Is the Franc Zone an Optimal Currency Area?*

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Abstract
In this paper we modify the method of Blanchard and Quah (1989) in order to estimate a structural VAR model appropriate for a small open economy. In this way we identify shocks to output and prices in the members of the two monetary unions that make up the African CFA Franc Zone. The costs of monetary union membership will depend on the extent to which price and output shocks are correlated across countries, and the degree of similarity in the long run effects of the shocks on the macro-economy. The policy conclusions depend on the relative importance of different macroeconomic variables to policymakers, and the speed with which a policymaker is able to respond to a shock.

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1. Introduction

The 1990s have seen a growing interest in the adoption of "hard fixed" exchange rates in LDCs as a possible way of making a credible commitment to a low domestic inflation rate (Edwards, 1993). An irrevocable commitment to a fixed exchange rate may help to solve the time inconsistency problems raised in Kydland and Prescott (1977) and Barro and Gordon (1983); it may also prevent self-fulfilling currency crises (Davies and Vines, 1995). Recent research indicates that countries that have made a realistic commitment to a fixed exchange rate policy do have lower average inflation rates (Ghosh *et al.*, 1995; Anyadike-Danes, 1995; Fielding and Bleaney, 1999). The realism of the commitment depends on the institutional framework within which the exchange rate is fixed. In the recent past the most successful unilateral attempts to adhere to a fixed exchange rate have involved the introduction of currency boards, as for example in Argentina or Estonia. This has led to a renewed interest in currency boards as a stabilization tool (Bennett, 1992; Schwartz, 1993; Hanke, 1996; Balino *et al*., 1997; Gulde, 1997; Ghosh *et al*., 1998; Edwards, 1999).

The credibility of commitment that comes with a currency board results from that fact that any devaluation is impossible without destroying the whole system. However, there are alternative ways of gaining credibility. In Africa the CFA Franc Zone consists of two monetary unions between different African states. The two CFA currencies have been pegged to the French Franc (and now the ECU[1]) since 1948, with the French treasury guaranteeing to exchange French currency for CFA currency at a fixed rate (Vizy, 1989). This rate can be adjusted for either of the two monetary unions, but only by the mutual consent of all the members of the union and France. In fact, the rate has been adjusted only once, in January 1994. The system preserves some flexibility with the option of devaluation *in extremis*: joining the CFA is *not* tantamount to ECU-ization. The credibility of the peg comes from the fact that such a devaluation is never a unilateral option, and can only be achieved by the unanimous agreement of the partner countries.

The disadvantage of Franc Zone membership is that there can only be a single monetary policy in each monetary union. Suppose that two countries experience heterogeneous shocks (by "shocks" we mean those innovations in macroeconomic variables that are not induced by changes in policy). The only country-specific response available to their governments is through fiscal policy; but in francophone Africa fiscal instruments are often too unwieldy for them to be used as stabilization tools (Chambas, 1994). So CFA members commit themselves to stabilization policy that is determined by some cross-country aggregate welfare function, a policy that may differ sharply from the optimal policy for any one individual country.[2]

In this paper we will not attempt to answer the grand question of whether, for each member of the CFA, the benefits of low inflation outweigh the costs of giving up monetary independence. But we will do some groundwork for an answer to this question by looking in more detail at the nature of the shocks experienced by Franc Zone countries. We will estimate the degree of cross-country correlation between shocks to different macroeconomic variables, and look at the degree of similarity in the effect these shocks eventually have on the economy.

[1] The fixed exchange rate is a budgetary agreement between France and its former colonies, so France's membership of the EMU has not prejudiced the system (Hadjimichael and Galy, 1997).

[2] The form of the social welfare function will depend on the voting or lobbying power of each country in the Adminstrative Council of each central bank. In the UEMOA central bank each member state plus France has two votes, regardless of their relative size. In the BEAC Cameroon has four votes, France three, Gabon two and the other member states one. In both unions the weights given to the interests of each African country are unlikely to be uniform, but neither are the weights given to the interests of the smaller countries likely to be zero.

1.1 The current composition of the Franc Zone

The two CFA monetary unions are the West African Economic and Monetary Union (UEMOA) and the region of the Central Bank of Equatorial Africa (BEAC). The countries that will appear in this paper are Benin (denoted in the tables below as *ben*), Burkina Faso (*bfa*), Cote d'Ivoire (*civ*), Senegal (*sen*), Togo (*tgo*), Mali (*mli*) and Niger (*ner*) – all UEMOA members - plus Cameroon (*cmr*), Congo Republic (*cgo*), Gabon (*gab*), Centrafrique (*car*) and Chad (*tcd*) – all BEAC members. There are two recent additions to the CFA missing from our paper because of inadequate data: Equatorial Guinea and Guinea-Bissau. With the exception of these two countries, the members of the CFA were all part of the French Empire in Africa, and the division between the UEMOA and the BEAC region corresponds to an imperial administrative division.

For the current structure of the CFA to be optimal the degree of similarity within each monetary union ought to be at least as great as the degree of similarity between any one country and the countries of the other monetary union. Otherwise, it would reduce the costs of monetary union membership to redraw the boundaries between the two unions. The two existing groups of countries, bound together largely by historical accident, embody a wide variety of economic structures, as illustrated in Table 1. The BEAC region includes three petroleum exporters (Cameroon, Congo Republic and Gabon) alongside three very poor countries exporting cash crops (Centrafrique, Chad and Equatorial Guinea). The UEMOA includes two relatively large economies (Cote d'Ivoire and Senegal) alongside six much smaller ones. Within this region there is some cross-border labour mobility, notably migration between Mali and Cote d'Ivoire, and to a lesser extent between Burkina Faso / Togo and Cote d'Ivoire. But Senegal and Guinea-Bissau are separated from their partner countries by the desert of western Mali, across which there is relatively little movement of labour.[3] It would be a very happy accident if the current partitioning of the Franc Zone turned out to be optimal.

A related question is whether there is a greater degree of similarity of shocks within the Franc Zone than there is between the Franc Zone and the rest of Africa. If it turns out that there is not, then the case for an exclusively francophone monetary area is much weaker. The monetary stability of the CFA is a positive externality generated by the European Monetary Union, which could in principle be extended to anglophone African countries. This question is difficult to answer because the nature of the shocks experienced by Franc Zone countries may partly be a consequence of their monetary and exchange rate system. Even if one controls for quantitative measures of monetary policy (as we intend to do), it is unlikely that the shocks experienced by a country with a floating exchange rate or a crawling peg will be the same as those experienced by a CFA country, *ceteris paribus*. There are not that many anglophone countries for which adequate macroeconomic data are available and which have maintained a fixed currency peg for any length of time, and with which one might therefore compare the CFA countries. In this paper we will compare shocks to the Franc Zone with shocks to Kenya, a coffee exporter with an economic structure similar to, for example, Cote d'Ivoire and with an historical inflation rate low by anglophone African standards (see Table 1). However, the comparison must be interpreted with a large caveat: Kenya's financial system is not the same as that of the CFA, and for long periods its currency peg was maintained at the expense of foreign exchange rationing (Adam, 1992).

[3] Appleyard (1999) details migration patterns in the area.

Table 1: Summary Statistics *(All figures are percentages)*

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
Agriculture share of GDP 1977*	31.9	34.3	24.3	27.1	35.4	61.3	51.8	33.6	15.4	5.5	40.2	35.2	42.0
Agriculture share of GDP 1987*	33.3	31.5	29.2	21.7	33.5	45.2	36.3	24.8	11.9	11.0	46.9	33.1	31.5
Agriculture share of GDP 1997*	38.4	31.8	27.3	18.5	42.2	44.0	38.0	42.1	9.5	7.5	54.1	37.4	27.5
Total debt share of GDP 1977*	22.3	16.4	41.1	31.7	47.6	44.9	13.2	31.4	75.6	52.6	26.0	15.8	36.9
Total debt share of GDP 1987*	76.4	38.4	134.6	87.6	98.9	94.2	75.1	33.2	145.2	79.8	47.8	27.9	72.2
Total debt share of GDP 1997*	75.9	54.5	152.3	81.0	89.2	119.9	88.7	101.9	227.0	67.5	92.3	54.9	61.3
Export share of GDP 1977*	23.5	9.0	42.6	42.0	41.5	12.8	19.6	25.1	45.6	51.6	25.2	15.4	35.0
Export share of GDP 1987*	29.3	10.6	33.4	24.1	41.4	16.6	21.5	15.7	41.7	42.7	16.2	15.4	21.3
Export share of GDP 1997*	24.9	11.2	46.6	32.8	34.7	25.5	16.2	26.8	77.0	64.0	19.5	18.7	28.2
Investment share of GDP 1977*	17.8	22.1	27.3	14.5	34.3	15.6	19.7	28.5	26.6	58.1	11.6	18.5	23.7
Investment share of GDP 1987*	12.9	20.9	12.3	12.5	17.6	20.7	12.0	24.7	19.7	26.4	12.5	9.1	20.8
Investment share of GDP 1997*	18.5	27.0	16.0	18.7	14.9	20.6	10.8	16.2	26.0	26.3	9.0	16.3	15.4
Trade taxes % of tax revenue 1980§	67.0	53.0	49.0	41.0	40.0	22.0	43.0	44.0	18.0	----	47.0	----	----
Trade taxes % of expenditure 1980§	43.0	40.0	31.0	32.0	28.0	16.0	28.0	32.0	9.0	----	30.0	----	----
Sample mean Dy¶	2.7	3.0	3.6	2.6	4.2	2.5	1.9	3.6	4.9	6.6	1.2	0.4	4.4
Sample mean Dp¶	6.1	5.4	7.2	6.3	6.2	7.0	6.0	7.8	7.4	6.6	6.4	5.8	10.9
Sample mean Dm¶	9.1	11.3	9.6	6.0	9.7	9.9	9.0	6.6	11.3	9.7	11.9	8.9	16.0
Sample s.d. Dy¶	4.5	4.0	6.3	3.8	7.4	5.3	9.0	5.7	6.9	9.0	4.2	11.4	6.9
Sample s.d. Dp¶	8.0	8.1	6.8	7.9	8.0	10.0	9.1	7.2	7.8	9.0	6.5	8.0	9.6
Sample s.d. Dm¶	30.0	9.9	10.5	16.0	34.3	11.1	13.6	13.1	13.7	16.8	13.7	16.8	9.3

* Data taken from World Bank *Development Indicators* 1999; § Data taken from Guillaumont and Guillaumont (1988)

¶ Statistics for the three variables appearing in the econometric model in section 3: Dy = GDP growth rate; Dp = inflation; Dm = money supply growth rate

1.2 Measuring and interpreting shocks

The aim of this paper is to identify and compare macroeconomic shocks to different members of the CFA, and to Kenya. We will focus on shocks to aggregate output growth and to aggregate consumer price inflation, which are the two variables that appear most often in analyses of the potential cost and benefits of CFA membership (Devarajan, 1991). We will assume nothing about the relative weights ascribed to hitting output and inflation targets: any policy conclusions drawn from the comparison of output and inflation shocks are conditional on the weights in the policymaker's social welfare function.

We will also be agnostic about the speed with which a monetary policy response to a shock is feasible. If an immediate response is possible then the prime concern will be the degree of similarity in the shocks hitting the economy (and therefore the degree of similarity in the monetary policy response most appropriate for each country), regardless of the degree of similarity in their consequent long run effects. When the policymaker can neutralize any shocks with a timely policy response their potential long run effects are not a prime concern. But if an immediate response is not possible then the long run effects are as important as the characteristics of the initial shocks, so we will look at both.

Many existing papers on the identification and cross-country comparison of macroeconomic shocks follow the method of Blanchard and Quah (1989). Examples are Bayoumi and Eichengreen (1994, 1996) and Funke (1995). This involves estimating a reduced form VAR for inflation and output growth, and identifying structural shocks to each variable by imposing a set of restrictions that includes the theory-based assumption that in the long run output shocks can affect inflation but not *vice versa*. We will adopt the general modelling strategy of Blanchard and Quah in this paper, but within the framework of a different theoretical model. We do not assume that output growth is independent of inflation in the long run, because there is evidence from empirical work on growth and investment in LDCs that high inflation can have deleterious consequences for long run growth (Fischer, 1993).[4] This could be either because high inflation is associated with a higher degree of price uncertainty, depressing investment (as in, for example, Green and Villanueva, 1990), or because larger and more frequent price changes increase search costs. Moreover, the motivation for the paper comes from the identification of those country-specific shocks that are not the result of innovations in monetary policy. So we need to identify shocks to output growth and inflation *conditional* on money supply growth in the CFA and Kenya and on common foreign price shocks. For this reason, our VAR will include four variables, not two. The theoretical model that provides the identifying restrictions in this VAR will be described in the next section; this will be followed by a discussion of the econometric modeling framework. Section 3 presents and interprets the econometric results, and Section 4 concludes.

2. The Modeling Framework

Our aim is to construct a structural VAR representation of the macro-economy of each member of the CFA for which data is available, plus Kenya. The estimated innovations in this VAR will be interpreted as macroeconomic shocks. Inference about the degree of similarity between the shocks to two countries will be based on the magnitude of the correlation of the innovations in their respective VARs, and on the degree of similarity in the impact of these innovations on the rest of the economy. We will focus particularly on shocks to domestic prices and output, conditional on domestic monetary policy and common foreign price shocks. So the VAR needs to include

[4] Bruno and Easterly (1998) contest the link between inflation and long run growth. But in the face of conflicting evidence, we choose not to impose the *a priori* restriction that inflation has no impact on long run growth.

domestic money and foreign prices alongside domestic prices and output. The structural model will be estimated by imposing exactly identifying restrictions on a reduced form VAR. These restrictions will be imposed on the long run equilibrium in the model, in the style of Blanchard and Quah (1989), not on short run coefficients. However, the macroeconomic model we employ is larger than the one used in the traditional Blanchard-Quah framework, and the restrictions embodied in it have a different theoretical motivation. We begin with a description of the theory, and then relate this to the econometric model to be estimated in the following section.

2.1 The theoretical framework

The theoretical model from which the restrictions are derived is a description of the macroeconomic steady state. The dependent variables in the model are *Dr* (real interest rate growth) *Dm* (nominal money stock growth) *Dy* (income growth) and *Dp* (inflation in domestic consumer prices). There is one independent variable, *Dpfr* (foreign consumer price inflation times the rate of nominal exchange rate depreciation). In the steady state, the dependent variables in each economy are determined as follows:[5]

$$D[m - p] = a_0 + a_1 \cdot Dy, \; + a_2 \cdot Dr, \; a_1 \geq 0 \geq a_2 \qquad \textit{Money Demand} \qquad (1)$$

$$Dp = b_0 + b_1 \cdot Dpfr, \; b_1 \geq 0 \qquad \textit{Relative PPP} \qquad (2)$$

$$Dy = c_0 + c_1 \cdot Dp + c_2 \cdot Dr, \; c_1 \leq 0, \; c_2 \leq 0 \qquad \textit{Aggregate Supply} \qquad (3)$$

$$Dr = f_0 + f_1 \cdot Dy + f_2 \cdot D[pfr - p], \; f_1 \leq 0 \leq f_2 \qquad \textit{Aggregate Demand} \qquad (4)$$

Equation (1) states that long run real money demand growth (with a reasonably wide definition of money) is a function of real income growth and real interest rate changes. In the steady state, the nominal money stock is assumed to adjust to clear the money market for a given level of nominal money demand, and the monetary authorities do not restrict the formation of bank deposits. There is some evidence for this assumption in Lowrey (1995).

Equation (2) embodies a weak version of the assumption of relative PPP. We do not assume that domestic and foreign consumer price inflation rates converge in the long run (although this is possible, if $b_0 = [1 - b_1] = 0$). Rather, we assume that if there is any divergence, it is at least at a constant rate. Lowrey (1995) provides some evidence for this weak form of relative PPP amongst CFA members, whereas Nuven (1994) is able to reject the hypothesis of strong PPP for most Franc Zone countries.

Equation (3) allows the growth of aggregate supply to depend on the growth of aggregate domestic prices, even in the long run. The introduction of the term $c_1 \cdot Dp$ is not intended to suggest that there is long run money illusion, or that nominal wages are permanently rigid. Rather, it allows for the possibility that high inflation can have deleterious consequences for long run growth, as discussed in section 1.2. The coefficient c_2 allows interest rate increases to depress capital stock growth and hence income growth in the long run.

Equation (4) is an inverted aggregate demand curve, in which the growth of aggregate demand depends on the growth of the interest rate (which will affect domestic demand for consumption and investment goods) and real exchange rate appreciation (which will affect net export growth).

[5] There is no uncovered interest parity condition in the model. I.e., capital does not flow freely across the borders of the Franc Zone. See Vizy (1989) for a discussion of the institutional restrictions on capital movement between France and the CFA (including multiple taxes on such transfers), and Fielding (1993) for evidence on the absence of interest parity between the CFA and France.

The one dependent variable which is difficult to measure in the CFA is the interest rate, *r*. The only rate reported consistently throughout the sample period is the official central bank discount rate, which is unlikely to equal the marginal cost of loanable funds. So we do not attempt to model *Dr*, and instead express equations (3-4) in reduced form:

$$Dy = [c_0 + c_2 \cdot f_0 + (c_1 - c_2 \cdot f_1) \cdot Dp + c_2 \cdot f_2 \cdot Dpfr]/[1 - c_2 \cdot f_1] \qquad (5)$$

Since $c_2 \cdot f_1 \geq 0$, the denominator of this expression, and therefore the impact of increases in *Dp* and *Dpfr* on *Dy*, are ambiguous. For the same reason the term $[c_1 - c_2 \cdot f_1]$ is ambiguously signed, but $c_2 \cdot f_2 \leq 0$; so the effects on *Dp* and *Dpfr* on *Dy* could work in the same or in opposite directions. The "normal" case is when an increase in inflation decreases output growth, because of its efficiency-reducing effects. However, there is also a "perverse" case when both the elasticity of aggregate supply with respect to the interest rate and the slope of the IS curve are greater than unity ($c_2 \cdot f_1 > 1$), so the response of long run growth to inflation flips sign.

Since equation (5) is constructed by substituting the aggregate demand curve into the aggregate supply curve, the shocks to output in our model are not to be interpreted as "aggregate demand" or "aggregate supply" shocks. They are more readily interpreted as aggregate "real" (as opposed to price or nominal money) shocks.

Our equation for money demand growth is also expressed in reduced form:

$$Dm = a_0 + a_2 \cdot f_0 + [a_1 + a_2 \cdot f_1] \cdot Dy + a_2 \cdot f_2 \cdot Dpfr + [1 - a_2 \cdot f_2] \cdot Dp \qquad (6)$$

Implicit in equations (5-6) is the equilibrium adjustment of the real marginal cost of loanable funds. At times both the two central banks of the CFA area and the Central Bank of Kenya have controlled nominal lending rates on certain types of loan, so it would be very heroic to assume the equilibrium adjustment of the formal financial sector loan rate. We are rather relying on the assumption that if the formal sector loans market does not clear, there is at the margin a flexible curb market interest rate that adjusts endogenously.

The steady state for each economy is described by the values of the parameters in equations (2) and (5-6) plus a statement of the long run level of *Dpfr*:

$$Dpfr = Dpfr_0 \qquad (7)$$

With a fixed / managed nominal exchange rate *Dpfr* is independent of the other variables in the model.

If we estimate the dynamics of the four variables (*Dpfr, Dp, Dy, Dm*) within a VAR framework for which equations (2) and (5-7) describe the steady-state, then there are six long run restrictions to be imposed. These are the absence of *Dm* in equation (5); the absence of *Dy* and *Dm* in equation (2); and the absence of *Dp*, *Dy* and *Dm* in equation (7).[6] These six restrictions will be used to identify the system. Note that in this model of a fixed exchange rate economy with relative PPP in the long run, and with a long run aggregate supply function that includes inflation, shocks to inflation will have a long run impact on output, but shocks to output will have no impact on inflation. In this way we differ from other papers that use long run restrictions to identify a macroeconomic model, in which output shocks typically have a long run impact on inflation, but inflation shocks have no impact on output.

[6] There will also be short run restrictions on the equation for *Dpfr*, since this variable is strictly exogenous to the other three.

We do not impose corresponding short run restrictions on equations (2) and (5). We allow changes in *Dm* to influence *Dy* in the short run, because a disequilibrium in the money market might well affect aggregate demand, as consumers respond to excess supply of or demand for money by increasing or reducing their spending. We also allow changes in *Dm* and *Dy* to affect *Dp* in the short run because short run deviations from PPP are possible, and in the short run prices rather than nominal money may adjust to clear the money market in response to changes in *Dy* or *Dm*.

There is no long run restriction on the money growth equation, equation (6). We are assuming that in the long run, the nominal value of bank deposits can adjust to satisfy people's demand, and that this demand depends on inflation, income and the interest rate. In the short run, when PPP does not have to hold, it may be that money market equilibrium is achieved (at least partially) by the adjustment of domestic prices. In this case, a shock to the money base could impact on *Dm* in the short run. This does not mean that *Dm* can be assumed to be weakly exogenous to *Dp* and *Dy*. Central bank decisions about narrow money creation are likely to depend on the current state of the macro-economy: there is evidence for this with respect to Cote d'Ivoire and Kenya in Fielding (1999). *Dm* is likely to depend on *Dp* and *Dy* in both the short run and the long run, but for different reasons.

In the absence of any short run restrictions in our model (except for the strict exogeneity of *Dpfr*) the dynamics of inflation, output growth and money growth can be described by a system of the form:

$$B_{11}(L)\ Dpfr_t\ = e_{1t} \qquad (7a)$$

$$B_{21}(L)\ Dpfr_t + B_{22}(L)\ Dp_t + B_{23}(L)\ Dy_t + B_{24}(L)\ Dm_t = e_{2t} \qquad (2a)$$

$$B_{31}(L)\ Dpfr_t\ + B_{32}(L)\ Dp_t + B_{33}(L)\ Dy_t + B_{34}(L)\ Dm_t = e_{3t} \qquad (5a)$$

$$B_{41}(L)\ Dpfr_t\ + B_{42}(L)\ Dp_t + B_{43}(L)\ Dy_t + B_{44}(L)\ Dm_t = e_{4t} \qquad (6a)$$

where equation (xa) corresponds to equation (x) above, the $B_{ij}(L)$ are lag polynomials embodying restrictions to ensure that equations (2) and (5-7) hold in the long run, and the e_{it} are orthogonal shocks to foreign inflation, domestic inflation, output growth and money growth respectively. The output growth shocks e_{3t} combine shocks to aggregate demand with shocks to aggregate supply, separate identification of the two components being impossible in the absence of appropriate interest rate data. To the extent that e_{3t} is dominated by productivity shocks, we might expect economies with similar production structures to have a relatively high correlation in e_{3t}. In the context of the Franc Zone such a group might be formed by the petroleum exporters (Cameroon, Congo Republic and Gabon) versus the petroleum importers (the rest); or by the semi-arid Sahelian economies (Burkina Faso, Senegal, Mali, Niger and Chad) versus the other countries with more tropical climates. But it is also possible that that e_{3t} is dominated by aggregate demand shocks. In the absence of any obvious differences in the structure of private sector demand across the CFA, the most likely reason for differences or similarities in aggregate demand shocks among Franc Zone members is government behavior. CFA governments differ in the extent to which their budget deficit is subject to large shocks, because some rely on a much narrower tax base than others (Bergougnoux, 1988; Chambas, 1994). A government that is less reliant on import duties or export taxes to finance its expenditure is less likely to have a highly variable deficit, or at least its deficit is less likely to vary with the international prices of primary commodities. In Table 1 Congo Republic and Mali stand out from the rest in this regard. However, if a government is prepared to make use of external borrowing in order to cushion the domestic economy from shocks to its deficit, such shocks need not translate into aggregate demand shocks. So governments which have relied on a relatively large amount of deficit financing and so become highly indebted may differ from the rest. As indicated in Table 1, Congo Republic, Mali and Cote d'Ivoire have the highest debt levels.

2.2 The econometric framework
The identification of the system is based on the methodological framework introduced by Blanchard and Quah (1989), although our macroeconomic model differs from theirs. For each country we estimate a reduced form VAR:

$$X_t = A(L)X_{t-1} + e_t = (I - A(L))^{-1}e_t \qquad (8)$$

where $A(L)$ is a 4 x 4 matrix of lag polynomials and X_t denotes the 4 x 1 vector of stationary variables:

$$X_t = [Dpfr_t, Dp_t, Dy_t, Dm_t]' \qquad (9)$$

and we impose the restriction that A_{12}, A_{13} and $A_{14} = 0$, i.e., *Dpfr* is strictly exogenous. This four-variable model corresponds to the system represented by equations (2) and (5-7) above. Appendix 1 presents evidence that the variables we are dealing with are stationary. e_t represents the vector of reduced form residuals. We impose no *a priori* restrictions on the reduced form residual covariance matrix. Moreover, the e_t are likely to be correlated across countries, so all the VARs must be estimated simultaneously.

In the absence of any theoretical restrictions the reduced form innovations e_t have no obvious economic interpretation. Such an interpretation will depend on the derivation of an alternative moving average representation to equation (8), which formulates variable movements as a function of past *structural* shocks, $\mathbf{e}_t$:

$$X_t = C(L)\mathbf{e}_t \qquad (10)$$

where, in terms of the theoretical model represented by equations (2a) and (5a-7a), $C = B^{-1}$ and the matrix $\mathbf{e}_t$ contains the structural shocks to each equation in the system. The elements of $\mathbf{e}_t$ are mutually uncorrelated. This will allow us to estimate the *cross-country* correlation coefficients for each element of $\mathbf{e}_t$. Moving from equation (8) to equation (10) requires the identification of a non-singular matrix *S* that links the reduced form and structural innovations, i.e.:

$$e_t = S\mathbf{e}_t \qquad (11)$$

where, in terms of equation (10), $S = C(0)$. In an n-variable model identification requires n^2 restrictions: in our case, $n^2 = 16$. Following the Blanchard-Quah framework, we assume that the structural shocks are orthogonal and have unit variance, i.e. $Var(\mathbf{e}_t) = I$. This gives us $(n+1)n/2 = 10$ restrictions.[7] The other six restrictions come from the assumption that in the moving average

[7] The normalization to unit variances, which is necessary to identify the structural shocks, does put a limit on their informational content: the cross-country correlation coefficients cannot be accompanied by a comparison of innovation variances. Nevertheless, as Table 2 below shows, the residual variances for each variable in the unrestricted VAR are quite similar across countries (except for money growth in Togo and Benin, which is due to just one large spike in these countries in the devaluation year, 1994). So the variances of the structural shocks that lie behind the innovations in the unrestricted VAR are unlikely to vary enormously across

process described in equation (10), which can be written out in full as:

$$X_t = \begin{bmatrix} \Delta pfr \\ \Delta p \\ \Delta y \\ \Delta m \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) & C_{13}(L) & C_{14}(L) \\ C_{21}(L) & C_{22}(L) & C_{23}(L) & C_{24}(L) \\ C_{31}(L) & C_{32}(L) & C_{33}(L) & C_{34}(L) \\ C_{41}(L) & C_{42}(L) & C_{43}(L) & C_{44}(L) \end{bmatrix} \begin{bmatrix} \mathbf{e}_{1t} \\ \mathbf{e}_{2t} \\ \mathbf{e}_{3t} \\ \mathbf{e}_{4t} \end{bmatrix} \tag{12}$$

the *C(L)* matrix is lower-triangular, i.e., $C_{12} = C_{13} = C_{14} = C_{23} = C_{24} = C_{34} = 0$. These are precisely the six restrictions embodied in the long run macroeconomic model described above.[8] The imposition of these restrictions will allow us to recover the structural shocks $\mathbf{e}_t$ from the reduced form shocks e_t in the original VAR. In the next section, we present the results of estimating the VARs for each country.

3. Estimating the Macroeconomic Shocks

The reduced form VAR represented by equation (8) was estimated (in GAUSS) for 13 countries: the 12 CFA countries for which data are available, plus Kenya.

3.1 Estimation

Data on real income for all the countries are taken from *Penn World Tables 5.6* for 1962-1991, measured as annual chain-linked real GDP. This is supplemented by comparable figures for 1991-1997 from the World Bank. *Dy* is defined as the annual change in the logarithm of this measure, from 1963 to 1997. Domestic consumer price data for this period are taken where possible from the IMF *International Financial Statistics*, line 64 (consumer prices); but for Centrafrique only line 63 (wholesale prices) is reported. For Benin, no price index at all is reported, so we use the GDP deflator as a proxy. *Dp* is defined as the annual change in the logarithm of the price index. The nominal money series used is line 34 plus line 35 in *International Financial Statistics* (including both time and savings deposits held in domestic banks, as well as the imputed share of each country in total currency issued). *Dm* is defined as the annual change in the logarithm of this measure. The foreign price series is measured as the French consumer price index multiplied by the CFA Franc – French Franc exchange rate (or in the case of Kenya by the Shilling – French Franc exchange rate); *Dpfr* is defined as the change in the logarithm of this series. In this way the evolution of domestic income, money and prices is conditioned on the same foreign price shock in all countries. Adjusting the definition of *Dpfr* to include a trade-weighted basket of currencies did not make a substantial difference to the results. The full data set is available on request. Appendix 1 discusses stationarity tests for the variables are interest; in all cases a null hypothesis of non-stationarity can be rejected.

If we were estimating a VAR for a single country then an OLS estimate would be efficient, since lags of all the endogenous variables appear in all of the equations, and we would not need to bother to estimate a residual covariance matrix. But in a model with several countries there is a potential efficiency gain from using a SUR estimator to capture cross-country residual correlations. It is not possible to estimate a complete covariance matrix for the residuals from every equation using annual data for 1963-97: altogether in our model there are 39 time series for domestic income, money and price growth. Nevertheless, we can estimate cross-country covariance matrices for each variable in the model by stacking the *Dp* equations for each country and estimating them by SUR, and then doing the same for *Dy* and *Dm.* This will be asymptotically more efficient than OLS,

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countries.

[8] In the original Blanchard and Quah (1989) paper, the macroeconomic model included only two variables, so the *C(L)* matrix was 2 x 2 and only one theoretical restriction was required to make it lower-triangular.

but does not allow for correlation between, say, *Dp* in one country and *Dy* in another.

Table 2: Regression Diagnostic Statistics

y Equation	R^2	***S.E.***	***D.W.***
ben	0.01	0.05	1.95
bfa	0.36	0.03	2.26
civ	0.30	0.05	1.84
sen	0.52	0.03	2.13
tgo	0.08	0.06	1.93
mli	0.36	0.03	1.84
ner	0.20	0.08	2.04
cmr	0.46	0.04	1.51
cgo	0.31	0.06	1.54
gab	0.30	0.08	2.25
car	0.03	0.04	1.37
tcd	0.35	0.10	2.13
ken	0.30	0.06	2.08
p Equation	R^2	***S.E.***	***D.W.***
ben	0.32	0.06	2.08
bfa	0.42	0.06	2.28
civ	0.35	0.05	1.63
sen	0.61	0.05	1.93
tgo	0.55	0.05	1.90
mli	0.60	0.06	2.08
ner	0.48	0.06	1.66
cmr	0.45	0.05	1.92
cgo	0.41	0.04	1.81
gab	0.75	0.04	1.77
car	0.64	0.04	2.02
tcd	0.60	0.04	1.77
ken	0.50	0.07	1.79
m Equation	R^2	***S.E.***	***D.W.***
ben	0.42	0.24	2.34
bfa	0.22	0.09	1.53
civ	0.22	0.09	1.80
sen	0.28	0.13	2.24
tgo	0.33	0.29	2.30
mli	0.12	0.11	1.63
ner	0.29	0.11	2.11
cmr	0.46	0.09	2.39
cgo	0.20	0.11	2.37
gab	0.58	0.10	2.25
gar	0.08	0.12	1.70
tcd	0.16	0.16	2.24
ken	0.10	0.08	1.98
pfr Equation	R^2	***S.E.***	***D.W.***
cfa	0.82	0.02	2.02
ken	0.04	0.11	2.01

Table 2 presents summary diagnostic statistics for equations estimated in this way. In each of the three SUR estimates (for *Dp*, *Dy* and *Dm*) the equations have been estimated with a lag order of two; this choice is made on the basis of the Akaike Information Criterion. The regression R^2s vary considerably, but are is typically between one third and one half, and are greater for *Dp* than for *Dy* and *Dm*. These proportions are perhaps a little smaller than the figures one might expect for a typical OECD country or NIC: the Franc Zone is made up of very small open economies which suffer from large shocks. There is no significant autocorrelation in any of the reduced form residuals. Table 2 also reports summary statistics for the foreign price inflation equation, which is modeled as an autoregressive process. For each individual country VAR, the set of regressors is jointly significant at the 1% level, though individual coefficients are sometimes insignificant; the same is true of each stack of variables across countries.[9]

These estimates are used to construct the reduced form innovation matrix e_t for each country. Imposing the restrictions outlined in the previous section allows us to construct the corresponding normalized structural innovation matrix $\boldsymbol{e}_t$. We do not report detailed estimates of each equation in each country, but these are available on request. In each country the asymptotic impulse responses implicit in the estimated model (that is, the estimated elements of the lower-triangular matrix *C(L)* in equation (12)) are theory-consistent in the sense that they either have a value consistent with the signs of the parameters of the theoretical model represented by equations (2) and (5-7), or are insignificantly different from zero.

In the rest of this section we present three features of interest in the regression results: the cross-country correlation coefficients for the price shocks in the structural model, the corresponding coefficients for the income shocks, and the corresponding impulse responses in the different countries.[10]

3.2 Price shock correlation coefficients

The full set of cross-country correlation matrices for each element of $\boldsymbol{e}_t$ is reported in full in Appendix 2, along with corresponding t-ratios and cross-country correlation coefficients for e_t. Tables 3-8 summarize the information in Appendix 2.

For the i^{th} member of the UEMOA, or of the BEAC region, one can compute coefficients of the correlation of each element of $\boldsymbol{e}_t$ with the corresponding element for another country. For each element, averaging over the correlation coefficients with respect to that member's partners (six in the UEMOA, four in the BEAC region) gives a measure of the degree of similarity of between shocks to that element in the i^{th} country and shocks in its partners. Such averages are shown in the right-hand columns of Tables 3-4. Averages are shown for the two elements of $\boldsymbol{e}_t$ relevant to the questions raised in Section 1: the innovations in *Dp* and *Dy*. The number of significant correlation coefficients ("+" for positive correlations and "-" for negative ones) is shown in parenthesis. If there are both significantly positive and significantly negative correlation coefficients, the term "mixed" appears in parenthesis. The reduced form e_t correlation averages are also noted in the left-hand columns for comparison.

Tables 5-6 show similar average correlation figures, but for the average correlation between a shock to one country and shocks to countries in the *other* monetary union. If these are larger (positive) numbers than in Tables 3-4, then the country is in some sense more similar to the members of the other union than it is to its existing partners. If the numbers are the same, then the country is as similar to the members of the other union as it is to its existing partners. Tables 7-8 show correlation coefficients for each CFA member *vis a vis* Kenya, to give a sense of the extent to which the CFA countries exhibit more similarity amongst themselves than any does to a representative non-CFA member.

For all CFA members, the averages of the price innovation correlation coefficients are large – mostly around 0.7 - and significantly different from zero. (And they are generally bigger than the correlation coefficients from the reduced-form price equation, so a structureless VAR tends to underestimate the degree of similarity in price shocks.) In other words, if we put a lot of weight on the importance of initial price shocks in assessing the costs and benefits of a monetary union, and

[9] The corresponding F-statistics are not reported in Table 2, but are available on request.

[10] Since the shocks in the $\boldsymbol{e}_t$ matrix are normalized with a unit variance we do not report the standard errors of structural shocks.

less weight on initial income shocks or on the eventual impact of a price shock on the whole economy, then the CFA comes out quite well. Price shocks tend to be quite highly correlated across member states, and on average a monetary policy response based on the average price shock to member states in one particular period will be appropriate for all countries individually. This conclusion would still be true if policy were weighted towards the largest members of the CFA (Cote d'Ivoire in the UEMOA and Cameroon in the BEAC region). As shown in Table A3 in Appendix 2, these two countries' price innovation correlation coefficients with respect to their partner states are all around 0.9, with two exceptions discussed below.

Moreover, there is generally no significant difference between a country's average price innovation correlation with its existing partners (Tables 3-4) and the average with the members of the other monetary union (Tables 5-6). There is no particular economic need for the border between the UEMOA and the BEAC region: a single monetary union would do as well.

There are however two countries for which the average correlation coefficients are a little lower than the rest, though still significantly positive: Niger in the UEMOA and Chad in the BEAC region. For Niger the average correlation coefficient is about 0.4 and for Chad about 0.5. These are both Sahelian economies on the northern edge of the CFA area with very little in the way of industry or mineral exports. In these countries a monetary policy response tailored to the cross-country average shock to the monetary union, or to the shock in its dominant member(s), would typically only roughly correspond to the ideal policy for the country.

For no CFA member is it possible to reject the null that its structural price innovations are orthogonal to those of Kenya (Tables 7-8). These innovations have been estimated in a model which conditions on money supply growth and foreign prices, so the result cannot be explained by the fact that a common monetary policy was pursued in CFA members that was different from the policy in Kenya. However, it is not possible to determine whether the differences between the CFA and Kenya are due to differences in the underlying economic structure of the Kenyan economy that would not have arisen had it been part of a CFA-style monetary union. The Kenyan economy has at times exhibited characteristics (such as extreme financial repression) that have not arisen in the CFA. All that can be said is that given the existing structure of the Kenyan economy, its price shocks, controlling for shocks to the money supply, are unlike those of the CFA.

3.3 Output innovation correlation coefficients

The correlation coefficients for structural innovations to income growth are rather different. In both the UEMOA and the BEAC region there are some significantly negative *and* some significantly positive coefficients for within-union shocks (Tables 3-4). The full correlation matrix is shown in Table 9, which shows the source of this asymmetry. There are two groups of CFA countries within which all the coefficients are significantly positive, and between which all the coefficients are significantly negative. The two groups are:

(i) Benin, Burkina Faso, Senegal, Togo, Niger, Cameroon, Gabon, Centrafrique, Chad
(ii) Cote d'Ivoire, Mali, Congo Republic

Within these groups, the correlation coefficients are mostly in the range 0.5 to 0.9; between the groups, the correlation coefficients are mostly in the range –0.5 to –0.9. The second, smaller group contains the two most indebted UEMOA members: Cote d'Ivoire, and its economically small neighbor Mali, which lies on the northern border of Cote d'Ivoire and provides the Ivorian economy with many migrant workers. It is not entirely surprising that Cote d'Ivoire and its northern satellite should exhibit some similarity in terms of shocks to aggregate supply and aggregate demand, and differ from the other members of their monetary union.

Table 3
UEMOA Countries: Average Innovation Correlations with the Rest of their Union
(Number and sign of significant correlations in parenthesis)

	Δp reduced form	Δp structural model
ben	0.30 (3+)	0.61 (6+)
bfa	0.34 (5+)	0.66 (6+)
civ	0.31 (3+)	0.69 (6+)
sen	0.19 (2+)	0.68 (6+)
tgo	0.34 (4+)	0.70 (6+)
mli	0.08 (0+)	0.67 (6+)
ner	0.30 (3+)	0.39 (6+)

	Δy reduced form	Δy structural model
ben	-0.12 (2-)	0.07 (mixed)
bfa	-0.03 (1-)	0.17 (mixed)
civ	0.01 (1-)	-0.38 (mixed)
sen	0.07 (0+)	0.14 (mixed)
tgo	0.06 (1+)	0.14 (mixed)
mli	0.17 (1+)	-0.40 (mixed)
ner	0.09 (0+)	0.17 (mixed)

Table 4
BEAC Countries: Average Innovation Correlations with the Rest of their Union
(Number and sign of significant correlations in parenthesis)

	Δp reduced form	Δp structural model
cmr	0.26 (1+)	0.69 (4+)
cgo	0.25 (2+)	0.69 (4+)
gab	0.18 (1+)	0.69 (4+)
car	0.29 (3+)	0.69 (4+)
tcd	0.17 (1+)	0.51 (4+)

	Δy reduced form	Δy structural model
cmr	-0.01 (0+)	0.27 (mixed)
cgo	-0.04 (1-)	-0.64 (4-)
gab	0.07 (1+)	0.27 (mixed)
car	0.12 (1+)	0.25 (mixed)
tcd	-0.14 (0+)	0.25 (mixed)

Table 5
UEMOA Countries: Average Innovation Correlations with BEAC Countries
(Number and sign of significant correlations in parenthesis)

	Δp reduced form	Δp structural model
ben	0.37 (3+)	0.74 (5+)
bfa	0.32 (2+)	0.79 (5+)
civ	0.37 (4+)	0.85 (5+)
sen	0.24 (2+)	0.87 (5+)
tgo	0.27 (2+)	0.84 (5+)
mli	0.20 (0+)	0.87 (5+)
ner	0.19 (1+)	0.35 (5+)
	Δy reduced form	Δy structural model
ben	-0.11 (mixed)	0.22 (mixed)
bfa	0.21 (1+)	0.38 (mixed)
civ	0.09 (1+)	-0.34 (mixed)
sen	-0.07 (0+)	0.29 (mixed)
tgo	0.28 (1+)	0.44 (mixed)
mli	0.16 (2+)	-0.41 (mixed)
ner	0.05 (mixed)	0.38 (mixed)

Table 6
BEAC Countries: Average Innovation Correlations with UEMOA Countries
(Number and sign of significant correlations in parenthesis)

	Δp reduced form	Δp structural model
cmr	0.23 (1+)	0.78 (6+)
cgo	0.37 (3+)	0.81 (7+)
gab	0.21 (2+)	0.82 (7+)
car	0.37 (4+)	0.82 (7+)
tcd	0.23 (2+)	0.56 (6+)
	Δy reduced form	Δy structural model
cmr	0.04 (1+)	0.26 (mixed)
cgo	0.09 (1+)	-0.29 (mixed)
gab	0.03 (1-)	0.28 (mixed)
car	0.18 (mixed)	0.22 (mixed)
tcd	0.09 (mixed)	0.22 (mixed)

Table 7
UEMOA Countries: Innovation Correlations with Kenya
(t-ratios in parenthesis)

	Δp reduced form	Δp structural model
ben	-0.06 (-0.32)	-0.15 (-0.83)
bfa	0.07 (0.36)	0.07 (0.39)
civ	-0.07 (-0.35)	0.02 (0.10)
sen	-0.00 (-0.00)	0.04 (0.19)
tgo	-0.17 (-0.92)	-0.04 (-0.23)
mli	-0.34 (-1.94)	-0.08 (-0.41)
ner	-0.23 (-1.25)	0.05 (0.26)

Table 7 continued

	Δy reduced form	Δy structural model
ben	-0.22 (-1.21)	-0.32 (-1.78)
bfa	0.32 (1.81)	-0.02 (-0.08)
civ	-0.28 (-1.54)	0.17 (0.90)
sen	-0.18 (-0.95)	-0.07 (-0.37)
tgo	-0.27 (-1.47)	-0.18 (-0.99)
mli	0.01 (0.07)	0.09 (0.49)
ner	-0.46 (-2.78)	-0.25 (-1.39)

Table 8
BEAC Countries: Innovation Correlations with Kenya
(t-ratios in parenthesis)

	Δp reduced form	Δp structural model
cmr	-0.41 (-2.37)	-0.09 (-0.46)
cgo	-0.24 (-1.32)	-0.01 (-0.05)
gab	-0.20 (-1.08)	-0.01 (-0.07)
car	-0.22 (-1.19)	-0.01 (-0.05)
tcd	-0.23 (-1.23)	-0.31 (-1.72)

	Δy reduced form	Δy structural model
cmr	0.03 (0.16)	-0.04 (-0.22)
cgo	-0.56 (-3.54)	0.10 (0.53)
gab	0.13 (0.68)	-0.05 (-0.25)
car	-0.19 (-1.00)	0.06 (0.33)
tcd	0.33 (1.87)	0.25 (1.37)

Table 9: Output Shock Correlations

	ben	bfa	sen	tgo	ner	cmr	gab	car	tcd		civ	mli	cgo
ben	1	0.47	0.13	0.56	0.38	0.52	0.48	0.31	0.28		-0.58	-0.48	-0.5
bfa	0.47	1	0.68	0.78	0.76	0.69	0.84	0.54	0.67		-0.73	-0.77	-0.83
sen	0.13	0.68	1	0.58	0.79	0.56	0.63	0.4	0.55		-0.56	-0.64	-0.68
tgo	0.56	0.78	0.58	1	0.85	0.81	0.9	0.67	0.77		-0.87	-0.93	-0.93
ner	0.38	0.76	0.79	0.85	1	0.76	0.82	0.58	0.65		-0.8	-0.83	-0.9
cmr	0.52	0.69	0.56	0.81	0.76	1	0.87	0.62	0.69		-0.74	-0.76	-0.83
gab	0.48	0.84	0.63	0.9	0.82	0.87	1	0.69	0.75		-0.82	-0.88	-0.93
car	0.31	0.54	0.4	0.67	0.58	0.62	0.69	1	0.61		-0.42	-0.57	-0.66
tcd	0.28	0.67	0.55	0.77	0.65	0.69	0.75	0.61	1		-0.61	-0.79	-0.8
civ	-0.58	-0.73	-0.56	-0.87	-0.8	-0.74	-0.82	-0.42	-0.61		1	0.86	0.87
mli	-0.48	-0.77	-0.64	-0.93	-0.83	-0.76	-0.88	-0.57	-0.79		0.86	1	0.94
cgo	-0.5	-0.83	-0.68	-0.93	-0.9	-0.83	-0.93	-0.66	-0.8		0.87	0.94	1

It is a little more surprising that the third member of the group is Congo Republic, a petroleum exporter and BEAC member at the southern edge of the Franc Zone. It is certainly difficult to see why Congo's aggregate supply shocks should exhibit more similarity with Cote d'Ivoire than with Gabon and Cameroon. The features that Congo has in common with the other countries in group (ii) are a high debt level and a low reliance on trade taxes for government expenditure (see Table 1). In the light of the discussion at the end of Section 2.1, it may be that these features reflect a commonality in the nature of shocks to aggregate demand.

In the absence of interest rate data it has not been possible to identify aggregate demand shocks separately from aggregate supply shocks: the estimated innovations in *Dy* are the sum of both together. One interpretation of the results here is that aggregate demand shocks dominate aggregate supply shocks (otherwise we should see commonality in the shocks to *Dy* in the petroleum exporters), and that the nature of aggregate demand shocks is linked to indebtedness. The VAR modeling framework is not well suited to picking out the structure of such links, but suggests a potentially fruitful line of complementary country-specific research into the links between fiscal policy and aggregate demand shocks.

Nevertheless, the results here suggest that if we put a lot of weight on the importance of initial output shocks in assessing the costs and benefits of a monetary union, and less weight on initial price shocks, then the CFA should be reorganized. It would be more appropriate for Cote d'Ivoire and Mali to form one monetary union (possibly joined by Congo Republic), and for the other existing CFA members to join together to form another.

3.4 Long Run Impulse Responses

The information in Tables 3-9 relates to the characteristics of structural shocks to the economies of the CFA. In a world where monetary authorities respond in a timely way to price and output shocks to their economies the long run effect of shocks is not of immediate concern: the shock will have been sterilized before its long run effect is realized. In a world where monetary authorities are slower to respond this is no longer true, and we must examine the impact of price and output shocks on the economic system over a longer time horizon.

Using the structural VAR we have estimated, it is possible to draw an impulse response function for the impact of each shock on each variable in each of the 13 countries. Rather than reproducing all of these charts, we will focus on the asymptotic effect of each shock on each variable. Table 10 summarizes the information in the impulse response functions by listing the long run responses to each shock, i.e., the total area underneath each impulse response curve. The points we have to make below would not be substantially altered if we instead reported figures for the areas below the impulse response curves up to a finite time horizon.

So Table 10 shows the long run effects on each economy of both a unit shock to inflation and a unit shock to output growth. Given the structure of our model, inflation shocks have a long run impact on both prices and output, whereas output growth shocks have an effect only on prices, so there are three columns of figures in Table 10.[11] The figures show the eventual impact of a one-period shock to inflation and output growth on the level of prices and output; for example, a figure of 0.1 implies that the level will increase by 10%.

The most striking aspect of Table 10 is the large cross-country variance in the estimated impulse responses. It is true that the long run effects of inflation shocks on inflation, and of output growth shocks on output growth, are all positive, and that the long run effect of a shock is smaller than the initial impact: all the figures in the first and third columns of Table 10 are in the interval [0,1]. However, the size of the inflation effect varies between 0.08 (Cameroon) and 0.73 (Benin), and the size of the output growth effect varies between 0.13 (Senegal, Congo Republic) and 0.48 (Chad). In some countries the initial shock is quickly dissipated, so that the long run effect on the level of the variable is very small; in others, the rate of dissipation is much slower, so the long run effect is quite large. If monetary authorities responded to shocks only after a considerable delay, response appropriate in each country

[11] The three sets of long run impulse responses are equivalent to the elements C_{22}, C_{32} and C_{33} in equation (12).

would vary widely across the Franc Zone. In other words, the costs of CFA membership in terms of lost monetary autonomy will be much larger than in a world where the monetary response to a shock is immediate.

Table 10: Long Run Impulse Responses (Standard Errors in Parenthesis)

	p on p	p on y	y on y
ben	0.73 (0.61)	0.31 (0.44)	0.20 (0.14)
bfa	0.28 (0.35)	0.17 (0.19)	0.21 (0.06)
civ	0.16 (0.27)	-0.04 (0.38)	0.18 (0.18)
sen	0.32 (0.24)	-0.08 (0.11)	0.13 (0.13)
tgo	0.34 (1.35)	1.49 (0.32)	0.40 (0.28)
mli	0.13 (2.37)	-0.15 (1.76)	0.16 (1.05)
ner	0.10 (0.17)	0.03 (0.63)	0.23 (3.44)
cmr	0.08 (0.42)	0.21 (0.34)	0.25 (0.36)
cgo	0.12 (0.22)	-0.17 (0.32)	0.13 (0.29)
gab	0.23 (2.72)	0.25 (1.97)	0.33 (0.62)
car	0.21 (1.06)	-0.01 (0.70)	0.19 (0.17)
tcd	0.15 (0.11)	-0.17 (0.28)	0.48 (1.28)
ken	0.29 (0.08)	-0.03 (0.04)	0.19 (0.02)

This conclusion is reinforced by the figures in the second column of Table 10, which shows the long run effect of an inflation shock on output. As noted in the discussion of equation (5) this effect, $[c_1 - c_2^y f_1]/[1 - c_2^y f_1]$, can in theory be positive or negative. Table 10 indicates that both cases are possible, with figures ranging from –0.17 (Congo Republic) to +1.49 (Togo). The standard errors on the long run impulse responses are generally quite large, since we have not imposed any over-identifying restrictions on the model; however, there are significant differences across the countries in our sample.[12] With this degree of long run heterogeneity, the costs of CFA membership with sluggish monetary policy responses will be even greater.

4. Summary and Conclusion

The two monetary unions that make up the CFA Franc Zone in continental Africa represent an alternative way of achieving a "hard" currency peg that embodies somewhat more flexibility than a currency board. The potential costs of membership arise from the need for all countries in a monetary union to pursue a single monetary policy. The size of these costs therefore depends on the degree of similarity across the countries in shocks to macroeconomic variables important to the policymaker, and in the degree of similarity in the long run impact that the shocks have on the economy.

The paper focuses on the identification of shocks to inflation and output growth, conditioning on common foreign price shocks and on money supply growth, the evolution of which is not independent of union membership. The method used to identify the shocks is based on the method of Blanchard and Quah (1989), but employs a larger macroeconomic model with different theoretical restrictions than in the traditional Blanchard-Quah framework.

It turns out that there is a high degree of correlation between inflation shocks to different CFA members, but not between inflation shocks to the CFA and those to a representative anglophone country, Kenya. So if the policy response to inflation shocks is immediate, and inflation is all that matters, the cost of CFA membership to current members is

[12] The standard errors are calculated by the method of Lutkepohl (1993, section 3.7). If individually insignificant regressors are removed from the unrestricted VAR then the standard errors in Table 10 are much smaller, but the estimated long run impulse responses are very similar.

unlikely to be large. Moreover, the correlation of inflation shocks across the two monetary unions in the CFA is as high as the correlations within them, so there is no particular advantage to having two currencies rather than just the one.

This conclusion is not necessarily applicable to potential future members of an enlarged monetary union including anglophone African states and underwritten by the European Central Bank instead of the French treasury. More work is required here in estimating shocks conditional on monetary policy over the wide variety of policy regimes encountered in Sub-Saharan Africa.

The picture with regard to shocks to output growth is rather different. There are within the CFA two groups of countries within which output growth shocks are highly positively correlated, but between which output growth shocks are negatively correlated. Since these two groups do not correspond to the two existing monetary unions there may be a reason to redraw the internal boundaries of the Franc Zone, if the policymaker is particularly concerned about output growth shocks.

If the policymaker is unable to respond immediately to inflation and output growth shocks, then the degree of similarity in the long run impact of shocks on the economy in different countries becomes important. Here the picture of the CFA is less attractive, with a considerable degree of heterogeneity in the impact of shocks across the Franc Zone. If shocks to the Zone are not immediately offset by a monetary policy response then their effect will vary substantially across member states, with no obvious common policy response appropriate to all.

The conclusions here are conditional on the way the monetary authorities in the CFA conduct their policy. In order to arrive at categorical conclusions we need to know more about the political and economic constraints faced by CFA policymakers, and on the political economy of policy formation. The model of the economy needs to be complemented by a model of the monetary authorities, and in particular of the Administrative Councils in each of the two CFA central banks.

Appendix 1: Stationarity Tests

Table A1 reports stationarity test statistics for the variables used in the estimates reported in section 3 of the paper. These are constructed using the method of Dickey and Fuller (1979). For each variable x_t, the statistic reported is the t-ratio on the parameter *b* in the regression:

$$Dx_t = a_0 + S_i a_i \times Dx_{t-i} + b \times x_{t-1} + u_t \qquad \text{(A1)}$$

where the lag order of *a* is determined by the Akaike Information Criterion for the regression, and the residual u_t is serially uncorrelated. Testing the null hypothesis that $b = 0$ constitutes a test of the null that x_t has a unit root against the alternative that it is stationary. For each of the three variables in all of the African countries, the statistic indicates that the parameter *b* is significantly different from zero, at least at the 5% level, using the critical values derived by Dickey and Fuller. The one variable for which the null cannot be rejected is the French inflation rate. However, if the regression equation is modified to allow for a deterministic logistic trend, as in Leybourne *et al.* (1998):

$$Dx_t = a_0 + S_i a_i \times Dx_{t-i} + b \times x_{t-1} + f(t) + u_t \qquad \text{(A2)}$$
$$f(t) = l \times t + [d_0 + d_1 \times t]/[1 + exp(-g \times (t - h))]$$

then the t-ratio on *b* is significant at the 10% level, so null can be rejected against the alternative that the series is stationary around a logistic trend.

Table A1: Unit-root tests

(i) Lag order = 0; (ii) Lag order = 1
** Significant at 5%; ** Significant at 1%*

Country	Dy	Dp	Dm
Ben	-5.4713** (i)	-4.1335** (i)	-9.8808** (i)
Bfa	-4.8828** (i)	-5.6078** (i)	-5.8475** (i)
Civ	-3.9804** (i)	-3.3293* (i)	-3.7591** (i)
Sen	-7.7930** (i)	-4.3811** (i)	-5.7128** (i)
Tgo	-5.5838** (i)	-3.9248** (i)	-6.3744** (ii)
Mli	-6.6406** (i)	-3.8636** (i)	-4.7066** (i)
Ner	-6.6979** (i)	-3.2160* (i)	-6.2694** (i)
Cmr	-3.1930* (i)	-4.2864** (i)	-4.7020** (i)
Cgo	-4.7717** (i)	-4.2958** (i)	-6.7290** (i)
Gab	-3.9571** (i)	-4.2961** (i)	-3.4484* (i)
Car	-6.1544** (i)	-3.6897** (i)	-5.2107** (i)
Tcd	-6.0013** (i)	-5.2133** (i)	-4.3629** (i)
Ken	-5.5230** (i)	-7.6460** (i)	-5.2110** (i)

Logistic trend model for French inflation

Variable	coeff.	std. err.	t ratio
a_0	0.11444	0.00576	19.875
l	0.00534	0.00057	9.325
g	1.32700	0.50491	2.628
h	4.44100	0.47432	9.363
d_1	-0.00718	0.00152	-4.732
d_0	-0.06647	0.01986	-3.347

R^2 = 0.85753

Unit-root test on residual (one lag): t = -5.126

Appendix 2: Innovation Correlation Statistics

Table A2: Reduced Form Innovation Correlations

p equation correlations

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	1.00	0.40	0.68	0.10	0.49	0.21	0.23	0.49	0.18	0.26	0.50	0.43	-0.06
bfa	0.40	1.00	0.57	0.60	0.39	0.00	0.40	0.19	0.45	0.35	0.32	0.29	0.07
civ	0.68	0.57	1.00	0.18	0.53	-0.09	0.31	0.43	0.32	0.36	0.36	0.37	-0.07
sen	0.10	0.60	0.18	1.00	0.14	-0.11	0.40	0.19	0.43	0.14	0.58	-0.14	-0.00
tgo	0.49	0.39	0.53	0.14	1.00	0.33	0.48	0.36	0.30	0.17	0.41	0.11	-0.17
mli	0.21	0.00	-0.09	-0.11	0.33	1.00	0.25	-0.01	0.27	0.28	0.19	0.27	-0.34
ner	0.23	0.40	0.31	0.40	0.48	0.25	1.00	-0.08	0.62	-0.08	0.20	0.27	-0.23
cmr	0.49	0.19	0.43	0.19	0.36	-0.01	-0.08	1.00	0.23	0.30	0.52	0.25	-0.41
cgo	0.18	0.45	0.32	0.43	0.30	0.27	0.62	0.23	1.00	0.12	0.49	0.41	-0.24
gab	0.26	0.35	0.36	0.14	0.17	0.28	-0.08	0.30	0.12	1.00	0.37	0.11	-0.20
car	0.50	0.32	0.36	0.58	0.41	0.19	0.20	0.52	0.49	0.37	1.00	0.08	-0.22
tcd	0.43	0.29	0.37	-0.14	0.11	0.27	0.27	0.25	0.41	0.11	0.08	1.00	-0.23
ken	-0.06	0.07	-0.07	-0.00	-0.17	-0.34	-0.23	-0.41	-0.24	-0.20	-0.22	-0.23	1.00

p equation t-ratios

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	0.00	2.30	4.91	0.54	2.96	1.11	1.23	2.99	0.95	1.42	3.05	2.49	-0.32
bfa	2.30	0.00	3.67	3.99	2.23	0.00	2.31	1.02	2.68	2.01	1.81	1.57	0.36
civ	4.91	3.67	0.00	0.94	3.30	-0.47	1.73	2.49	1.79	2.05	2.04	2.11	-0.35
sen	0.54	3.99	0.94	0.00	0.76	-0.58	2.32	1.04	2.55	0.77	3.75	-0.77	-0.00
tgo	2.96	2.23	3.30	0.76	0.00	1.84	2.90	2.07	1.69	0.93	2.40	0.59	-0.92
mli	1.11	0.00	-0.47	-0.58	1.84	0.00	1.39	-0.05	1.46	1.53	1.04	1.46	-1.94
ner	1.23	2.31	1.73	2.32	2.90	1.39	0.00	-0.42	4.21	-0.41	1.07	1.51	-1.25
cmr	2.99	1.02	2.49	1.04	2.07	-0.05	-0.42	0.00	1.23	1.66	3.23	1.38	-2.37
cgo	0.95	2.68	1.79	2.55	1.69	1.46	4.21	1.23	0.00	0.64	2.99	2.40	-1.32
gab	1.42	2.01	2.05	0.77	0.93	1.53	-0.41	1.66	0.64	0.00	2.10	0.56	-1.08
car	3.05	1.81	2.04	3.75	2.40	1.04	1.07	3.23	2.99	2.10	0.00	0.42	-1.19
tcd	2.49	1.57	2.11	-0.77	0.59	1.46	1.51	1.38	2.40	0.56	0.42	0.00	-1.23
ken	-0.32	0.36	-0.35	-0.00	-0.92	-1.94	-1.25	-2.37	-1.32	-1.08	-1.19	-1.23	0.00

y equation correlations

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	1.00	-0.50	-0.38	-0.10	0.18	-0.10	0.04	0.36	0.01	-0.45	-0.41	-0.08	-0.22
bfa	-0.50	1.00	0.04	0.04	0.01	0.19	0.00	0.05	0.15	0.24	0.24	0.37	0.32
civ	-0.38	0.04	1.00	0.11	-0.09	0.27	0.13	-0.13	-0.17	0.18	0.45	0.10	-0.28
sen	-0.10	0.04	0.11	1.00	-0.05	0.23	0.29	-0.19	-0.10	0.04	-0.08	-0.02	-0.18
tgo	0.18	0.01	-0.09	-0.05	1.00	0.38	-0.02	0.22	0.24	0.13	0.51	0.29	-0.27
mli	-0.10	0.19	0.27	0.23	0.38	1.00	0.19	-0.16	0.01	0.10	0.48	0.36	0.01
ner	0.04	0.00	0.13	0.29	-0.02	0.19	1.00	0.14	0.48	-0.01	0.06	-0.40	-0.46
cmr	0.36	0.05	-0.13	-0.19	0.22	-0.16	0.14	1.00	0.12	0.34	-0.17	-0.34	0.03
cgo	0.01	0.15	-0.17	-0.10	0.24	0.01	0.48	0.12	1.00	-0.12	0.07	-0.27	-0.56
gab	-0.45	0.24	0.18	0.04	0.13	0.10	-0.01	0.34	-0.12	1.00	0.45	-0.31	0.13
car	-0.41	0.24	0.45	-0.08	0.51	0.48	0.06	-0.17	0.07	0.45	1.00	0.24	-0.19
tcd	-0.08	0.37	0.10	-0.02	0.29	0.36	-0.40	-0.34	-0.27	-0.31	0.24	1.00	0.33
ken	-0.22	0.32	-0.28	-0.18	-0.27	0.01	-0.46	0.03	-0.56	0.13	-0.19	0.33	1.00

y equation t -ratios

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	0.00	-3.09	-2.16	-0.51	0.98	-0.51	0.20	2.06	0.04	-2.66	-2.38	-0.40	-1.21
bfa	-3.09	0.00	0.23	0.19	0.04	1.04	0.01	0.28	0.82	1.28	1.29	2.11	1.81
civ	-2.16	0.23	0.00	0.56	-0.50	1.49	0.68	-0.69	-0.94	0.98	2.70	0.55	-1.54
sen	-0.51	0.19	0.56	0.00	-0.24	1.26	1.62	-1.02	-0.52	0.20	-0.41	-0.08	-0.95
tgo	0.98	0.04	-0.50	-0.24	0.00	2.17	-0.10	1.17	1.29	0.69	3.12	1.62	-1.47
mli	-0.51	1.04	1.49	1.26	2.17	0.00	1.00	-0.89	0.04	0.55	2.93	2.05	0.07
ner	0.20	0.01	0.68	1.62	-0.10	1.00	0.00	0.75	2.91	-0.07	0.34	-2.31	-2.78
cmr	2.06	0.28	-0.69	-1.02	1.17	-0.89	0.75	0.00	0.63	1.94	-0.90	-1.93	0.16
cgo	0.04	0.82	-0.94	-0.52	1.29	0.04	2.91	0.63	0.00	-0.66	0.38	-1.51	-3.54
gab	-2.66	1.28	0.98	0.20	0.69	0.55	-0.07	1.94	-0.66	0.00	2.65	-1.74	0.68
car	-2.38	1.29	2.70	-0.41	3.12	2.93	0.34	-0.90	0.38	2.65	0.00	1.29	-1.00
tcd	-0.40	2.11	0.55	-0.08	1.62	2.05	-2.31	-1.93	-1.51	-1.74	1.29	0.00	1.87
ken	-1.21	1.81	-1.54	-0.95	-1.47	0.07	-2.78	0.16	-3.54	0.68	-1.00	1.87	0.00

Table A2 (Continued)

m equation correlations

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	1.00	0.21	0.12	0.41	0.63	-0.15	-0.12	0.21	0.60	0.12	0.39	0.18	0.07
bfa	0.21	1.00	0.37	0.49	0.25	0.44	0.40	-0.10	0.15	0.11	0.37	0.26	0.09
civ	0.12	0.37	1.00	0.43	0.60	0.41	0.08	0.51	0.37	0.24	0.65	0.53	0.15
sen	0.41	0.49	0.43	1.00	0.56	0.07	0.24	0.45	0.34	0.43	0.53	0.06	0.17
tgo	0.63	0.25	0.60	0.56	1.00	0.28	-0.01	0.57	0.56	0.34	0.70	0.37	-0.02
mli	-0.15	0.44	0.41	0.07	0.28	1.00	0.52	0.06	-0.08	0.27	0.28	0.09	0.12
ner	-0.12	0.40	0.08	0.24	-0.01	0.52	1.00	-0.02	-0.31	0.19	0.16	-0.16	0.16
cmr	0.21	-0.10	0.51	0.45	0.57	0.06	-0.02	1.00	0.16	0.21	0.52	0.17	0.24
cgo	0.60	0.15	0.37	0.34	0.56	-0.08	-0.31	0.16	1.00	0.32	0.21	0.34	-0.07
gab	0.12	0.11	0.24	0.43	0.34	0.27	0.19	0.21	0.32	1.00	0.38	-0.11	-0.39
car	0.39	0.37	0.65	0.53	0.70	0.28	0.16	0.52	0.21	0.38	1.00	0.17	0.00
tcd	0.18	0.26	0.53	0.06	0.37	0.09	-0.16	0.17	0.34	-0.11	0.17	1.00	0.08
ken	0.07	0.09	0.15	0.17	-0.02	0.12	0.16	0.24	-0.07	-0.39	0.00	0.08	1.00

m equation t -ratios

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	0.00	1.13	0.62	2.41	4.32	-0.79	-0.62	1.12	3.97	0.62	2.22	0.95	0.35
bfa	1.13	0.00	2.13	2.99	1.37	2.58	2.28	-0.55	0.81	0.58	2.10	1.45	0.46
civ	0.62	2.13	0.00	2.49	3.97	2.39	0.44	3.14	2.11	1.29	4.57	3.27	0.80
sen	2.41	2.99	2.49	0.00	3.62	0.35	1.33	2.69	1.91	2.51	3.29	0.33	0.94
tgo	4.32	1.37	3.97	3.62	0.00	1.56	-0.06	3.62	3.62	1.90	5.14	2.11	-0.12
mli	-0.79	2.58	2.39	0.35	1.56	0.00	3.23	0.30	-0.43	1.50	1.54	0.50	0.63
ner	-0.62	2.28	0.44	1.33	-0.06	3.23	0.00	-0.12	-1.70	1.03	0.87	-0.85	0.87
cmr	1.12	-0.55	3.14	2.69	3.62	0.30	-0.12	0.00	0.87	1.12	3.22	0.90	1.30
cgo	3.97	0.81	2.11	1.91	3.62	-0.43	-1.70	0.87	0.00	1.77	1.13	1.94	-0.39
gab	0.62	0.58	1.29	2.51	1.90	1.50	1.03	1.12	1.77	0.00	2.15	-0.59	-2.27
car	2.22	2.10	4.57	3.29	5.14	1.54	0.87	3.22	1.13	2.15	0.00	0.90	0.02
tcd	0.95	1.45	3.27	0.33	2.11	0.50	-0.85	0.90	1.94	-0.59	0.90	0.00	0.43
ken	0.35	0.46	0.80	0.94	-0.12	0.63	0.87	1.30	-0.39	-2.27	0.02	0.43	0.00

Table A3: Structural Form Innovation Correlations

p equation correlations

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	1.00	0.74	0.82	0.72	0.82	0.74	0.41	0.75	0.74	0.75	0.77	0.67	-0.15
bfa	0.74	1.00	0.89	0.89	0.84	0.81	0.47	0.81	0.86	0.87	0.84	0.56	0.07
civ	0.82	0.89	1.00	0.90	0.90	0.86	0.46	0.91	0.89	0.92	0.91	0.64	0.02
sen	0.72	0.89	0.90	1.00	0.91	0.92	0.41	0.94	0.94	0.95	0.97	0.56	0.04
tgo	0.82	0.84	0.90	0.91	1.00	0.91	0.50	0.89	0.90	0.90	0.93	0.59	-0.04
mli	0.74	0.81	0.86	0.92	0.91	1.00	0.47	0.89	0.91	0.94	0.94	0.66	-0.08
ner	0.41	0.47	0.46	0.41	0.50	0.47	1.00	0.27	0.44	0.39	0.39	0.25	0.05
cmr	0.75	0.81	0.91	0.94	0.89	0.89	0.27	1.00	0.91	0.96	0.95	0.63	-0.09
cgo	0.74	0.86	0.89	0.94	0.90	0.91	0.44	0.91	1.00	0.92	0.95	0.69	-0.01
gab	0.75	0.87	0.92	0.95	0.90	0.94	0.39	0.96	0.92	1.00	0.97	0.61	-0.01
car	0.77	0.84	0.91	0.97	0.93	0.94	0.39	0.95	0.95	0.97	1.00	0.60	-0.01
tcd	0.67	0.56	0.64	0.56	0.59	0.66	0.25	0.63	0.69	0.61	0.60	1.00	-0.31
ken	-0.15	0.07	0.02	0.04	-0.04	-0.08	0.05	-0.09	-0.01	-0.01	-0.01	-0.31	1.00

p equation t-ratios

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	0.00	5.77	7.60	5.44	7.63	5.78	2.41	5.99	5.88	5.96	6.42	4.73	-0.83
bfa	5.77	0.00	10.10	10.32	8.09	7.23	2.84	7.18	8.81	9.35	8.17	3.56	0.39
civ	7.60	10.10	0.00	11.06	11.09	8.83	2.73	11.38	10.15	12.65	11.81	4.35	0.10
sen	5.44	10.32	11.06	0.00	11.31	12.02	2.41	14.35	15.14	16.38	19.72	3.60	0.19
tgo	7.63	8.09	11.09	11.31	0.00	11.44	3.04	10.57	11.22	11.15	13.16	3.88	-0.23
mli	5.78	7.23	8.83	12.02	11.44	0.00	2.79	10.11	11.76	13.98	15.28	4.68	-0.41
ner	2.41	2.84	2.73	2.41	3.04	2.79	0.00	1.46	2.61	2.22	2.22	1.37	0.26
cmr	5.99	7.18	11.38	14.35	10.57	10.11	1.46	0.00	11.46	17.25	15.66	4.28	-0.46
cgo	5.88	8.81	10.15	15.14	11.22	11.76	2.61	11.46	0.00	12.47	16.46	5.02	-0.05
gab	5.96	9.35	12.65	16.38	11.15	13.98	2.22	17.25	12.47	0.00	21.10	4.10	-0.07
car	6.42	8.17	11.81	19.72	13.16	15.28	2.22	15.66	16.46	21.10	0.00	3.99	-0.05
tcd	4.73	3.56	4.35	3.60	3.88	4.68	1.37	4.28	5.02	4.10	3.99	0.00	-1.72
ken	-0.83	0.39	0.10	0.19	-0.23	-0.41	0.26	-0.46	-0.05	-0.07	-0.05	-1.72	0.00

y equation correlations

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	1.00	0.47	-0.58	0.13	0.56	-0.48	0.38	0.52	-0.50	0.48	0.31	0.28	-0.32
bfa	0.47	1.00	-0.73	0.68	0.78	-0.77	0.76	0.69	-0.83	0.84	0.54	0.67	-0.02
civ	-0.58	-0.73	1.00	-0.56	-0.87	0.86	-0.80	-0.74	0.87	-0.82	-0.42	-0.61	0.17
sen	0.13	0.68	-0.56	1.00	0.58	-0.64	0.79	0.56	-0.68	0.63	0.40	0.55	-0.07
tgo	0.56	0.78	-0.87	0.58	1.00	-0.93	0.85	0.81	-0.93	0.90	0.67	0.77	-0.18
mli	-0.48	-0.77	0.86	-0.64	-0.93	1.00	-0.83	-0.76	0.94	-0.88	-0.57	-0.79	0.09
ner	0.38	0.76	-0.80	0.79	0.85	-0.83	1.00	0.76	-0.90	0.82	0.58	0.65	-0.25
cmr	0.52	0.69	-0.74	0.56	0.81	-0.76	0.76	1.00	-0.83	0.87	0.62	0.69	-0.04
cgo	-0.50	-0.83	0.87	-0.68	-0.93	0.94	-0.90	-0.83	1.00	-0.93	-0.66	-0.80	0.10
gab	0.48	0.84	-0.82	0.63	0.90	-0.88	0.82	0.87	-0.93	1.00	0.69	0.75	-0.05
car	0.31	0.54	-0.42	0.40	0.67	-0.57	0.58	0.62	-0.66	0.69	1.00	0.61	0.06
tcd	0.28	0.67	-0.61	0.55	0.77	-0.79	0.65	0.69	-0.80	0.75	0.61	1.00	0.25
ken	-0.32	-0.02	0.17	-0.07	-0.18	0.09	-0.25	-0.04	0.10	-0.05	0.06	0.25	1.00

y equation t-ratios

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	0.00	2.80	-3.77	0.70	3.59	-2.88	2.18	3.21	-3.10	2.86	1.73	1.55	-1.78
bfa	2.80	0.00	-5.70	4.87	6.64	-6.30	6.22	5.04	-7.79	8.10	3.37	4.78	-0.08
civ	-3.77	-5.70	0.00	-3.56	-9.19	9.05	-6.98	-5.76	9.36	-7.44	-2.45	-4.04	0.90
sen	0.70	4.87	-3.56	0.00	3.74	-4.40	6.76	3.54	-4.85	4.28	2.33	3.47	-0.37
tgo	3.59	6.64	-9.19	3.74	0.00	-13.07	8.59	7.25	-12.92	10.95	4.76	6.43	-0.99
mli	-2.88	-6.30	9.05	-4.40	-13.07	0.00	-7.81	-6.11	14.21	-9.94	-3.71	-6.72	0.49
ner	2.18	6.22	-6.98	6.76	8.59	-7.81	0.00	6.12	-10.86	7.49	3.80	4.54	-1.39
cmr	3.21	5.04	-5.76	3.54	7.25	-6.11	6.12	0.00	-7.84	9.30	4.13	5.11	-0.22
cgo	-3.10	-7.79	9.36	-4.85	-12.92	14.21	-10.86	-7.84	0.00	-13.24	-4.71	-6.96	0.53
gab	2.86	8.10	-7.44	4.28	10.95	-9.94	7.49	9.30	-13.24	0.00	5.02	5.92	-0.25
car	1.73	3.37	-2.45	2.33	4.76	-3.71	3.80	4.13	-4.71	5.02	0.00	4.07	0.33
tcd	1.55	4.78	-4.04	3.47	6.43	-6.72	4.54	5.11	-6.96	5.92	4.07	0.00	1.37
ken	-1.78	-0.08	0.90	-0.37	-0.99	0.49	-1.39	-0.22	0.53	-0.25	0.33	1.37	0.00

Table A3 (Continued)

m equation correlations

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	1.00	-0.13	-0.52	-0.20	-0.05	-0.41	0.32	-0.31	-0.32	-0.37	-0.31	-0.46	-0.09
bfa	-0.13	1.00	-0.10	0.00	0.02	-0.28	0.22	-0.32	-0.29	-0.31	-0.18	-0.31	0.05
civ	-0.52	-0.10	1.00	0.82	0.71	0.89	-0.87	0.92	0.92	0.92	0.93	0.89	-0.26
sen	-0.20	0.00	0.82	1.00	0.77	0.73	-0.72	0.83	0.78	0.79	0.83	0.72	-0.33
tgo	-0.05	0.02	0.71	0.77	1.00	0.68	-0.61	0.71	0.71	0.67	0.75	0.59	-0.40
mli	-0.41	-0.28	0.89	0.73	0.68	1.00	-0.86	0.90	0.91	0.92	0.93	0.94	-0.40
ner	0.32	0.22	-0.87	-0.72	-0.61	-0.86	1.00	-0.89	-0.91	-0.88	-0.88	-0.85	0.40
cmr	-0.31	-0.32	0.92	0.83	0.71	0.90	-0.89	1.00	0.94	0.96	0.94	0.91	-0.39
cgo	-0.32	-0.29	0.92	0.78	0.71	0.91	-0.91	0.94	1.00	0.95	0.94	0.93	-0.44
gab	-0.37	-0.31	0.92	0.79	0.67	0.92	-0.88	0.96	0.95	1.00	0.95	0.90	-0.43
car	-0.31	-0.18	0.93	0.83	0.75	0.93	-0.88	0.94	0.94	0.95	1.00	0.91	-0.40
tcd	-0.46	-0.31	0.89	0.72	0.59	0.94	-0.85	0.91	0.93	0.90	0.91	1.00	-0.36
ken	-0.09	0.05	-0.26	-0.33	-0.40	-0.40	0.40	-0.39	-0.44	-0.43	-0.40	-0.36	1.00

m equation t-ratios

	ben	bfa	civ	sen	tgo	mli	ner	cmr	cgo	gab	car	tcd	ken
ben	0.00	-0.72	-3.21	-1.07	-0.29	-2.37	1.79	-1.73	-1.79	-2.11	-1.75	-2.71	-0.49
bfa	-0.72	0.00	-0.54	0.00	0.08	-1.56	1.22	-1.81	-1.58	-1.70	-0.98	-1.71	0.28
civ	-3.21	-0.54	0.00	7.66	5.34	10.20	-9.50	12.67	12.33	12.36	13.66	10.08	-1.43
sen	-1.07	0.00	7.66	0.00	6.40	5.64	-5.48	7.85	6.67	6.83	7.81	5.52	-1.85
tgo	-0.29	0.08	5.34	6.40	0.00	4.97	-4.11	5.30	5.27	4.78	5.99	3.82	-2.30
mli	-2.37	-1.56	10.20	5.64	4.97	0.00	-8.74	11.06	11.48	12.85	13.75	14.19	-2.34
ner	1.79	1.22	-9.50	-5.48	-4.11	-8.74	0.00	-10.33	-11.82	-9.78	-9.99	-8.36	2.29
cmr	-1.73	-1.81	12.67	7.85	5.30	11.06	-10.33	0.00	14.70	17.55	14.22	11.64	-2.24
cgo	-1.79	-1.58	12.33	6.67	5.27	11.48	-11.82	14.70	0.00	16.00	14.51	12.95	-2.58
gab	-2.11	-1.75	12.36	6.83	4.78	12.85	-9.78	17.55	16.00	0.00	15.57	11.25	-2.50
car	-1.75	-0.98	13.66	7.81	5.99	13.75	-9.99	14.2	14.51	15.57	0.00	11.40	-2.34
tcd	-2.71	-1.71	10.08	5.52	3.82	14.19	-8.36	11.64	12.95	11.25	11.40	0.00	-2.06
ken	-0.49	0.28	-1.43	-1.85	-2.30	-2.34	2.29	-2.24	-2.58	-2.50	-2.34	-2.06	0.00

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