_{ij} observations are equal to zero (see Table 3); so it is likely that a Tobit regression will be more appropriate than the equivalent linear form. Second, the ifs_{ij} and ifz_{ij} dummies appear in equation (5) in order to capture the possibility that sharing a common currency (or having a fixed exchange rate) reduces transactions costs in international trade, as outlined above. In this sense, they have a role similar to the variables in the equation reflecting the determinants of international transport costs: ifb_{ij}, $dist_{ij}$ and ifc_{ij}. A simple version of equation (5) might treat the four cost variables as linearly separable arguments of *f*(). However, in the light of comments by, for example, Persson (2001), the linearity assumption is questionable. The magnitude of the impact of a common currency (or of a fixed exchange rate) on trade between two countries could depend on the size of transport costs, if only because larger transport costs could increase the size of the currency transactions involved, *ceteris paribus*. But also, the magnitude of informal barriers to trade might depend on the two elements of costs – for transport and for currency transactions – in a more complex way. For this reason, it might be more appropriate to fit a form of equation (5) that includes terms interacting ifs_{ij} and ifz_{ij} with the other cost variables:

$$\log(T_{ij}) = T_{ij}^* \mid \log(T_{ij}) > 0$$

$$T^*_{ij} = \theta_i D_i + \theta_j D_j + \beta_1 y_i y_j + \beta_2 p_i p_j + \eta_1 ifz_{ij} + \eta_2 ifs_{ij} + \eta_3 ifb_{ij} + \eta_4 dist_{ij} + \eta_5 ifc_{ij} \quad (6)$$
$$+ \gamma_1 [ifz_{ij} \cdot ifb_{ij}] + \gamma_2 [ifz_{ij} \cdot dist_{ij}] + \gamma_3 [ifz_{ij} \cdot ifc_{ij}] + \delta_1 [ifs_{ij} \cdot dist_{ij}] + \delta_2 [ifs_{ij} \cdot ifc_{ij}] + u_{ij}$$

Table 3
Dependent variable descriptive statistics

(i) Trade: T_{ij}						
	fraction of obs. > 0		*log mean of obs. > 0*		*log std dev. of obs. > 0*	
	1980s	1990s	1980s	1990s	1980s	1990s
one country outside CFA	0.79	0.93	10.71	10.65	0.38	0.41
UEMOA-UDEAC pairings	0.86	0.97	10.28	10.65	0.51	0.57
single currency pairings	0.87	0.97	13.28	13.14	0.54	0.60

(ii) Price and output correlations			
The reported figures are mean values, with standard deviations in parenthesis.			
variable	one country outside CFA	UEMOA-UDEAC pairings	single currency pairings
$f(corr(\varepsilon_i^p, \varepsilon_j^p))$	-0.03 (0.39)	0.17 (0.40)	0.23 (0.44)
$f(corr(\varepsilon_i^y, \varepsilon_j^y))$	0.15 (0.39)	0.15 (0.29)	0.05 (0.38)
$f(corr(u_i^p, u_j^p))$	-0.06 (0.37)	0.16 (0.40)	0.24 (0.49)
$f(corr(u_i^y, u_j^y))$	0.00 (0.47)	0.12 (0.37)	0.16 (0.43)
number of observations	70	35	31

Table 4
Tobit regression results for T_{ij}
The regression equations also include fixed effects.

LR test for Tobit with linear arguments vs. non-linear model (1980s):
$\chi^2(5) = 07.44$ [0.190]

LR test for Tobit with linear arguments vs. non-linear model (1990s):
$\chi^2(5) = 14.58$ [0.012]

1980s variable	coeff.	s.e.	t ratio	prob.	coeff.	s.e.	t ratio	prob.
$p_i.p_j$	-0.08661	0.10074	-0.860	0.3918				
$y_i.y_j$	0.00348	0.09392	0.037	0.9705				
ifc_{ij}	-0.13173	0.45852	-0.287	0.7744				
ifs_{ij}	-0.20570	0.30229	-0.680	0.4976				
ifz_{ij}	1.88630	0.48366	3.900	0.0002	1.86310	0.44649	4.173	0.0001
ifb_{ij}	1.15060	0.30728	3.744	0.0003	1.15610	0.23941	4.829	0.0000
$dist_{ij}$	-0.00702	0.00932	-0.753	0.4532				
σ	0.32007	0.02246	14.254	0.0000	0.31846	0.02236	14.246	0.0000
log-lik.	-206.5				-207.4			

1990s variable	coeff.	s.e.	t ratio	prob.	coeff.	s.e.	t ratio	prob.
$p_i.p_j$	0.25962	0.09933	2.614	0.0103	0.23677	0.09832	2.408	0.0177
$y_i.y_j$	-0.31900	0.10085	-3.163	0.0020	-0.28429	0.09780	-2.907	0.0044
ifc_{ij}	0.60560	0.46618	1.299	0.1967				
ifs_{ij}	1.05590	0.86601	1.219	0.2254				
ifz_{ij}	-1.00030	0.90488	-1.105	0.2715				
ifb_{ij}	0.45976	0.41701	1.103	0.2727	0.70984	0.38808	1.829	0.0700
$dist_{ij}$	-0.03266	0.01060	-3.082	0.0026	-0.02342	0.00902	-2.596	0.0107
$ifc.ifs_{ij}$	-0.52189	0.54242	-0.962	0.3382				
$ifc.ifz_{ij}$	-0.37906	0.46095	-0.822	0.4127				
$ifb.ifz_{ij}$	1.29040	0.62511	2.064	0.0414	1.17400	0.45701	2.569	0.0115
$dist.ifs_{ij}$	-0.04403	0.03140	-1.402	0.1637				
$dist.ifz_{ij}$	0.04736	0.02063	2.295	0.0237	0.02753	0.01080	2.548	0.0122
σ	0.50524	0.03194	15.819	0.0000	0.49028	0.03101	15.809	0.0000
log-lik.	-161.5				-165.6			

where T_{ij}* is the latent variable in a Tobit regression. The logarithmic transformation is used because the positive values of T_{ij} are approximately log-normally distributed. Note that while ifz_{ij} is interacted with ifb_{ij}, ifs_{ij} is not. This is because there is only one case of a land border between a UEMOA country and a UDEAC country (Niger and Chad).

For these reasons we proceed according to the following modelling strategy. We first fit both a Tobit with non-linear arguments, as in equation (6), and one with only linear arguments (k $\gamma_k = \delta_k = 0$) to the trade intensity data for each period (the 1980s and the 1990s). We then calculate an LR test statistic for the joint significance of the non-linear terms. These statistics are reported in Table 4. It turns out that the linear form can be rejected for the 1990s, but not for the 1980s. For this reason, the 1980s regression equation reported in the table has only linear arguments, but the 1990s regression equation includes the interaction terms.

Table 4 lists the estimated coefficients for each explanatory variable alongside the corresponding standard error and the resulting t-ratio. The final row in the table reports the estimated residual variance, σ. For both sample periods (the 1980s and the 1990s) the table includes two regression equations. The first is unrestricted, but the second is a more parsimonious form in which a subset of the conditioning variable coefficients have been set to zero so as to minimize the Hannon-Quinn Information Criterion. Those coefficients that are statistically significant in the unrestricted equation do not change substantially in the restricted one, so we can be reasonably confident that our inferences are robust to the inclusion of nuisance parameters in the model.

For the 1980s regression equation, there are just two significant explanatory variables in addition to the country fixed effects: the land border dummy ifb_{ij} and the CFA membership dummy ifz_{ij}. The coefficients on these two variables are both quite large (around 1.2 and 1.9 respectively), so both CFA membership and geographical proximity appear to have made a substantial difference to trade volumes. However, the common currency dummy ifs_{ij} is not statistically significant. In other words, when we consider trade volumes over the whole decade of the 1980s, there was no robust common currency effect on trade over-and-above the CFA membership effect. Moreover, the insignificance of the interaction terms in the regression implies that the effects of CFA membership, substantial as they were in the 1980s, did not depend on any geographical characteristics.

For the 1990s regression, the picture is slightly more complex. Again it is the ifz_{ij} term rather than the ifs_{ij} term that is statistically significant. However, in this case the significant effect appears in the interaction terms $ifz_{ij}.ifb_{ij}$ and $ifz_{ij}.dist_{ij}$. There is a positive coefficient on $ifz_{ij}.dist_{ij}$ that is insignificantly different from the negative coefficient on $dist_{ij}$. In other words, greater distance reduces trade volumes (with an elasticity of about 3 per cent) *except* when the two countries are CFA members, in which case distance has no significant effect. The coefficients on ifb_{ij} and $ifz_{ij}.ifb_{ij}$ are both positive: the estimated coefficients are equal to around 0.5 and 1.2 respectively. In other words, sharing a common land border increases trade volumes, *ceteris paribus*, but the effect is much larger among CFA members.

The overall implication of the fitted model for the 1990s is that the CFA membership effect is greatest for very close neighbours, but also quite large for very distant countries. In the case of close neighbours, CFA membership substantially reduces the barriers to trade inherent in the existence of a political boundary: it attenuates the ‘pure border’ effect. In the case of very distant countries, common membership of the CFA represents an institutional link that creates a basis for trade between countries that would otherwise have little or nothing to do with one another. That the non-linearities apparent in the fitted model for the 1990s are not significant in the fitted model for the 1980s is not entirely surprising. As indicated in Table 3, the total volume of intra-African trade was lower in the 1980s, and in the 1980s data there are far more instances of zero reported trade, especially among the non-CFA trade pairs. As a consequence there is rather less sample variation to explain in the 1980s data, especially at the lower end, and what variation there is can be explained by a simple intercept dummy. Overall, the effect of CFA membership on trade implicit in the regression equations is greater for the 1980s than for the 1990s, as one might expect given the prevalence of distortionary trade policies in anglophone countries in the earlier period.[11]

5 The impact of the CFA on real exchange rate and output correlations

In this section we consider the impact of CFA membership on cross-country correlations in the reduced-form and structural shocks to the real exchange rate and output, u_{ij}^{p}, u_{ij}^{y}, ε_{ij}^{p} and ε_{ij}^{y}. First of all, we estimate the parameters in equations (1-4), using annual data reported in the World Bank *World Development Indicators*. Data are available for all countries at least for the period 1968-99, with the exception of the Central African Republic, where National Accounts data end in 1991. For some countries, data are available from as early as 1963. In all cases, the model parameters (and the resulting pairwise correlations) are estimated on as large a sample as possible. Our main interest is in the shocks implicit in the model, which are depicted in Figures 2-7. Corresponding summary statistics are given in Table 3.

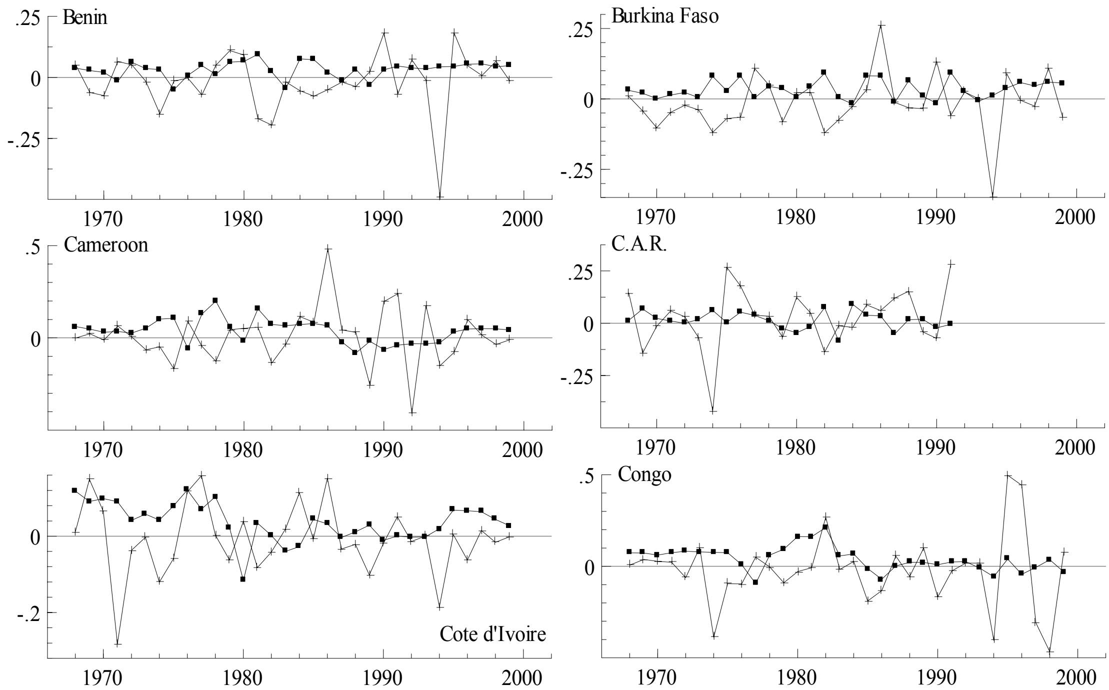

Figure 2: u_{it}^{p} (+) and u_{it}^{y} (■) time series

[11] These stylized facts are still true if one uses individual years' trade data, instead of ten-year totals. For some individual years, there are significant terms in the *ifs* dummy, indicating a common currency effect over-and-above the CFA membership effect. However, this difference is not statistically significant in regression equations for trade over longer time horizons.

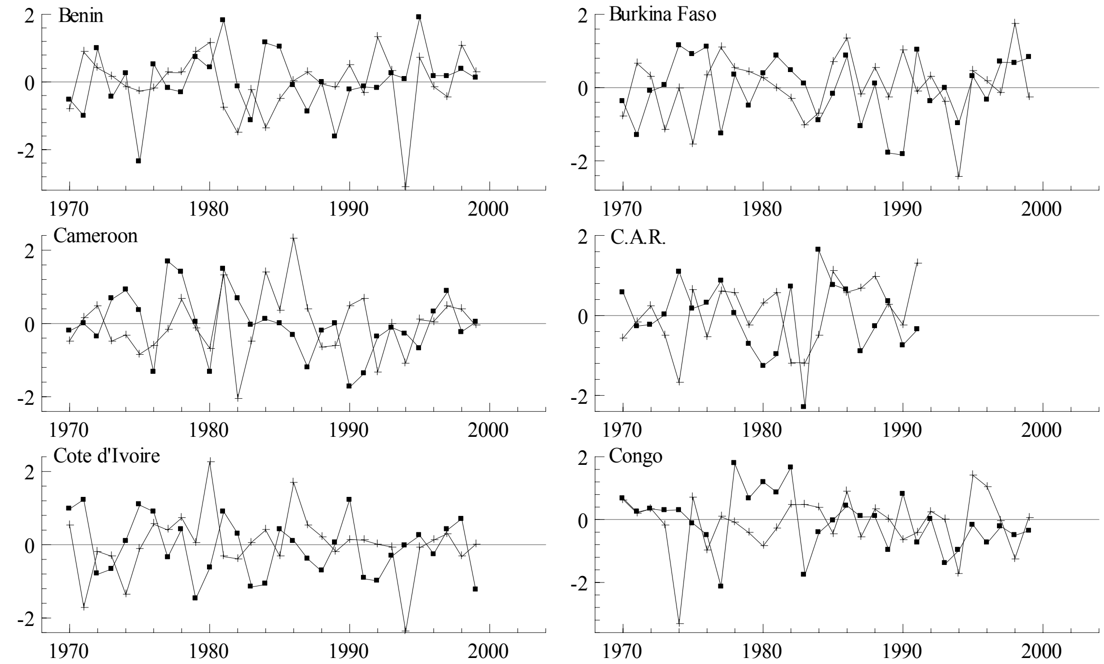

Figure 3: ε_{it}^{p} (+) and ε_{it}^{y} (■) time series

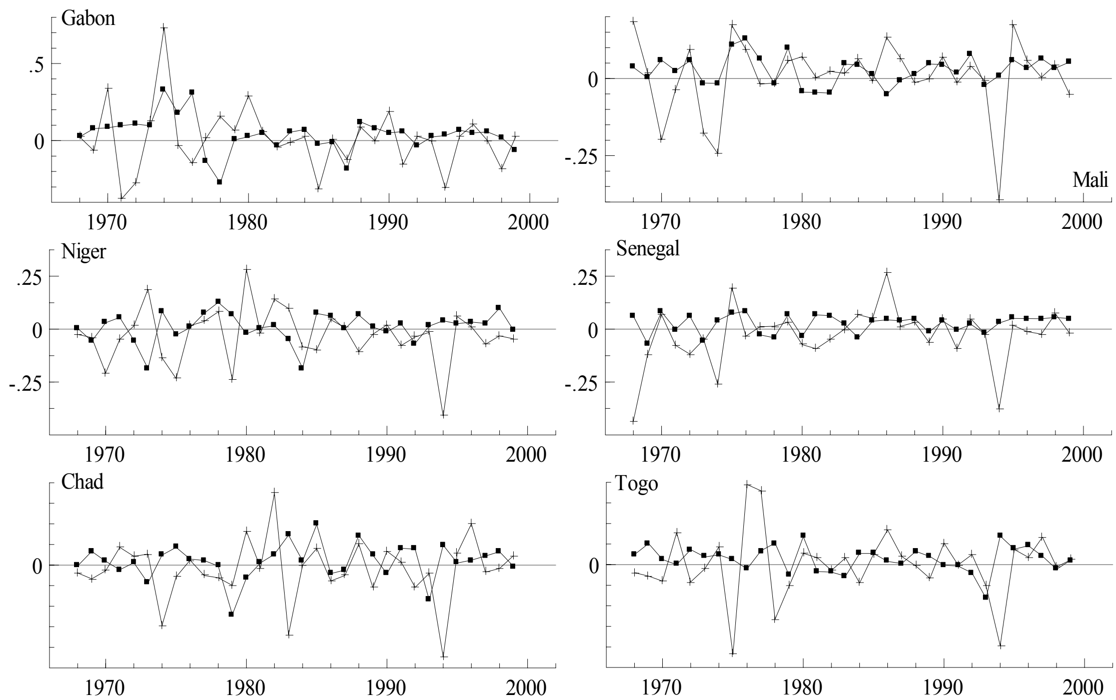

Figure 4: u_{it}^{p} (+) and u_{it}^{y} (■) time series

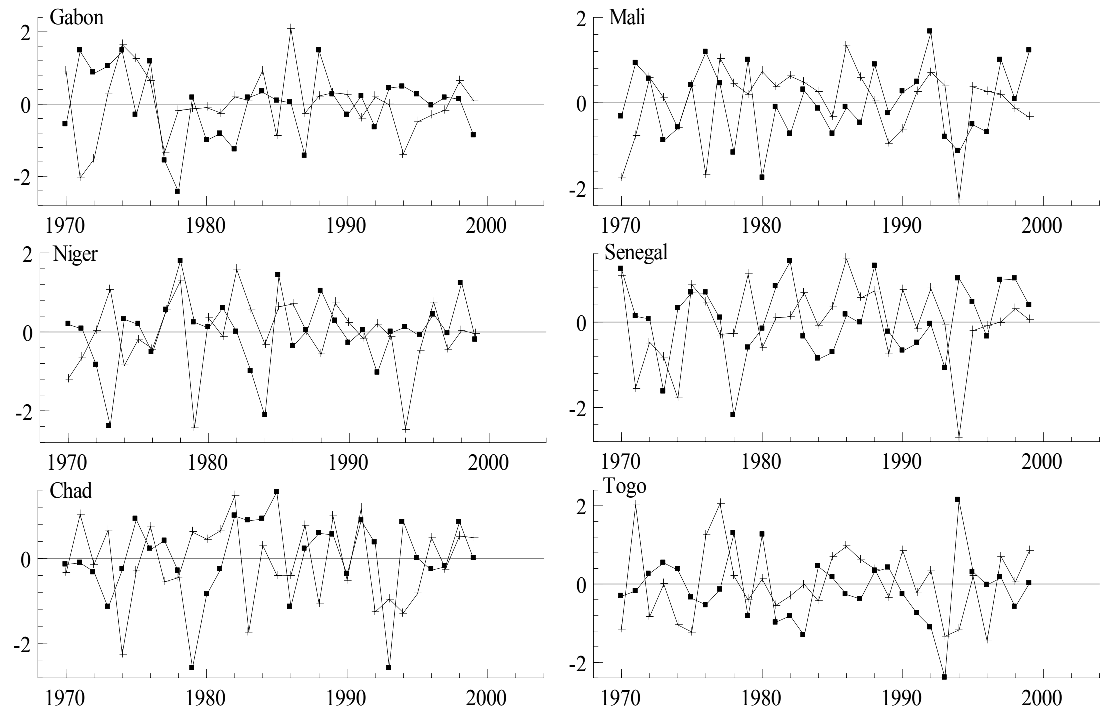

Figure 5: ε_{it}^{p} (+) and ε_{it}^{y} (■) time series

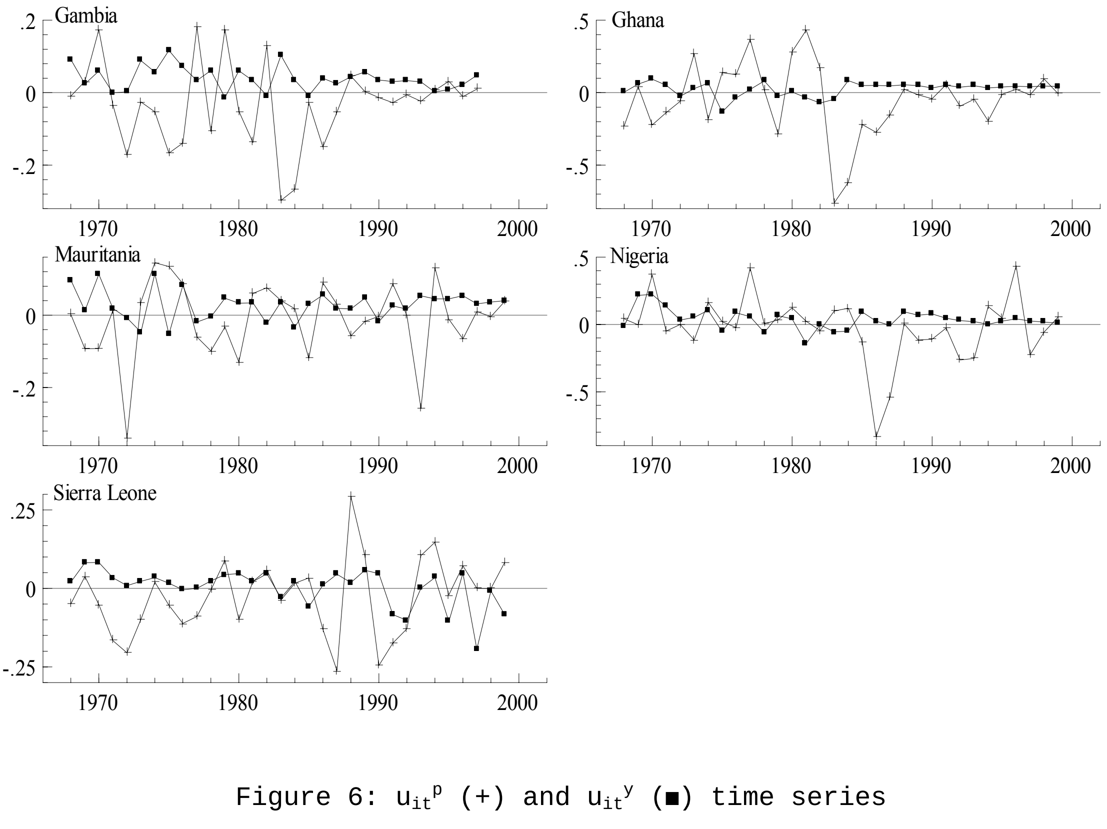

Figure 6: u_{it}^{p} (+) and u_{it}^{y} (■) time series

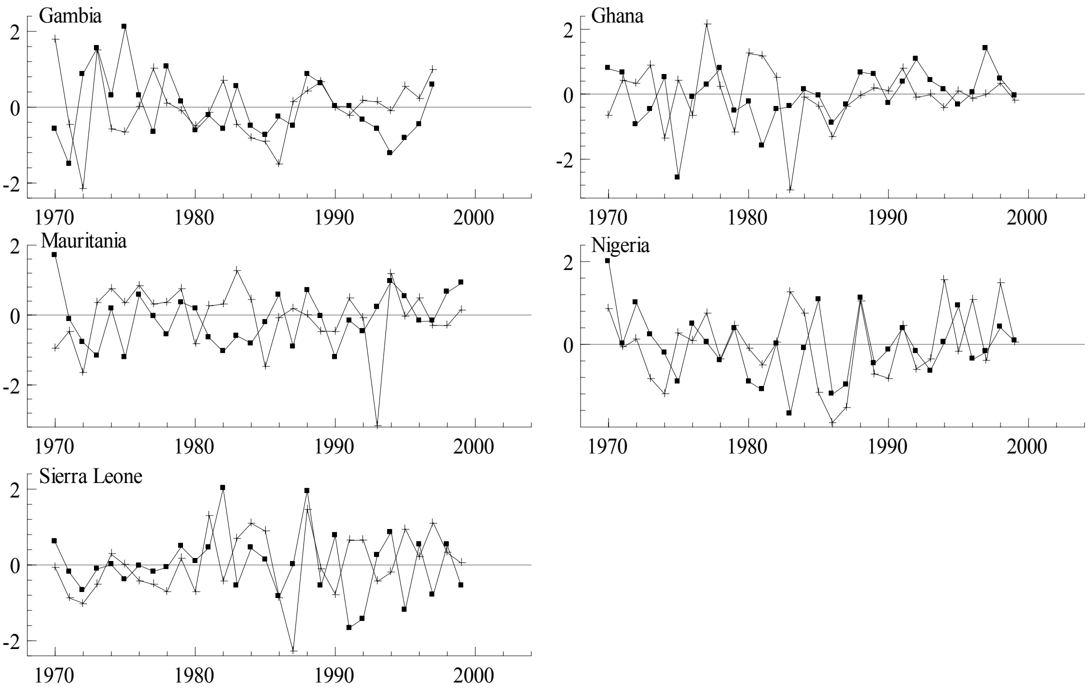

Figure 7: ε_{it}^{p} (+) and ε_{it}^{y} (■) time series

It can be seen from the table that in three out of four cases (the exception being ε_{it}^{y}), the unconditional correlations are higher for UEMOA-UDEAC pairs than for pairs with at least one country outside the CFA, and those for single currency pairs are even higher. However, the time-series model from which these innovations have been constructed conditions only on money and terms of trade shocks. There might also be time-invariant country-specific characteristics that affect the size of the correlations. In the light of the discussion in section 2, we ought also to condition on the distance/transport cost variables used for the trade regression, and also on some measures of the extent of heterogeneity in economic structure. The two measures that we shall use in the regressions reported below are the absolute values of the difference between i and j in (i) the ratio of agricultural value added to GDP, $|a_i - a_j|$ and (ii) the ratio of industrial value added to GDP, $|d_i - d_j|$. Figures are again taken from *World Development Indicators*. We estimate the impact of the CFA on real exchange rate and output correlations, conditional on these factors, by means of regression equations of the form:

$$\text{f}(\text{corr}(q_i,q_j)) = \phi_1 \cdot ifz_{ij} + \phi_2 \cdot ifs_{ij} + \phi_3 \cdot ifb_{ij} + \phi_4 \cdot ifc_{ij} + \phi_5 \cdot dist_{ij} + \phi_6 \cdot |a_i - a_j| + \phi_7 \cdot |d_i - d_j| + v_{ij}^{q} \quad (7)$$

$$\text{f}(x) = \log(1 + x) - \log(1 - x);\ (q_i,q_j) = \{(u_i^p,u_j^p), (u_i^y,u_j^y), (\varepsilon_i^p,\varepsilon_j^p), (\varepsilon_i^y,\varepsilon_j^y)\}$$

where v_{ij}^{q} is a residual, and all variables have been orthogonalized with respect to country fixed effects (D_i,D_j). The logistic transformation is used to ensure that the dependent variable distributions are unbounded. Note that this is a linear regression equation; we will see presently that there are no statistically significant non-linearities in the cross-country correlations for the macroeconomic shocks. Note also in Figures 2-7 that the 1994 devaluation shows up very markedly in the innovation time series for many of the CFA countries. The regressions reported below use measures of the dependent variables that exclude the 1994 observations, on the grounds that the devaluation was an atypical shock to the CFA macroeconomies that is unlikely to be repeated. If the 1994 observations are included, the stylized facts discussed below are even more marked.

Equation (7) does not include $\log(T_{ij})$ as an explanatory variable. It is possible to include the trade volume measure in the regression, using the explanatory variables in Table 4 as instruments. However, $\log(T_{ij})$ is not statistically significant in any of these four regressions. This suggests that the impact on CFA membership on real exchange rate and output correlations is through channels other than increased trade.

Tables 5 and 6 report the regression results. For each of the four correlation measures, the table includes both a restricted and unrestricted version of equation (7). The restricted model allows the omission any variable except the dummy variables ifs_{ij} and ifz_{ij}. The unrestricted version minimizes the Akaike Information Criterion, but the restricted version minimizes the Hannon-Quinn Criterion. In any case, the significant coefficients in the unrestricted model are very similar to those in the restricted model, so the choice of model specification does not substantially alter the inferences we make. Because the residuals in each regression are correlated with each other, the OLS estimator for the restricted model differs from the Maximum Likelihood estimator; we report the latter. The summary statistics in Table 6 indicate that the regression residuals are normally distributed and homoskedastic. Ramsey RESET tests for the validity of our functional form (testing the significance of powers of v_{ij}^q up to the fourth order in the regression equations) indicate that the linear model is acceptable.

The dummy variable ifz_{ij} is significant in three out of four of the regression equations – all except $\text{corr}(\varepsilon_i^y,\varepsilon_j^y)$. In no equation is the ifs_{ij} dummy significant; in other words, the impact of CFA membership on these correlations appears to be a consequence of the fixed exchange rate rather than monetary union *per se*. In this respect, the results are similar to those for trade intensity.

For the correlations in the reduced-form residuals, $\text{corr}(u_i^p,u_j^p)$ and $\text{corr}(u_i^y,u_j^y)$, the coefficient on the ifz_{ij} dummy is equal to about 0.3. This means that the expected difference between the correlations inside the CFA and those outside the CFA, conditional on other variables in the model, is roughly 0.15. For the real exchange rate correlation, the only other significant variable is the coastline dummy, ifc_{ij}, with a coefficient also equal to about 0.3. The natural interpretation of this effect is that lower transport costs reduce the magnitude of deviations from PPP. In the reduced-form output correlation regression, the distance variable, $dist_{ij}$, and the economic structure variable, $|a_i - a_j|$, are statistically significant, with coefficients equal to –0.12 and –0.55 respectively. In this case the correlation appears to depend not only on transport costs, but also on the degree of similarity with respect to agriculture's share of GDP.

We turn now to the regressions for the structural innovation correlations, $\text{corr}(\varepsilon_i^p,\varepsilon_j^p)$ and $\text{corr}(\varepsilon_i^y,\varepsilon_j^y)$. The CFA dummy coefficient in the $\text{corr}(\varepsilon_i^p,\varepsilon_j^p)$ regression is about twice as big as in the corresponding regression for $\text{corr}(u_i^p,u_j^p)$; but the coefficient in the $\text{corr}(\varepsilon_i^y,\varepsilon_j^y)$ regression is insignificantly different from zero. This suggests that the dependency of the reduced-form output correlations on common CFA membership is solely a consequence of the fact that the fixed nominal exchange rate reduces the size of asymmetric shocks to the real exchange rate equations (ε_{it}^p) for each country. In other words, there is strong evidence for the importance of the CFA in terms of integration concept (ii) in section 2 above, but no evidence for the importance of the CFA in terms of integration concept (iii).

Table 5
FIML regression results for real exchange rate and output correlations
All variables have been orthogonalized with respect to fixed effects.

corr(ε_i^p, ε_j^p)								
variable	coeff.	s.e.	t ratio	prob.	coeff.	s.e.	t ratio	prob.
ifc_{ij}	+0.0222	0.1636	+0.136	0.8923				
ifb_{ij}	+0.2526	0.1157	+2.183	0.0308	+0.1453	0.0803	+1.811	0.0724
$dist_{ij}$	+0.0743	0.0691	+1.074	0.2847				
$\|a_i-a_j\|$	-0.0137	0.4329	-0.032	0.9749				
$\|d_i-d_j\|$	-0.4174	0.3176	-1.314	0.1911				
ifs_{ij}	-0.0265	0.1134	-0.234	0.8154	-0.0333	0.1024	-0.325	0.7457
ifz_{ij}	+0.6029	0.1698	+3.550	0.0005	+0.5939	0.1652	+3.594	0.0005
σ	+0.3687				+0.3691			
corr(ε_i^y, ε_j^y)								
Variable	coeff.	s.e.	t ratio	prob.	coeff.	s.e.	t ratio	prob.
ifc_{ij}	-0.1582	0.1462	-1.083	0.2607				
ifb_{ij}	-0.0208	0.1034	-0.201	0.7312				
$dist_{ij}$	+0.0044	0.0618	+0.071	0.9349				
$\|a_i-a_j\|$	+0.2959	0.3868	+0.765	0.4457				
$\|d_i-d_j\|$	+0.1305	0.2837	+0.460	0.6465				
ifs_{ij}	-0.1328	0.1013	-1.312	0.1918	+0.0881	0.0956	+0.922	0.3582
ifz_{ij}	-0.0212	0.1517	-0.140	0.8361	-0.0497	0.1453	-0.342	0.7330
σ	+0.3294				+0.3283			
corr(u_i^p,u_j^p)								
Variable	coeff.	s.e.	t ratio	prob.	coeff.	s.e.	t ratio	Prob.
ifc_{ij}	+0.3187	0.1675	+1.903	0.0593	+0.3290	0.1394	+2.359	0.0198
ifb_{ij}	+0.1522	0.1184	+1.285	0.2011				
$dist_{ij}$	+0.0934	0.0708	+1.320	0.1893				
$\|a_i-a_j\|$	+0.4529	0.4432	+1.022	0.3087				
$\|d_i-d_j\|$	-0.4446	0.3251	-1.368	0.1738				
ifs_{ij}	+0.0465	0.1160	+0.401	0.6891	-0.0287	0.1055	-0.272	0.7860
ifz_{ij}	+0.3201	0.1738	+1.842	0.0678	+0.2872	0.1688	+1.702	0.0911
σ	+0.3775				+0.3773			
corr(u_i^y,u_j^y)								
Variable	coeff.	s.e.	t ratio	prob.	coeff.	s.e.	t ratio	Prob.
ifc_{ij}	+0.0866	0.1737	+0.498	0.6191				
ifb_{ij}	+0.0358	0.1228	+0.292	0.7711				
$dist_{ij}$	-0.0892	0.0734	-1.215	0.2264	-0.1230	0.0508	-2.423	0.0167
$\|a_i-a_j\|$	-0.3560	0.4596	-0.775	0.4400	-0.5478	0.3007	-1.822	0.0707
$\|d_i-d_j\|$	-0.0225	0.3372	-0.067	0.9469				
ifs_{ij}	-0.0359	0.1203	-0.298	0.7662	-0.1119	0.0829	-1.349	0.1796
ifz_{ij}	+0.3621	0.1803	+2.008	0.0467	+0.3681	0.1713	+2.149	0.0335
σ	+0.3915				+0.3866			

Table 6
Descriptive statistics for the Table 5 regressions

Regression residual correlations
(Lower diagonal: unrestricted model; upper diagonal: restricted model)

	$corr(\varepsilon_i^p, \varepsilon_j^p)$	$corr(\varepsilon_i^y, \varepsilon_j^y)$	$corr(u_i^p, u_j^p)$	$corr(u_i^y, u_j^y)$
$corr(\varepsilon_i^p, \varepsilon_j^p)$		-0.0413	0.51733	0.12617
$corr(\varepsilon_i^y, \varepsilon_j^y)$	-0.02493		0.06562	0.51549
$corr(u_i^p, u_j^p)$	0.50864	0.07109		0.15054
$corr(u_i^y, u_j^y)$	0.12791	0.52277	0.14737	

Correlation of actual and fitted values (unrestricted model)

equation	$corr(\varepsilon_i^p, \varepsilon_j^p)$	$corr(\varepsilon_i^y, \varepsilon_j^y)$	$corr(u_i^p, u_j^p)$	$corr(u_i^y, u_j^y)$
correlation	0.37398	0.20008	0.31235	0.25606

		Unrestricted Model	*Restricted Model*
log-likelihood		605.93	600.13
Hannan-Quinn Criterion		-8.2553	-8.5445
Akaike Criterion		-8.9107	-8.8254
Residual Normality Test		p = 0.92	p = 0.90
Heteroskedasticity Test		p = 0.52	p = 0.39
R^2(LR)		0.3010	
RESET (order 2)	eq. 1	p = 0.49	
	eq. 2	p = 0.88	
	eq. 3	p = 0.41	
	eq. 4	p = 0.68	
RESET (order 3)	eq. 1	p = 0.46	
	eq. 2	p = 0.93	
	eq. 3	p = 0.61	
	eq. 4	p = 0.32	
RESET(order 4)	eq. 1	p = 0.64	
	eq. 2	p = 0.66	
	eq. 3	p = 0.41	
	eq. 4	p = 0.52	

6 Summary and conclusion

In this paper we have explored the factors that determine the degree of macroeconomic integration in West Africa. Our sample of countries includes, but is not restricted to, countries in the two monetary unions that make up the CFA Franc Zone. These two monetary areas share a common peg to the French Franc/Euro. Consequently, when we consider pairwise measures of integration, we have examples of countries sharing a single currency, of countries with different currencies but a hard exchange rate peg, and of countries between whose currencies' bilateral exchange rate has been flexible. Our aim has been to see whether sharing a common currency delivers an extra degree of macroeconomic integration, as compared with sharing a common peg, and whether the peg delivers more integration than do flexible exchange rates. Five indicators of integration are considered, including measures of trade intensity, real exchange rate correlation and business cycle synchronicity.

For a wide variety of measures the exchange rate peg delivers more integration than a flexible exchange rate. The differences are statistically significant and economically substantial. In the case of trade integration, the size of the difference depends on geographical factors reflecting international transportation costs. The extra trade that CFA membership delivers is greatest among countries that share a common land border. For more distant trading partners the effect of the single currency is smaller (though still statistically significant). However, in no case is there a significant difference between the level of integration between CFA members in different monetary unions and the level of integration between monetary union partners. In this respect, the division of the CFA into two separate monetary areas appears to be of little economic consequence.

Other authors, on the basis of cross-country and panel data spanning the whole world, have claimed that there is evidence for a link between macroeconomic integration and countries' exchange rate regime. We have estimated the magnitude of this effect specifically for West Africa, one of the poorest parts of the world, and found that the effect substantial, though not always linearly separable from other economic characteristics.

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