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# Determinants of Inflation among Franc Zone Countries in Africa

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Despite belonging to a monetary union with a common currency and pooled foreign reserves, the countries of Africa's franc zone (CFA) experience substantially different inflation rates, especially in the short run. This is partly explained by the fact that for primary exporters in general, and for CFA zone members in particular, the volatility of commodity prices implies a high variance in government revenues.

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This paper—a product of the Public Economics Division, Policy Research Department—is part of a larger effort in the department to study structural adjustment in Sub-Saharan Africa. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Carlina Jones, room N10-063, extension 37699 (September 1993, 45 pages).

Despite belonging to a monetary union with a common currency and pooled foreign reserves, the countries of Africa's franc zone (CFA) experience substantially different inflation rates, especially in the short run.

Boccara and Devarajan develop a model of inflation differentials for the franc zone countries based on behavioral differences in fiscal policy responses to fluctuations in the price of the main export commodity. The model is based on the fact that for primary exporters in general, and for CFA zone members in particular, the volatility of commodity prices implies a high variance in government revenues.

The model identifies two effects: a monetary effect (commodity booms imply a surge in foreign reserves which, if unsterilized, is inflationary) and a fiscal effect (higher government revenues are, to varying degrees, accompanied by a marked increase in the level of spending, which is again inflationary).

The fiscal relationship is the key behavioral equation of the model, as the other relationships are essentially derived from accounting identities.

Boccara and Devarajan empirically test the model for Côte d'Ivoire. It tracks quite well the inflationary cycle that Côte d'Ivoire experienced after the boom in coffee prices in 1975–76.

Since the countries are in a monetary union, if some countries have expansionary fiscal policy (and thus inflation) the others must take a more contractionary fiscal stance. One issue for future research is what determines whether a member country has the freedom to follow an expansionary fiscal policy or whether it must contract because other members have already expanded. A discussion of potential "games" played by countries in a monetary union may shed light on these issues.

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**DETERMINANTS OF INFLATION AMONG FRANC ZONE COUNTRIES IN AFRICA**

by

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and

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The Franc zone in Africa is a unique institution in the developing world. Thirteen sovereign countries are engaged in two monetary unions with France. Membership in the union involves pooled foreign reserves, a common currency (whose convertibility is guaranteed by France) and a fixed exchange rate with the French Franc. There are no foreign exchange implications for currency flows among members of the Franc zone.

Membership in the Franc zone has provided countries with a substantial amount of monetary discipline. In particular, the inflation rates in these countries are much lower than in other developing countries (see Table 1).

**Table 1: Average Annual Inflation**

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	1973-81	1982-89
CFA	12.0	4.3
Other:		
Sub-Saharan African	24.3	29.7
Low-income LDC's	18.4	33.3
Primary Producers LDC's	24.4	44.9

Note: Unweighted averages  
Source: Devarajan and de Melo [1991]

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In addition to lower overall inflation, one would expect little difference among inflation rates within the zone. Perfect capital mobility between the countries implies convergence of real interest rates, and thus of inflation rates if nominal interest rates are aligned (in the absence of country-specific risk premia). In practice, however, capital movements within the CFA zone are restricted and the interbank market is not sufficiently developed to enable perfect

arbitrage among various financial instruments<sup>1</sup>. Thus, and in spite of the fact that labor mobility is very high between the CFA countries, there can still be inflation differentials among member countries of the CFA zone (see Table 2).

**Table 2: Inflation within the CFA Zone**

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	1983	1984	1985	1986	1987
Burkina	8.4	4.9	6.9	-2.6	-2.6
Cote d'Ivoire	5.9	4.3	1.9	6.6	5.3
Mali	9.8	12.4	7.8	-3.9	-16.7
Niger	2.5	8.5	-1.0	-3.2	-6.8
Senegal	11.7	11.8	13.0	6.0	-4.3
Togo	8.2	-3.5	-1.8	3.2	-0.6

Source: Direction de la Statistiques des Etats  
Banque de France

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This paper analyzes inflation differentials in the Franc zone. In Section I, the existence of inflation differentials is verified by analyzing and conducting tests on the data. Section II develops a model of inflation in the CFA countries which incorporates important institutional aspects of the zone. In Section III, we test the model empirically and conduct a simulation.

The main conclusion is that inflation differentials can be explained by the choice of

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<sup>1</sup>For example, transferring funds to France is subject to fees and often involves substantial delays. Also banks themselves do not act as intermediaries between regions where there is a shortage of funds and regions where there is a surplus.

adjustment policies made by member countries of the monetary union. More specifically, given the countries' reliance on primary exports, the differences in inflation rates reflect different fiscal policy responses to changes in the international price of the main export commodity. We show that the changes in the export commodity prices have important effects on the domestic price level and therefore on the real exchange rate. Thus, a commodity boom will translate into inflation through a monetary effect (due to the unsterilized increase in foreign reserves) and through a fiscal effect (due to increased government spending, especially investment).

## **I. INFLATION DIFFERENTIALS IN THE FRANC ZONE**

In this section we evaluate whether there are inflation differentials in the CFA zone. We test whether there are long-run relationships in price levels and inflation rates between the two unions, France and in the CFA countries and among countries in the Western (BCEAO) and Central (BEAC) monetary unions.

First, unit root tests are performed for each price level<sup>2</sup>. We use an augmented Dickey-Fuller test (with two lags) which is based on least squares estimation of the following

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<sup>2</sup>Data consist of yearly observations (all between 1960 and 1988) ranging from 29 observations for France and Burkina Faso to 23 for Senegal and 21 for Cameroon.

regression equation

$$\Delta X_t = \beta X_{t-1} + \sum_{j=1}^{j=p} \gamma_j \Delta X_{t-j} + \varepsilon$$

where the null hypothesis,  $H_0 (\beta = 0)$  is no stationarity. The regression equation above is run for the price levels and the logarithm of the price levels and for the first two differences of these variables. As documented in Engle and Granger (1987), the distribution of the t-statistic for the coefficient  $\beta$  is non-standard. The 99 (respectively 95) percent confidence level for rejection of non-stationarity is 3.77 (respectively 3.17). Tests for higher order stationarity are only relevant if all the lower order stationarity tests fail. The results show all price levels and their logarithms to be I(2) (second-order stationarity) except for Burkina Faso for which we have first-order stationarity (and therefore, a stationary inflation rate).

Next, cointegration tests are performed for price levels which have the same order of integration. The test, following Engle and Granger (1987), is an augmented Dickey-Fuller

test on the residual of the cointegration equation

$$y_t = \beta x_t + c + \epsilon_t$$

where  $x_t$  and  $y_t$  are the variables for which cointegration is tested and  $c$  is a constant. Table 3 shows the results of the cointegration tests which are conducted between France and the two most important countries of each of the unions, Côte d'Ivoire (which accounts for 38 percent of BCEAO GDP) and Cameroon (which accounts for 60 percent of BEAC GDP), between Côte d'Ivoire and Cameroon, between BCEAO countries (excluding Burkina Faso) and Côte d'Ivoire and, between BEAC countries and Cameroon. Cointegration is always rejected except between France and Côte d'Ivoire and between Senegal and Côte d'Ivoire.

In sum, there is evidence of inflation differentials among the Franc zone countries in Africa. This can be seen in Figures 1 - 4, which plot inflation rates among various combinations of CFA countries and France. Although Honohan (1990) rejected cointegration between the French and CFA zone price levels, he nevertheless argued for inflation convergence based on his principal components analysis. This analysis showed that half of the variance of the zone members' inflation rates could be explained by a common factor (the principal component). Honohan (1990) then assumed this factor was French inflation. Since the principal component analysis only accounted for half the variance, it is worth investigating what might explain the other half. Furthermore, the convergence of inflation rates described by Honohan (1990) is a long-run phenomenon. We are interested in explaining inflation differentials in the short-run. We turn therefore to a model which

interprets these differences in terms of fiscal policy responses to commodity price booms.

## II. A MODEL OF INFLATION DIFFERENTIALS IN THE FRANC ZONE

The starting point of our analysis is the definition of the price level in a CFA country as:

$$P = P_M^\alpha P_N^{(1-\alpha)},$$

where  $P_M$  is the domestic price of imports,  $P_N$  is the domestic price of all other goods consumed in the economy, and  $\alpha$  the share of imports in consumption.

Thus, the inflation rate is a weighted average of the inflation rates of nontradables and imported goods. The domestic price of imports, in turn, is equal to the nominal exchange rate multiplied by the world price (absent any trade taxes.) Since the nominal exchange rate in a CFA country is fixed, domestic policymakers have little control over the price of imports. Furthermore, import prices are likely to move in tandem across CFA countries, so that this component will not explain inflation differentials. Hence, the focus of our investigation will be movements in  $P_N$ . Recall that we classify as "nontradables" all goods in the consumption basket which are not imported. We therefore include import substitutes. This is justified by the fact that, in most of these countries, domestically produced goods are only imperfect substitutes for imported goods. Consequently, domestic prices of substitute goods are determined by domestic demand and supply conditions, rather than by the world prices of imported goods. In what follows, we present a model of how  $P_N$

is determined in a fixed-exchange rate regime that is subject to periodic shocks in its external terms of trade.

Most of the member countries of the zone are dependent upon exports of primary commodities for foreign exchange. These commodities are also the main source of government revenues, as the government sets the producer price below the world market price, with the difference accruing to a marketing board. A surge in the world price of this commodity has two effects. The first can be called the fiscal effect: the commodity boom is accompanied by a surge in government expenditures which often continues in spite of the subsequent decline in the price of primary commodities. The second can be called the monetary effect: the pooling of reserves and the maintenance of a fixed exchange rate result in incomplete sterilization of the foreign exchange. The domestic money supply rises following the boom. Fluctuations in commodity prices, through these effects, ultimately cause changes in the domestic price level.

## 2.1 Specifying the Model

It is assumed that there are three goods in the economy: a primary commodity C which is not consumed domestically, imports M and nontradables N.

The notation used is the following:

$A_t$  = productivity variable;

- $H_t$  = nominal money;  
 $R_t$  = nominal net foreign assets in CFA francs;  
 $Cr_t$  = total domestic credit;  
 $Z_{1t}$  = nominal net foreign transfers in CFA francs;  
 $Z_{2t}$  = nominal capital account in CFA francs;  
 $P^{C*}_t$  = international price of main export commodity;  
 $P^{M*}_t$  = foreign price of imports;  
 $P^M_t$  = domestic price of imports;  
 $T_t$  = nominal government revenues;  
 $G_t$  = nominal government expenditures (including investment);  
 $G_{1t}$  = nominal government expenditures (excluding investment);  
 $\tau^C_t$  = tax rate on commodity exports;  
 $\tau^M_t$  = tax rate on imports;  
 $E_t$  = nominal exchange rate defined as CFA francs per dollar;  
 $P^N_t$  = domestic price of nontradables;  
 $P_t$  = domestic price level.

$A_t$ ,  $Z_{1t}$ ,  $Z_{2t}$ ,  $P^{C*}_t$ ,  $P^{M*}_t$ ,  $\tau^M_t$  and  $E_t$  are exogenous while the remaining 10 other variables are endogenous. All Greek letters represent parameters of the model. For any

variable  $x$ ,

$$\hat{x} = \frac{\frac{dx}{dt}}{x}$$

A dependent economy model for the CFA countries is proposed and empirically tested in Devarajan and de Melo, (1987). Their model focuses on the adjustment needed in real variables to correct an external deficit. It ignores monetary aspects and treats government spending as exogenous. It is shown that alternative assumptions about the labor market (full employment or real wage rigidity) do not alter the qualitative nature of the results. Since our model aims at capturing the effects of fluctuations in export prices on domestic inflation (and thus, on the real exchange rate), labor market and wage behavior issues are also ignored and the nominal wage is assumed to be constant<sup>3</sup>.

The monetary side of the model is represented by equations (1) through (3) below.

$$\hat{H}_t = (1 - \omega)\hat{R}_t + \omega\hat{C}_t \quad (1)$$

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<sup>3</sup>We assume that the production of the exogenous level of the main export commodity requires a fixed amount of labor  $L_C$ . Denoting the labor force in the nontradables sector  $L_N$ ,  $L_C + L_N$  is the employment level. A model which analyzes the impact of the fluctuations of the international price of coffee for Colombia can be found in Edwards (1986). A common feature of that model and ours is that terms of trade changes affect the money supply.

$$\hat{C}r_t = \hat{R}_t \quad (2)$$

$$\hat{R}_t - \rho\hat{R}_{t-1} = \phi_1\hat{Z}_{1t} + \phi_2\hat{Z}_{2t} + \psi_1(\hat{P}_t^{C*} + \hat{C}) - \psi_2(\hat{P}_t^{M*} + \hat{M}) \quad (3)$$

Equation (1) comes from the balance sheet of the monetary authorities, namely, the identity that base money equals net foreign assets plus domestic credit. Thus, the percentage change in money is equal to a weighted share of the percentage change in net foreign assets and of the percentage change in domestic credit.

Equation (2) is the rule for domestic credit creation. The percentage change in domestic credit is assumed to be equal to the percentage change in net foreign assets since the balance of payments determines money in the absence of sterilization. In theory, this relationship only holds for the Franc zone as a whole since it corresponds to the monetary rules of the BCEAO and of the BEAC. The solvency rule for each of the two central banks states that the ratio of foreign reserves to all assets be limited from below or

$$\frac{R}{R + Cr} \geq r_0$$

Assuming the constraint to be binding, (i.e. the central bank issues as much credit as it can),  $R = r_0(R + Cr)$  always holds and we have R proportional to Cr, which is equation (2). In fact, some countries have obtained a proportionally greater share of credit while others had their allocation of central bank credit kept more in check. By including the zone-

wide rule in a country specific model of inflation, we are imposing an additional restriction which in turn enables us to identify more clearly the relationship between fiscal-policy responses to changes in commodities price and inflation.

Equation (3) comes from the log-differentiation of the equation defining nominal net foreign assets since

$$E_t R_t = E_t R_{t-1} + E_t (Z_{1t} + Z_{2t}) + E_t (P_t^{C^*} C_t - P_t^{M^*} M_t)$$

where  $C_t$  represents exports of the primary commodity and  $M_t$  represents imports. We have:

$$\rho = \frac{R_{t-1}}{R_t}, \phi_1 = \frac{Z_{1t}}{R_t}, \phi_2 = \frac{Z_{2t}}{R_t}, \psi_1 = \frac{P_t^{C^*} C}{R_t}, \psi_2 = \frac{P_t^{M^*} M}{R_t}$$

The fiscal side of the model is described as follows. Receipts from commodity exports are the main source of government revenues in these countries. As  $P^{C^*}$  increases, the government starts spending (e.g, new projects, increases in public employment or in public sector wages). The longer the commodity boom lasts, the more difficult it will be for the government to reverse its spending pattern since it faces policy reversal costs (which increase with the length of the commodity boom) such as disinvestment costs for ongoing projects and firing costs for the public sector labor force. Once there is a commodity bust, the government must decide whether or not to reverse its spending policy. If the policy reversal costs are high, the government will prefer to let the public debt build up. Once the debt

build-up costs exceed the policy reversal costs, the government will start reversing its spending policy. (See, Boccara, 1991 for a description of policy reversal costs and of other effects which characterize the environment in which fiscal policy decisions must be made.)

This discussion suggests the following equation to characterize fiscal policy:

$$\hat{G}_t = \sum_i \gamma_i \hat{P}_{t-i}^{C^*} + \zeta \hat{G}_{t-1} \quad (4)$$

The coefficients on  $P^{C^*}$ , and its lagged values characterize the extent of the government response to changes in commodity prices while the coefficient on  $G_{t-1}$  characterizes the inertia in the government's spending pattern<sup>4</sup>.

The percentage change in government revenues is equal to:

$$\hat{T}_t = \hat{E}_t + \mu(\hat{P}_t^{C^*} + \hat{\tau}_t^C + \hat{C}_t) + (1-\mu)(\hat{P}_t^{M^*} + \hat{\tau}_t^M + \hat{M}_t) \quad (5)$$

Equation (5) comes from the definition of trade taxes,  $T = E(\tau^C P^{C^*} C + \tau^M P^{M^*} M)$

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<sup>4</sup>Equation (4) does not differentiate between positive export commodity price shocks and negative export commodity price shocks. In practice, the reluctance to reverse a spending pattern would be observed only for the transition from a commodity boom to a commodity bust while the government would immediately readjust its spending pattern if there is a commodity boom. It can be argued that the observed behavior is consistent with a high prior for  $Prob(\text{commodity boom at } t | \text{commodity bust at } t-1)$  and a low prior for  $Prob(\text{commodity bust at } t | \text{commodity boom at } t-1)$ .

and we have

$$\mu = \frac{\tau^C P_i^{C*} C}{\tau^C P_i^{C*} C + \tau^M P_i^{M*} M}$$

The percentage change in the export tax for the export commodity is given by:

$$\hat{\tau}_i^C = \chi \hat{P}_i^{C*} + \chi \hat{E}_i \quad (6)$$

Equation (6) corresponds to the fixed producer price of the primary commodity export, so that all of the windfall gains from the price surge accrue to the government.

From

$EP^{C*}(1-\tau^C) = P^C = \text{constant}$ , we obtain equation (6) with

$$\chi = \frac{\tau^C}{1-\tau^C}$$

$\tau^M$  is assumed to be exogenous.

On the supply side, the production function for nontradables is assumed to be of

the form:

$$N_t = A_t \text{ Min } (f(k_t, L_N); \frac{M_t}{\beta}).$$

where  $f$  is a function (e.g. Cobb-Douglas) of  $k_t$  and of the employment level  $L_N$ . This assumes that a fixed amount of imported intermediate goods ( $\beta$  for each unit of nontradables) is necessary to the production process which otherwise uses domestic factors of production. Profit maximization can be written as:

$$\text{Max}_{L_{N,t}} [(P_t - \beta P_t^M) f(\bar{k}_t, L_{N,t}) - w_t L_{N,t} - r \bar{k}_t]$$

with the capital stock  $k_t$  fixed in the short run. The price that matters for production is

$$P_t' = P_t^N - \beta P_t^M$$

and we have

$$\hat{P}_t' = \lambda \hat{P}_t^N + (1-\lambda) \hat{P}_t^M$$

with

$$\lambda = \frac{P_N}{P_N - \beta P_M}$$

where  $\lambda$  is the share of value added in production. Percentage changes in the supply of nontradables are a function of percentage changes in the price  $P'$  and in the capital stock  $k$ , and therefore, we have:

$$\hat{N}_t = \text{function} (\hat{A}_t, \hat{k}_t, \hat{P}'_t)$$

We also have

$$\hat{k} = \hat{K} - \hat{P} = \frac{I}{K} - \hat{P}$$

where  $I$  is investment and  $K$  the nominal capital stock.  $K_t$  is related to past investment (i.e., lagged once). Any positive contribution to savings, either from foreign sources ( $Z_{2,t-1}$ ) or from domestic sources -- essentially public sector savings (i.e., primary surplus  $T_{t-1} - G_{1,t-1}$ ) -- contributes to capital formation. Incorporating the identity between savings and investment gives us the following equation:

$$\hat{N}_t = \hat{A}_t + v\left(\frac{Z_{2,t-1}}{K_t}\right) + v\left(\frac{T_{t-1} - G_{1,t-1}}{K_t}\right) - v\hat{P}_t + v'\hat{P}'_t$$

and finally,

$$\hat{N}_t = \hat{A}_t + v\left(\frac{Z_{2,t-1}}{K_t}\right) + v\left(\frac{T_{t-1} - G_{1,t-1}}{K_t}\right) - v\hat{P}_t + v'\lambda\hat{P}'_t^N + v'(1-\lambda)\hat{P}'_t^M \quad (7)$$

where  $\nu$  is the supply elasticity of capital for the production of nontradables and  $\nu'$  is the price elasticity of supply. Note that the coefficients for  $Z_{2,t-1}/K_t$  and for  $(T_{1,t-1}-G_{1,t-1})/K_t$  are equal since we do not differentiate among sources of savings when looking at capital formation.

On the demand side, we assume fixed spending shares of imports and nontradables. We have

$$V H_t = P_t^N N_t + P_t^M M_t$$

where  $V$  designates the constant velocity of money and we have substituted for absorption  $HV$ , using the quantity theory equation. Let  $\alpha$  designate the fixed spending share on imports. Then,

$$\alpha V H_t = P_t^M M_t, \quad (1-\alpha) V H_t = P_t^N N_t$$

Therefore, we have

$$\hat{M}_t = \hat{H}_t - \hat{P}_t^M \tag{8}$$

$$\hat{N}_t = \hat{H}_t - \hat{P}_t^N \tag{9}$$

We assume the quantity of commodity exports to be exogenously determined.

The domestic price level and the domestic price of imports are defined by

$$P_t = (P_t^M)^\alpha (P_t^N)^{1-\alpha}$$

$$P_t^M = E_t (1 + \tau_t^M) P_t^{M*}$$

Exports, other than the primary commodity for which domestic consumption is marginal, are excluded. Log-differentiating the equations above, we finally have

$$\hat{P}_t = \alpha \hat{P}_t^M + (1-\alpha) \hat{P}_t^N \quad (10)$$

$$\hat{P}_t^M = \hat{E}_t + \omega \hat{\tau}_t^M + \hat{P}_t^{M*} \quad (11)$$

with

$$\omega = \frac{1 + \tau^M}{\tau^M}$$

## 2.2 Estimating the Model

In what follows, we ignore changes in productivity. Combining equations (1), (2), (3) with equations (8) and (11), we can see that the growth rate of money at time  $t$  can be expressed as a function of the growth rate of money at time  $t-1$  and of the percentage

changes of exogenous variables at time t.

We obtain the following equation for the monetary side of the model:

$$\hat{H}_t = \left[ \frac{1}{1+\psi_2} \right] (\rho \hat{H}_{t-1} + \phi_1 \hat{Z}_{1t} + \phi_2 \hat{Z}_{2t} + \psi_1 \hat{P}_t^{C*} + \psi_2 \hat{E}_t + \psi_2 \omega \hat{t}_t^M) \quad (I)$$

Equation (4), the first equation of the fiscal side of the model, is repeated here for convenience. It expresses the percentage change in government expenditures at time t as a function of the percentage change in government expenditures as of time t-1 and of the percentage change at time t (including lagged values) of the international price of the main export commodity.

$$\hat{G}_t = \sum_i \gamma_i \hat{P}_{t-i}^{C*} + \zeta \hat{G}_{t-1} \quad (II)$$

Combining equations (5) and (6) with equations (8) and (11), we obtain the second equation of the fiscal side of the model:

$$\hat{T}_t = \mu(1+\chi) \hat{E}_t + \mu(1+\chi) \hat{P}_t^{C*} + (1-\mu)(1-\omega) \hat{t}_t^M + (1-\mu) \hat{H}_t \quad (III)$$

This equation shows that the percentage change in government revenues is a

function of the percentage change in exogenous variables at time t and of the growth rate money at time t.

Combining equations (9), (7) and (10), we obtain an equation for the percentage change in the price of nontradables:

$$\hat{P}_t^N = \left[ \frac{1}{1+v'\lambda-v(1-\alpha)} \right] \left( \hat{H}_t - v \frac{I_{t-1}}{K_t} + (v\alpha - v'(1-\lambda)) \hat{P}_t^M \right)$$

This corresponds to the reduced form for the price of nontradables which clears the market.

Combining the equation above with the price equations (10) and (11), we obtain the inflation equation of the model:

$$\hat{P}_t = \left[ \frac{1-\alpha}{1+v'\lambda-v(1-\alpha)} \right] \left( \hat{H}_t - v \frac{I_{t-1}}{K_t} \right) + F_1(\hat{E}_t, \hat{\tau}_t^M, \hat{P}_t^{M*}) \quad (IV)$$

where the function  $F_1$  is equal to:

$$\left[ \alpha + \frac{(1-\alpha)(v\alpha - v'(1-\lambda))}{1+v'\lambda-v(1-\alpha)} \right] (\hat{E}_t + \omega \hat{\tau}_t^M + \hat{P}_t^{M*})$$

We now have defined a system of four equations. Equation (I) corresponds to the

monetary side of the model; equations (II) and (III) correspond to the fiscal side; equation (IV) corresponds to the inflation side of the model.

This is a system of equation with 4 endogenous and 6 exogenous variables. A change in  $P^{C^*}$  at time  $t$  affects nominal money at time  $t$  and government spending for a number of periods equal to the number of lags in equation (II). Government revenues are in turn affected for only one period at time  $t$  by the change in  $P^{C^*}$  and by the change in nominal money. Inflation is a function of the change in nominal money at time  $t$  and of lagged investment, itself a function of lagged government revenues and government expenditures.

The equations above capture the link between the change in the international price of the main export commodity and the inflation rate. Since the Franc zone countries are in a monetary union with a common currency pegged to the French franc, the only adjustment in the real exchange rate (ignoring changes in import taxes) is through the domestic price level.

The difference in the adjustment experience of the CFA countries is naturally related to the choices of fiscal and monetary policies. The countries share a common central bank and the overall money supply is largely an exogenous variable. However, the distribution of the money supply, within the union, is left to the discretion of the central bank and is related to the fiscal policy adopted by each member country. Thus, the key behavioral difference between the member countries is their fiscal policy and more precisely the government's response to the fluctuations in the international price of its main commodity

export. For this reason, the model was specified with the same monetary rule for all the countries. In theory, as seen earlier, this monetary rule is only valid for the zone as a whole.

Whether in a commodity boom or bust, it is the fiscal side that governs the macroeconomics since the price of nontradables  $P^N$ , the only variable that can freely adjust in the Franc zone countries, is affected by government's demand for nontradables which in turn is a function of the fiscal response to the fluctuations in the international price of the main export commodity.

The essence of the model is that the behavioral differences in fiscal policy between the CFA countries are reflected in differences in inflation rate between these countries.

### **III. ESTIMATION AND SIMULATION RESULTS**

In this section we test empirically the model of inflation differentials by estimating it for one country, Côte d'Ivoire, and by conducting a simulation with the estimated parameters. Section 3.1 presents estimation results for a slightly modified version of the model presented in equations (I), (II), (III) and (IV). Section 3.2 describes the simulation.

### 3.1 Estimation Results

The data used for Côte d'Ivoire came from various sources, International Financial Statistics (IMF), African Economic and Financial Data (World Bank), and World Bank country reports. Variables for which we had several data sources were systematically checked for consistency. Excluding missing observations, the final data consists of yearly observations from 1970 until 1987. Three variables had to be constructed, capital K, an index of commodity export price PCOM and government revenues T.

The capital variable is needed since it appears in equation (IV). Relying on investment data, a time series for K was constructed starting in 1960<sup>5</sup> using an initial capital output ratio of 5 and a depreciation rate of 5 percent. Taylor, (1979) suggests as a rule of thumb a depreciation rate of 4% and a capital output ratio of 3. Since he was referring to developing countries as a whole, we use slightly higher figures for African countries.

The two main export commodities for Côte d'Ivoire are coffee and cocoa. PCOM is constructed as a weighted sum of the international price of coffee and of cocoa (whose movements are incidentally strongly positively correlated), the weights being the

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<sup>5</sup>K is built recursively as  
 $K_t = K_{t-1} (1-\delta) + I_t$  with  $K_{60} = 5 Y_{60}$ .  
Although estimation starts at 1970, we started the series in 1960 so that our final result would be less sensitive to the selected value for the initial capital output ratio. Several values of  $\delta$  were tried (3%, 5% and 7%) but did not modify the estimation results greatly.

quantity shares  $(Q_{cocoa}/Q_{cocoa} + Q_{coffee})$  and  $(Q_{coffee}/Q_{cocoa} + Q_{coffee})$ .<sup>6</sup> The quantity shares were obtained from African Economic and Financial Data.

Data on government revenues were constructed using data on government (current) expenditures and on the government's (primary) deficit available from World Bank documents.

Difficulty in obtaining reliable information on government expenditures and revenues prevented us from testing the model for a country other than Côte d'Ivoire. As one of the more advanced diversified coastal countries, Cote d'Ivoire's experience may deviate from that of a poorer, undiversified, landlocked country like Niger.

The modifications made to the original system given by equations (I) through (IV) are explained below.

First, it is assumed that there are no changes in the tax rate  $\tau^M$ <sup>7</sup> and equations (I), (III) and (IV) are modified accordingly by removing the corresponding terms.

Second, in equation (IV), the percentage change in nominal money at time  $t$  has

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<sup>6</sup>We use the fact that export revenues  $PQ$  are equal to  $P_1Q_1$  plus  $P_2Q_2$  which implies that  $P = P_1 (Q_1/(Q_1 + Q_2)) + P_2 (Q_2/(Q_1 + Q_2))$

<sup>7</sup>Data was unavailable for  $\tau^M$ .

been replaced by its one period lagged value since equation (IV) gave a better fit when the variable was replaced by its one period lagged value. Recall that the percentage change in money in equation (IV) comes from the log-differentiation of the demand side equations. These equations, in turn, are based on fixed spending shares and on the quantity theory of money. Therefore, specifying that total spending (between time t-1 and time t) on nontradables  $P_t^N N_t$  is equal to  $(1-\alpha)VH_t$  or to  $(1-\alpha)VH_{t-1}$  are equal approximations, since what is really required under our assumptions is an average of the money stock over the period between t-1 and t.

Finally, since investment data are available, equation (IV), can also be estimated using the investment figures (instead of computing investment as in equation (7)), directly. In that case, an equation defining government revenues is no longer necessary and equation (III) can be deleted from the system<sup>8</sup>.

In sum, the system of equation which is estimated is the following:

$$\hat{H}_t = \left[ \frac{1}{1+\psi_2} \right] (\rho \hat{H}_{t-1} + \phi_1 \hat{Z}_{1t} + \phi_2 \hat{Z}_{2t} + \psi_1 \hat{P}_t^{C*} + \psi_2 \hat{E}_t) \quad (I)$$

---

<sup>8</sup>Note that in both cases, keeping or deleting the equation from the system did not (as we would expect under the assumption that (III) is well-specified) modify in any significant way the coefficients from the remaining equation.

$$\hat{G}_t = \sum_{i=0}^{i=2} \gamma_i \hat{P}_{t-i}^{C*} + \zeta \hat{G}_{t-1} \quad (II)$$

or

$$\hat{G}_{2,t} = \sum_{i=0}^{i=2} \gamma_i \hat{P}_{t-i}^{C*} + \zeta \hat{G}_{2,t-1} \quad (II')$$

which is the same equation as above except that government expenditures  $G$  are replaced by government capital expenditures  $G_2$ ,

$$\hat{P}_t = \left[ \frac{1-\alpha}{1+v'\lambda-v(1-\alpha)} \right] (\hat{H}_{t-1} - v \frac{I_{t-1}}{K_t}) + F_t (\hat{E}_t, \hat{P}_t^{M*}) \quad (IV)$$

with  $F_1$  equal to

$$\left[ \alpha + \frac{(1-\alpha)(v\alpha - v'(1-\lambda))}{1+v'\lambda-v(1-\alpha)} \right] (\hat{E}_t + \hat{P}_t^{M*}).$$

The results obtained from the estimation by three-stage least squares are shown in Table 4 and in Table 4'. The results correspond to a final estimation for which insignificant variables that did not contribute to a better fit were deleted. In Table 4', the fiscal relationship is estimated with  $G_2$  instead of  $G$  (i.e equation (II') instead of (II)). In both cases, there is only one lagged term (in addition to the current term) for the percentage change in the index price of export commodities.

The results confirm the hypothesis that fiscal policy is driven by fluctuations in

the price of the main export commodity. The coefficient corresponding to percentage change (lagged once) in PCOM is significant. Without a lag, the percentage change in PCOM was found insignificant and this whether or not the variable lagged once is also in the equation. A two period lag structure did not improve the results and showed the percentage change in PCOM lagged twice to be insignificant (at least when the same variable lagged only once was also present in the equation). Estimation with  $G_2$  instead of  $G$  gave similar results in terms of fit and significance (i.e., the one period lagged change in PCOM is significant while it is not without a lag or with a two period lag). Furthermore, the change in government expenditures lagged once is no longer significant. The fact that lagged percentage change in  $G_2$  is no longer significant reinforces strongly our hypothesis since usually a one period lagged value of the independent variable is expected to be significant (unless there is lack of correlation in policy orientation between one time period and the next).<sup>9</sup> The significance of the lagged percentage change of  $G$  (which is equal to  $G_1$  plus  $G_2$ ) is explained by the fact that  $G_1$  (government consumption) responds much less to a change in the price of the export commodity than  $G_2$  (government investment) so that  $G$  and its one period lagged value are more correlated than  $G_2$  and its one period lagged value. Therefore, the imputed fiscal response to fluctuations in export commodity prices is explained mostly by the public sector investment response.

The results show that both lagged money growth and current percentage change

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<sup>9</sup>Note that we are not talking about  $G_2$  in level (i.e the policy variable itself) but about the percentage change in  $G_2$  (i.e the policy orientation from one period to the next).

in PCOM are significant in the money growth equation. The other variables which appear in equation (I) were all insignificant. The results indicate that changes in commodity export prices can have (through the unsterilized accumulation of foreign reserves) important effects on the money supply.

The results for the inflation equation show that investment, an indicator of fiscal policy, is significant. Other variables and in particular, the percentage changes in the exchange rate (in dollars per CFA) and in the international price of imports, are not significant.

Although money creation (lagged once) is insignificant, it becomes significant (whether or not it is lagged), regardless of whether one uses  $G$  or  $G_2$  in the fiscal relationship, if the inflation equation is estimated with investment proxied by  $Z_2 + T - G_1$  (as is done in the original model, see equation (7)). However, it is again insignificant if investment is proxied by  $G_2$  alone. The conditions under which different proxies can be used for investment are outlined in what follows.

Using the savings equal investment identity and a decomposition of investment by sources and of savings by sources, it can be shown that using the primary surplus  $G_1 - T$  plus  $Z_2$  as a proxy for investment is a valid assumption if private saving is close to zero. Using  $G_2$  as a proxy for investment is a valid assumption if private saving is essentially equal to government private borrowing and if foreign borrowing by the private sector is close to zero.

It can also be shown that using  $G_2$  plus  $Z_2$  (where  $Z_2$  is the nominal capital account) as a proxy for investment is a valid assumption if again private saving is essentially equal to government private borrowing and if foreign borrowing by the public sector is close to zero. All these assumptions are not necessarily in contradiction with each other. For example, whether public or private foreign borrowing can be assumed to be close to zero, depends upon whether public enterprises are considered to be in the public or in the private sector.

To summarize, the results conform well to the predictions of our model and are consistent with our explanation of inflation in a typical CFA country. They highlight the dependence of the economy of Côte d'Ivoire on its two export commodities: coffee and cocoa.

### **3.2 Simulation Results**

The results above have shown that changes in commodity export prices have important effects on the domestic price level (and hence, given the fixed exchange rate, on the real exchange rate). The purpose of the simulation exercise is to analyze the response of a typical CFA economy (or more generally a typical primary commodity exporter with a fixed exchange rate) to exogenous changes in the international price of its main export commodity.

The simulation scenario is that of a commodity boom followed by a commodity

bust. The international price of the main export commodity is the only exogenous variable allowed to vary in the simulation and all the other exogenous variables of the model are assumed to be constant. The simulation scenario does not correspond exactly to the actual behavior of the price of coffee (or that of cocoa) since there were two coffee (and cocoa) booms. Figure 5 shows the simulation scenario while Figure 6 shows the actual behavior of PCOM for Côte d'Ivoire.

As can be seen in Figures 7 and 8, the behavior of investment and of public capital expenditures are similar in Côte d'Ivoire<sup>10</sup>. Thus, equation (IV) is modified with investment proxied by public capital expenditures  $G_2$ . To be consistent,  $G_2$  is also used in the fiscal equation (i.e equation (II')) instead of (II)). Using  $G_2$  in the inflation equation (instead of investment) simplifies the simulation and emphasizes the key behavioral aspects of the economy reviewed above. Without  $G_2$ , an additional equation relating investment to fiscal policy would be needed as well as a specification of private and direct foreign investment (the latter can probably be considered as exogenous).

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<sup>10</sup>The scales of the figures are different. Thus, public investment appears to be a (constant) fraction of total investment. This would suggest that the behavior of the private sector, as far as investment goes, is similar to the public sector's behavioral response to fluctuations in the price of the main export commodity.

Thus, the simulation model is the following:

$$\hat{H}_t = \left[ \frac{1}{1+\psi_2} \right] (\rho \hat{H}_{t-1} + \psi_1 \hat{P}_t^{C^*})$$

$$\hat{G}_{2,t} = \sum_{i=0}^{t-2} \gamma_i \hat{P}_{t-i}^{C^*} + \zeta \hat{G}_{2,t-1}$$

$$\hat{P}_t = \left[ \frac{1-\alpha}{1+v'\lambda - v(1-\alpha)} \right] (\hat{H}_{t-1} - v \frac{G_{2,t-1}}{K_t}).$$

Note that the first two equations can be estimated (or simulated) independently since no other endogenous variable except the independent variable is included. This reflects the fact that a change in the price of the export commodity has, as has been explained earlier, a fiscal and a monetary effect (i.e., the first two equations of the simulation) which in turn translate into inflation.

Again it should be emphasized that the key behavioral equation of the model is the specification of fiscal policy. The remaining equations are essentially accounting identities which are written in the context of a primary commodity exporter in a fixed exchange rate regime. To stress this point, the simulation uses only the estimated parameters

for the fiscal equation while all parameters for the other equations are assigned "realistic" values independently. The values and the rationale for selecting them are given below.

In the monetary relationship the parameters selected are  $\psi_1 = \psi_2 = 2$  and  $\rho = 0.95$ . Since  $\psi_1$  ( $\psi_2$ ) is the ratio of exports (imports) to reserves, the underlying assumptions are balanced trade (at least in the long run) and that the central bank has enough reserves to cover six months of imports. A decrease in reserves would increase  $\psi_1$  and  $\psi_2$ .  $\rho$  is simply the ratio of reserves from one period to the next.

In the inflation relationship, the parameters selected are  $\alpha$  (share of imports including intermediate inputs in the consumption basket) = 0.25;  $\nu$  (supply elasticity of capital for the nontraded good) = 3;  $\nu'$  (supply price elasticity for the nontradable good) = 0.4 and  $\lambda$  (value added in production<sup>11</sup>) = 1.333.

Finally, in the fiscal relationship, the parameters used are the estimated values of a fiscal equation (with  $G_2$  as in (II')) which is part of a model for which  $G_2$  is used as a proxy for investment in the inflation equation. The parameters are  $\zeta = 0.198$ ,  $\gamma_0 = 0.227$  and  $\gamma_1 = 0.556$ .

Figure 9 shows the predicted public investment. It corresponds to a simulation

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<sup>11</sup>It was shown earlier that  $\lambda$  is equal to  $P_N / (P_N - \beta P_M)$ . With  $P_M = 1$  (numeraire) and  $\beta = 1/4$  (i.e. 0.25 unit of import needed for the production of each unit of domestic good), we get  $\lambda = 4/3$  or 1.333.

of the estimated fiscal equation and replicates the "hump" in public capital expenditures associated with a commodity boom followed by a commodity bust.

Figures 10 and 11 show actual and predicted inflation in Côte d'Ivoire. The simulation shows the increase in inflation during the commodity boom followed by a decrease during the commodity bust and a stabilization (with a minor increase) once commodity prices stabilize again. The predicted behavior is again consistent with the data. The differences in levels in the later periods may be attributed to the fact that the simulation scenario does not correspond to the exact values of the exogenous variables in Côte d'Ivoire.

To summarize, the simulation performs well and could be used for other CFA countries (or more generally countries whose economic structure is similar). Naturally, for the simulation to be more than the tool we use here to enhance the explanation of our model, it would be necessary to have forecasts of export commodity prices<sup>12</sup> and to know the fiscal parameters of a particular country. To get these parameters, one needs only to estimate the fiscal equation since it is independent of the rest of the system. It is also possible to use the simulation under different hypothetical fiscal responses. However, such an exercise is not meaningful since a plausible range for the magnitude of the fiscal equation parameters is not known. At the very least, we would need to estimate the fiscal equation for other CFA

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<sup>12</sup>Although the simulation can be used as a predictive measure of real exchange rate behavior under different scenarios.

countries<sup>13</sup>.

#### IV. CONCLUSIONS

In this paper, we first showed that, despite the monetary union and other extensive ties with France, a fixed exchange rate and substantial intra-zonal labor mobility, there are, at least in the short run, substantial inflation differentials across the countries of the CFA zone.

We next proposed a model of inflation differentials for the CFA zone. The model is based on the fact that for primary exporters in general, and CFA zone members in particular, the volatility in commodity prices implies a high variance of government revenues. The model identifies two effects: a monetary effect (commodity booms imply a surge in foreign reserves which, if unsterilized, is inflationary) and a fiscal effect (higher government revenues are, to varying degrees, accompanied by a marked increase in the level of public spending which again is inflationary). Although some countries get a proportionally greater share of the pooled reserves, our model ignores this<sup>14</sup> (by imposing on each country a constraint on the level of reserves which in fact is only valid for the zone as a whole) and attributes the differences in inflation across countries to the fiscal response. The fiscal relationship is the key behavioral equation of the model since the other relationships

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<sup>13</sup>Data on government expenditures (general and on capital) is unfortunately very unreliable and often inexistent altogether.

<sup>14</sup>The rationale for doing this is explained in Section 3.

are essentially derived from accounting identities.

The model is empirically tested for Côte d'Ivoire. The results show the key parameters to be statistically significant. The model is also simulated. The simulation exercise requires estimated coefficients from the fiscal relationship only since all the other parameters are selected independently. Therefore, once the fiscal behavioral response is known, the simulation provides a tool to analyze real exchange rate responses under different scenarios of fluctuations in export commodity prices. The simulation exercise shows that the path of inflation in Cote d'Ivoire can, indeed, be tracked by a model like ours.

The rationale for the fiscal behavior itself is left unexplained by the model (see, Boccara (1991) for an analysis of fiscal policy in primary commodities exporters). The typical fiscal response to commodity booms can hardly be considered as optimal. As stressed in Cuddington (1988), the expected response would be to limit the increase in expenditures to the perpetuity equivalent of the present value of the windfall gain. This would imply an increase in net savings in good times and reduction in net savings in bad times. This has, however, limited practical applications since it is often difficult to tell whether shocks are temporary or permanent.

Furthermore, since the countries are in a monetary union in which foreign reserves are pooled, it is necessary that if some countries have expansionary fiscal policy (and thus, inflation) that others take a more contractionary fiscal stance. Another issue for

future research is what determines whether a member country has the freedom to follow an expansionary fiscal policy or whether it must contract because other members have already expanded before. A discussion of potential "games" played by countries in a monetary union may help in understanding these issues.

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**Table 3. Cointegration Tests Results**

<b>Cointegration Tests Results for Price Levels (Augmented Dickey Fuller Statistic, 2 lags)</b>	
<b>France and major country of each zone</b>	
Côte d'Ivoire / France	Yes -3.56
Cameroon / France	No -1.49
<b>Major country of each zone</b>	
Côte d'Ivoire / Cameroon	No -1.65
<b>BCEAO countries</b>	
Niger / Côte d'Ivoire	No -1.41
Senegal / Côte d'Ivoire	Yes -3.49
Togo / Côte d'Ivoire	No -2.80
<b>BEAC countries</b>	
Gabon / Cameroon	No -1.71
Congo / Cameroon	No -1.19

**Table 4. Estimation Results (3SLS)**

**Equation 1 Fiscal Relationship**

Dependent Variable HG 17 Observations from 1971:1 until 1987:1		
	coefficient	t-statistic
HG_1	.528	3.71
HPCOM	.072	.65
HPCOM_1	.233	2.11
RBAR**2	.278	

**Equation 2 Monetary Relationship**

Dependent Variable HH 17 Observations from 1971:1 until 1987:1		
	coefficient	t-statistic
HH_1	.678	5.32
HPCOM	.281	3.14
RBAR**2	.216	

**Equation 3 Inflation**

Dependent Variable HP 17 Observations from 1971:1 until 1987:1		
	coefficient	t-statistic
HH_1	.114	.95
100* I_1/K	1.09	3.50
RBAR**2	.188	

*\_1 indicates a one period lag. Any variable whose label starts with an H (hat) is in percentage change. G is government expenditures, H is money, P the price level, PCOM the export commodity price index, I is investment and K capital.*

**Table 4'. Estimation Results (3SLS)**

**Equation 1 Fiscal Relationship**

Dependent Variable HG2 17 Observations from 1971:1 until 1987:1		
	coefficient	t-statistic
HG2_1	.233	1.16
HPCOM	.251	1.14
HPCOM_1	.541	2.50
RBAR**2	.20	

**Equation 2 Monetary Relationship**

Dependent Variable HH 17 Observations from 1971:1 until 1987:1		
	coefficient	t-statistic
HH_1	.671	5.53
HPCOM	.282	3.15
RBAR**2	.218	

**Equation 3 Inflation**

Dependent Variable HP 17 Observations from 1971:1 until 1987:1		
	coefficient	t-statistic
HH_1	.120	1.02
100* I_1/K	1.09	3.48
RBAR**2	.189	

*The notation is identical to that of Table 4. G2 is public capital expenditures.*

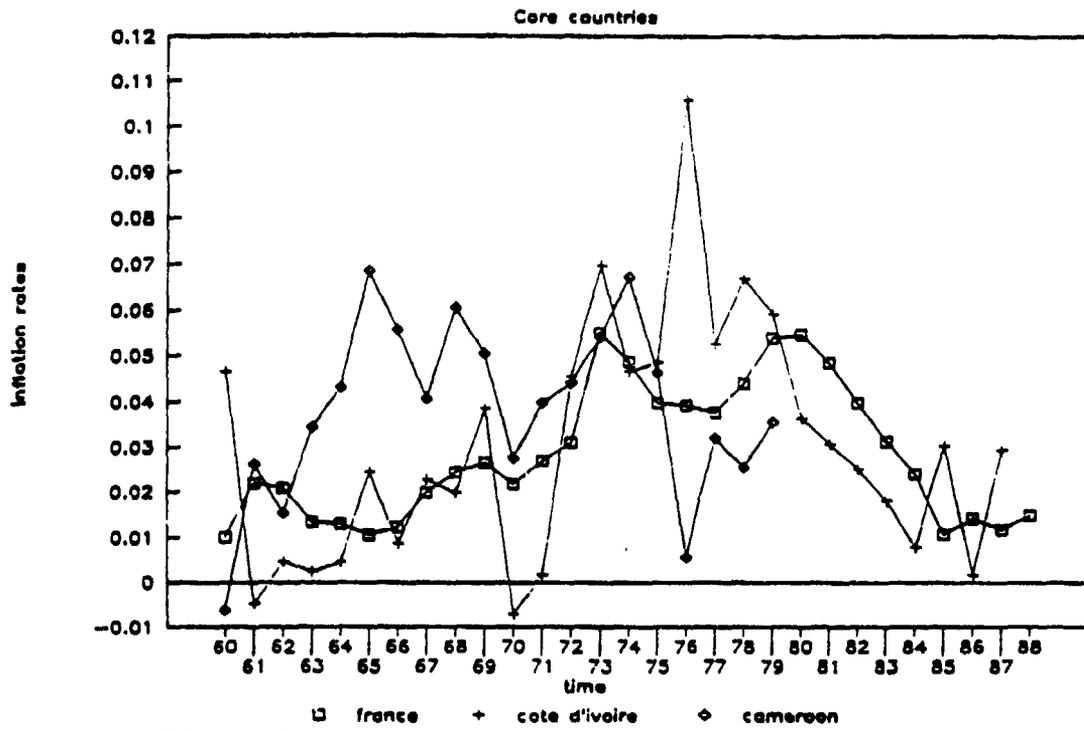


Figure 1

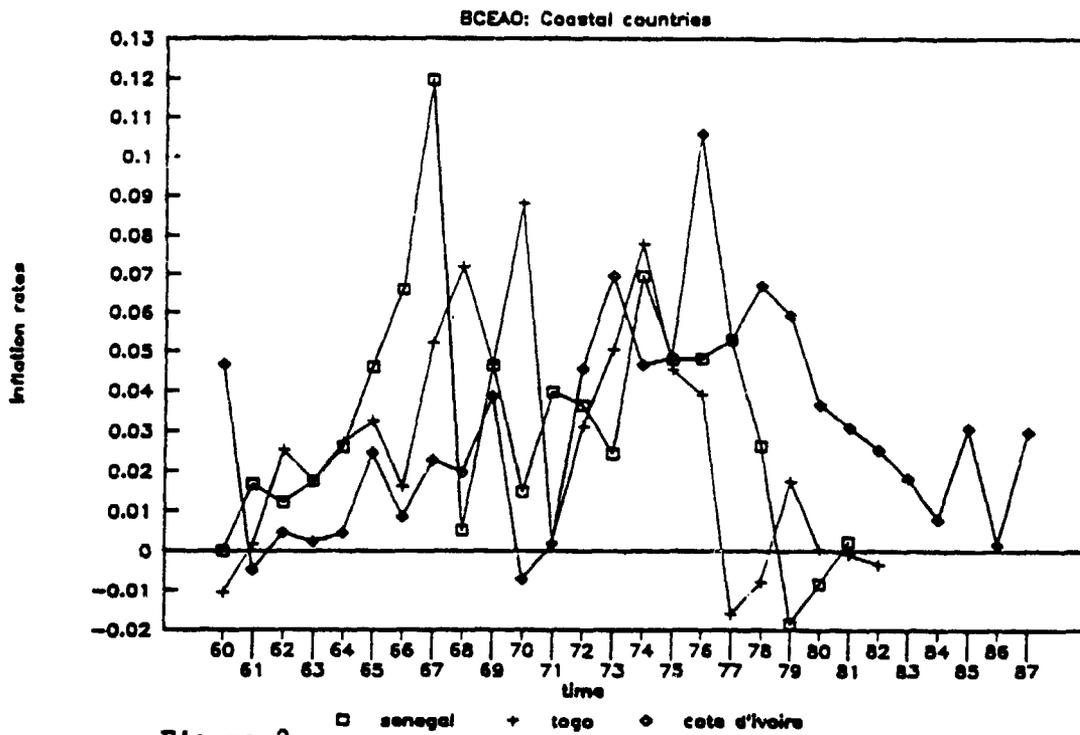


Figure 2

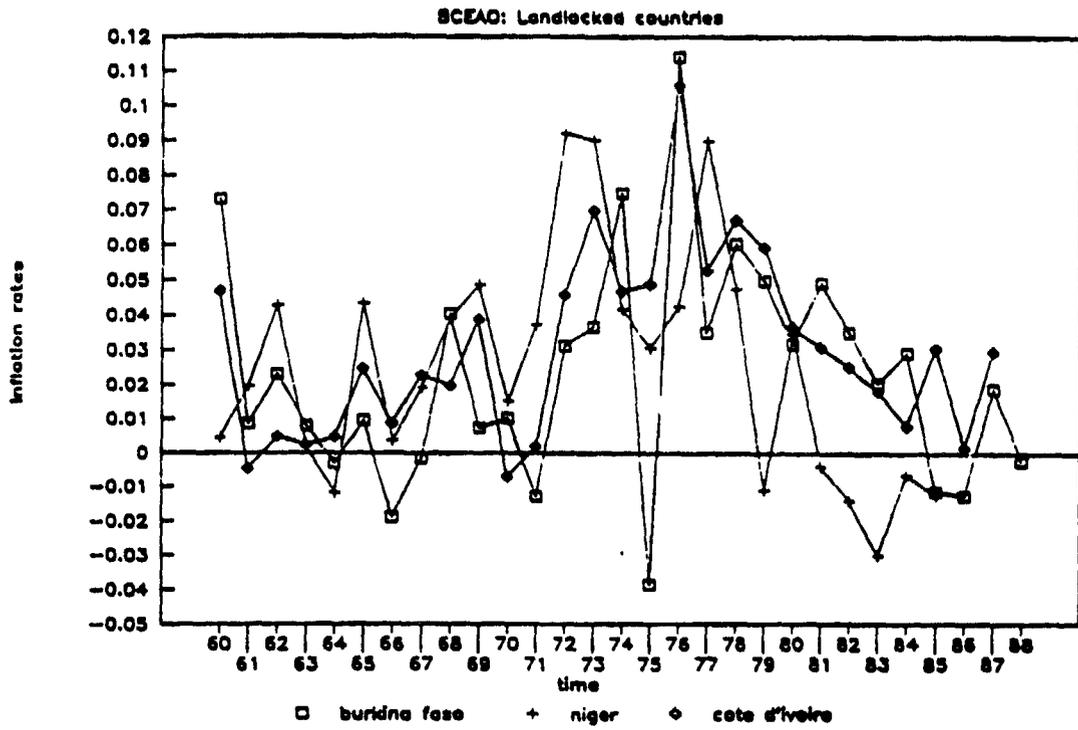


Figure 3

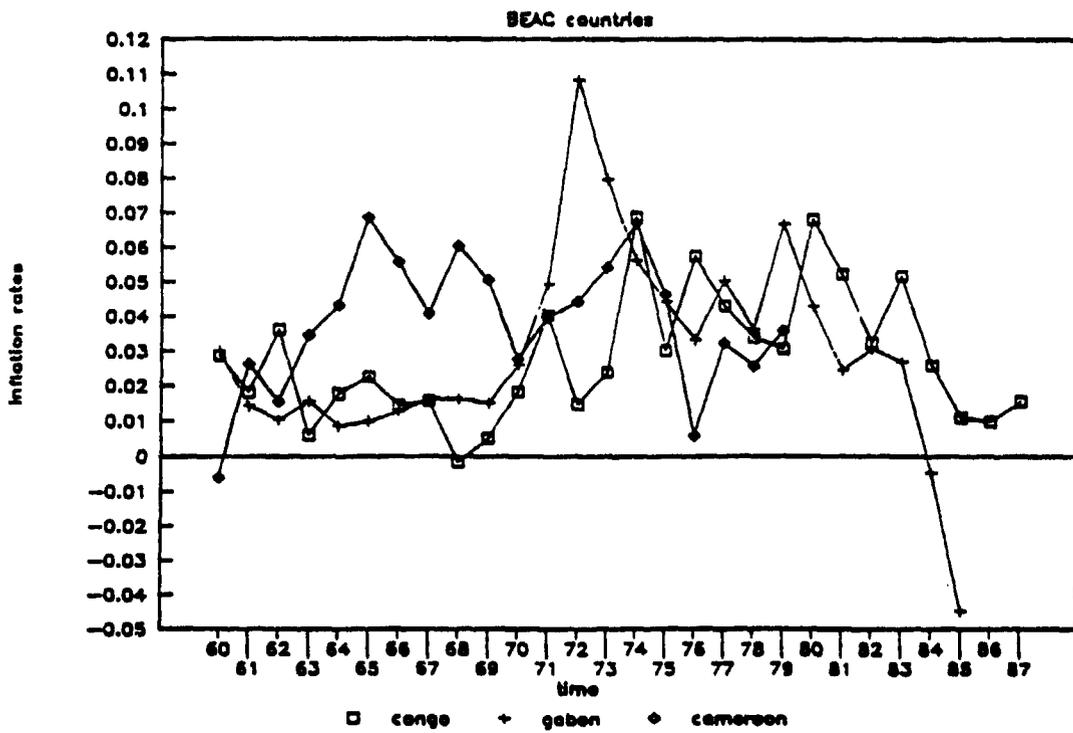


Figure 4

# Export Commodity Price

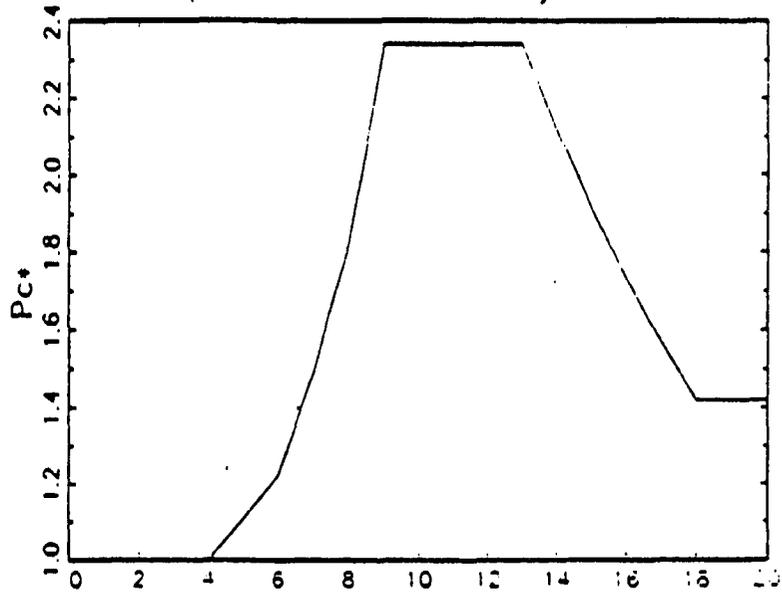


Figure 5  
Simulated Export Commodity Price

# Cote D'Ivoire

Foreign Price of Export Commodity, Pcom

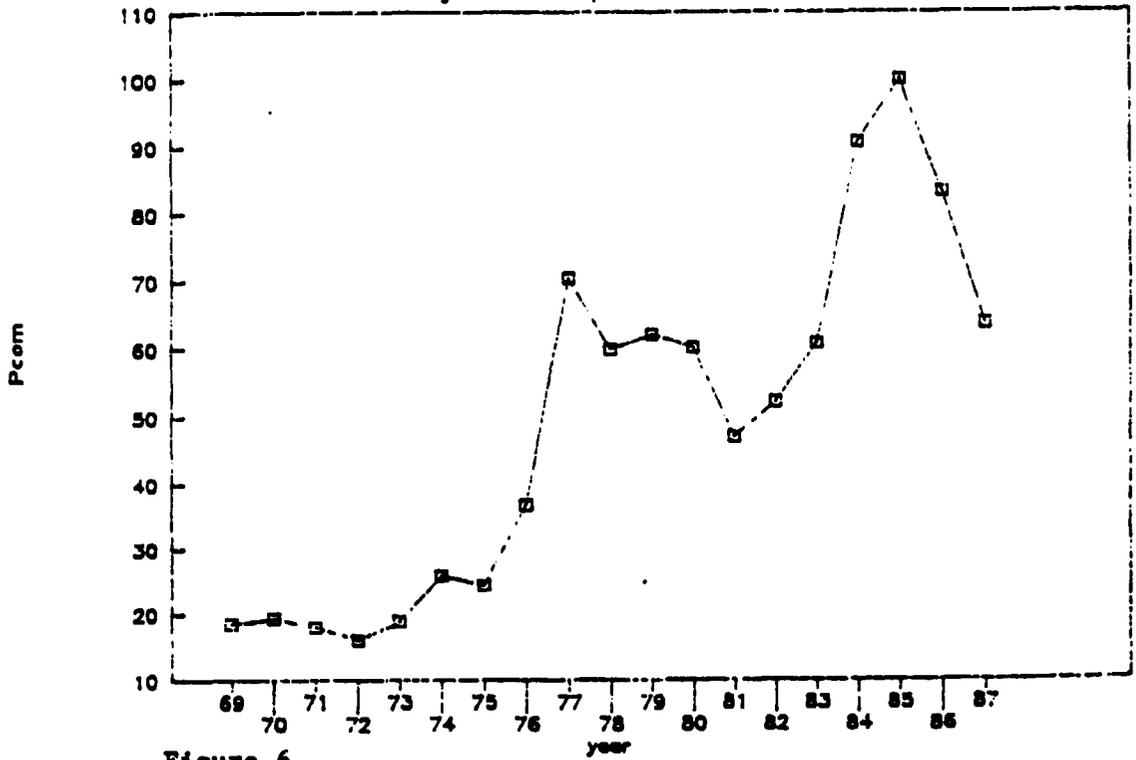


Figure 6

# Cote D'Ivoire

Investment I

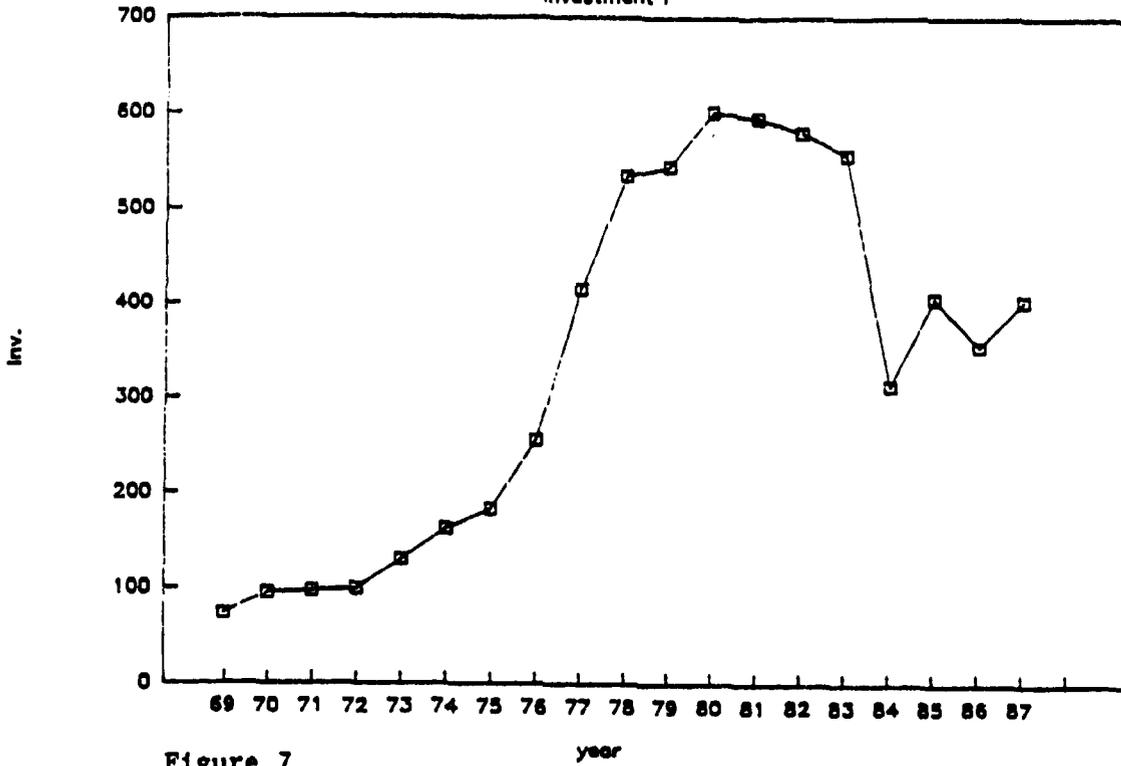


Figure 7

# Cote D'Ivoire

Govt. Investment Expenditure G2

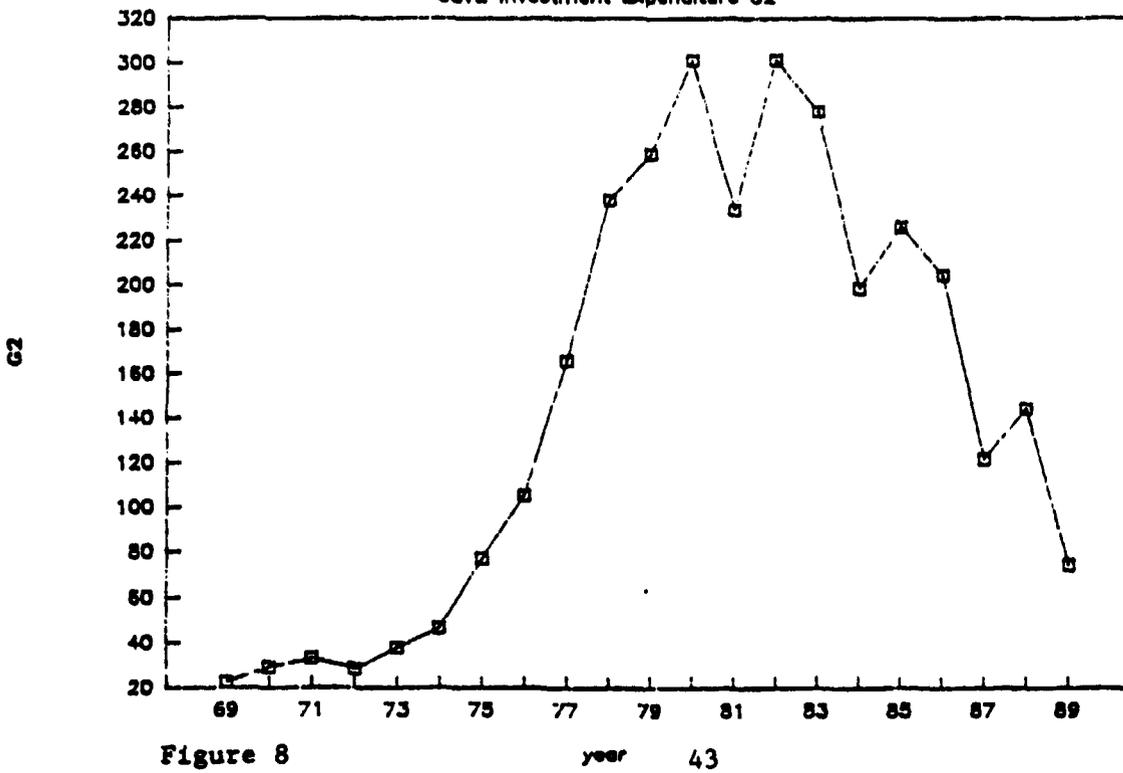
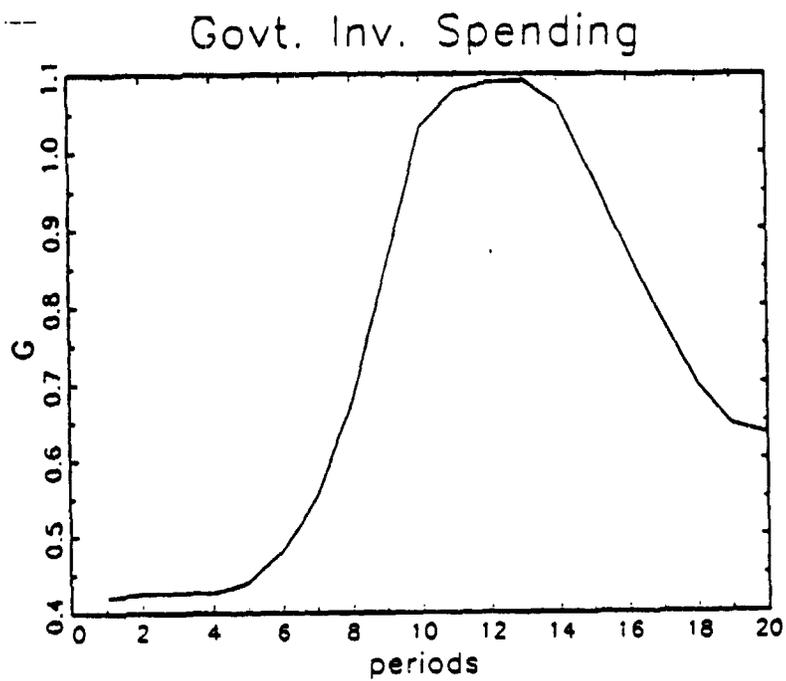


Figure 8



**Figure 9**  
**Simulation Results for Government Investment Spending**

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# Cote D'Ivoire

% Change in P (Inflation)

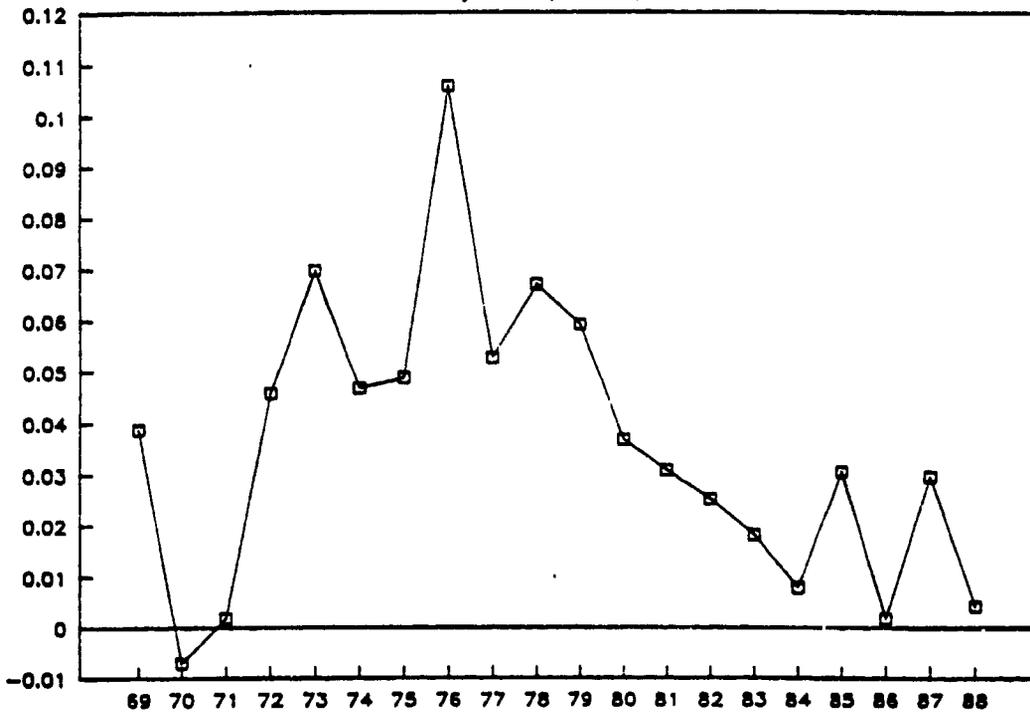


Figure 10

# Inflation

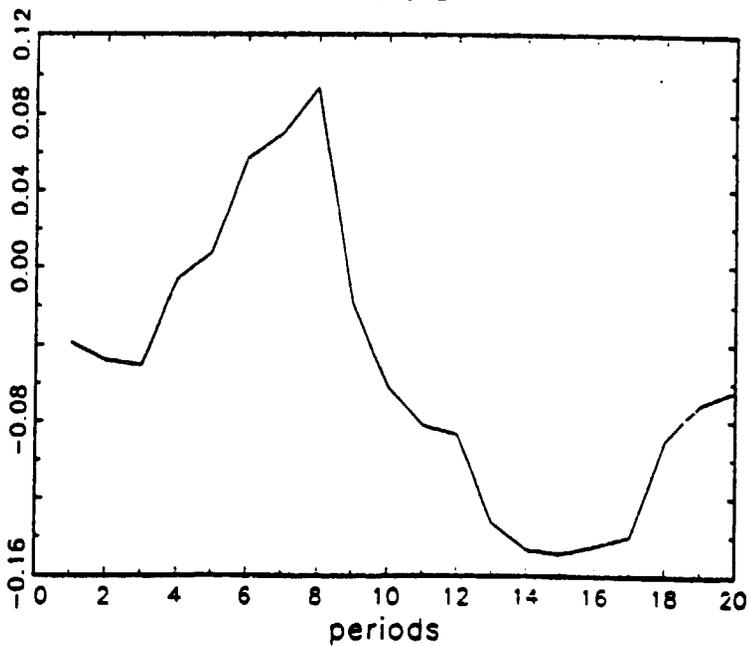


Figure 11  
Simulation Results for Inflation

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