IMPACTS OF MONETARY AND MACROECONOMIC FACTORS ON FOOD PRICES IN WEST AFRICA

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Abstract

After almost two decades of implementing structural and macroeconomic adjustment programmes, some West African countries continue to experience declining trends in per capita domestic food production, rising food imports and volatile food prices. Real food prices increased up to 7 percent per year during the 1980-1998 period. A vector error correction model was used in investigating the impacts of monetary and macroeconomic factors on food prices during the 1960-1998 period. Food price shocks have significant impacts on domestic food production, and are a major source of macroeconomic instability in West Africa. Trade, exchange rate and monetary policy reforms have significant impacts on food prices and domestic agricultural production. These policies influence consumption patterns, and have serious implications for poverty reduction, food security issues and agricultural growth in Africa.

1. INTRODUCTION

The high volatility of food prices is a concern to the general public and policy makers because such price movements are a deterrent to increased agricultural productivity and tend to intensify inflationary pressures. Food price volatility increases the uncertainty faced by farmers and agribusiness firms. In particular, price volatility affects farmer's investment decisions, which has serious ramifications for the growing farm debt, farm incomes and productivity. Extensive research efforts have been devoted to understanding the behaviour of food prices over the years (see for example, Hathaway, 1974; Belongia and King, 1983; Barnett, Bessler and Thompson, 1983; Kargbo, 2000). Retail food prices were more volatile in the 1970s than in earlier periods. The combination of oil price shocks experienced during the 1970s and 1980s, persistent droughts in some parts of Africa with reductions in global food supplies, and inflationary pressures triggered adjustments in the agriculture sectors of various countries (see Timmer, 1984; Cleaver and Donovan, 1995; Oden, 2003).

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Explanations for the rising food prices generally fall in two broad categories. First the Structuralists argue that real shocks in certain sectors of the economy raise the prices of food and other commodities. Eventually, these price increases are either accommodated or validated by increases in money supply, thereby, keeping upward pressure on prices of other goods. Roy and Darbha (2000) argue that the Structuralist perspective describes adequately the situation in developing countries, where price and output mechanisms are different across sectors and the existence of structural bottlenecks (e.g. low supply elasticities for agricultural products, foreign exchange constraints, and high price and wage indexation in the industrial sector) greatly influences the origins and persistence of inflation. Second, Monetarists argue that price increases are due to autonomous increases in money supply, and not just a reaction to accommodate real shocks in the economy.

The impacts of macroeconomic factors on the agricultural sector has received attention in several studies in the United States and other industrial countries (see for example, Schuh, 1974; Chambers and Just, 1982; Oden, 1986; 2003). The above studies provide evidence of significant linkages between real supply shocks, agricultural prices, exchange rates and international monetary reserves in the United States. Exchange rates, interest rates, and the level of money supply are key monetary variables that are determined mainly within domestic or international markets. Macroeconomic variables, including trade policy instruments on imports and exports are determined by domestic policy makers. These variables are viewed as exogenous to the agricultural sector. Other researchers, including: Van Duyne (1979) and Hathaway (1974) investigated an aspect of macroeconomic linkages to the agricultural sector that viewed the latter as a source of instability in the general economy.

We are interested in studying food price behaviour in West Africa because of the large increases in nominal food prices experienced by several countries in the region since 1980. Despite the implementation of structural adjustment programmes for almost two decades, some West African countries continue to experience declining per capita agricultural production, which raises food imports and food prices. Real food prices in some West African countries grew as much as 7 percent per year over the 1980-1998 period. Kargbo (2000) reported that real food prices in some eastern and southern African countries grew at the rate of 7-11 percent per annum over the 1980-1996 period. Declining per capita incomes along with annual growth rates in population that exceed those of agricultural production are common characteristics of some African countries.

The use of models that capture the impacts of both nominal and real price changes enhances our understanding of food price behaviour and effective policy formulation. We use annual data and a vector error correction model (VECM) in examining the relationships between macro price variables derived from food, monetary, exchange rate, fiscal and trade policies covering the 1960-98 period. The model identifies and evaluates the strength of the linkages between variables which enables us to trace the dynamic responses of variables in the system at different time horizons in reaction to specific shocks. This type of analysis is very useful from a policy perspective, and has gained wide applications in the economics literature (see Sims, 1980; Oden, 1986; Davidson and MacKinnon, 1993; Johansen, 2000; Kargbo, forthcoming). Past studies on structural adjustment programmes in Africa have not pursued this particular line of inquiry (see for example, Johnson, 1994; Kargbo, 2000; Jaeger and Humphreys, 1988). West Africa consists of some 20 countries. However, the availability of consistent data for the entire study period has forced us to focus our attention on Cote d'Ivoire, Ghana, Nigeria and Senegal. Cote d'Ivoire and Senegal are members of the CFA franc zone with extensive coordination of monetary policy between France and the zone's African member states (Hajimichael and Galy, 1997, Kargbo, 2003a,b; 2004).

The rest of the analysis in this paper is organized as follows: section two deals with the behaviour of food prices under macroeconomic adjustment programmes. Section 3 presents the model that outlines the relationship between food prices and other variables. The empirical results are presented in section 4, and the conclusions are in the final section.

2. FOOD PRICES UNDER MACROECONOMIC ADJUSTMENT PROGRAMMES

The implementation of macroeconomic (e.g. monetary, exchange rate and trade) policies by West African countries has tremendous impacts on food prices, real incomes of farmers, and the terms of trade between tradables and non-tradables. The reforms are a response to significant balance of payments problems experienced during the 1970s and early 1980s. Price reforms that target agricultural producers at the farm level and stabilization of food prices for consumers are key components of the macroeconomic adjustment packages (Kargbo, 2000; forthcoming; Jaeger and Humphreys, 1988). In particular, price reforms include the removal of price controls, subsidies on food prices and farm inputs, such as fertilizers and pesticides. As Dorward *et al* (2003) argued recently, these policies have serious implications for the reduction of poverty and increased agricultural growth in Africa. Figure 1

presents the behaviour of food prices and exchange rates in selected West African countries over the past four decades.

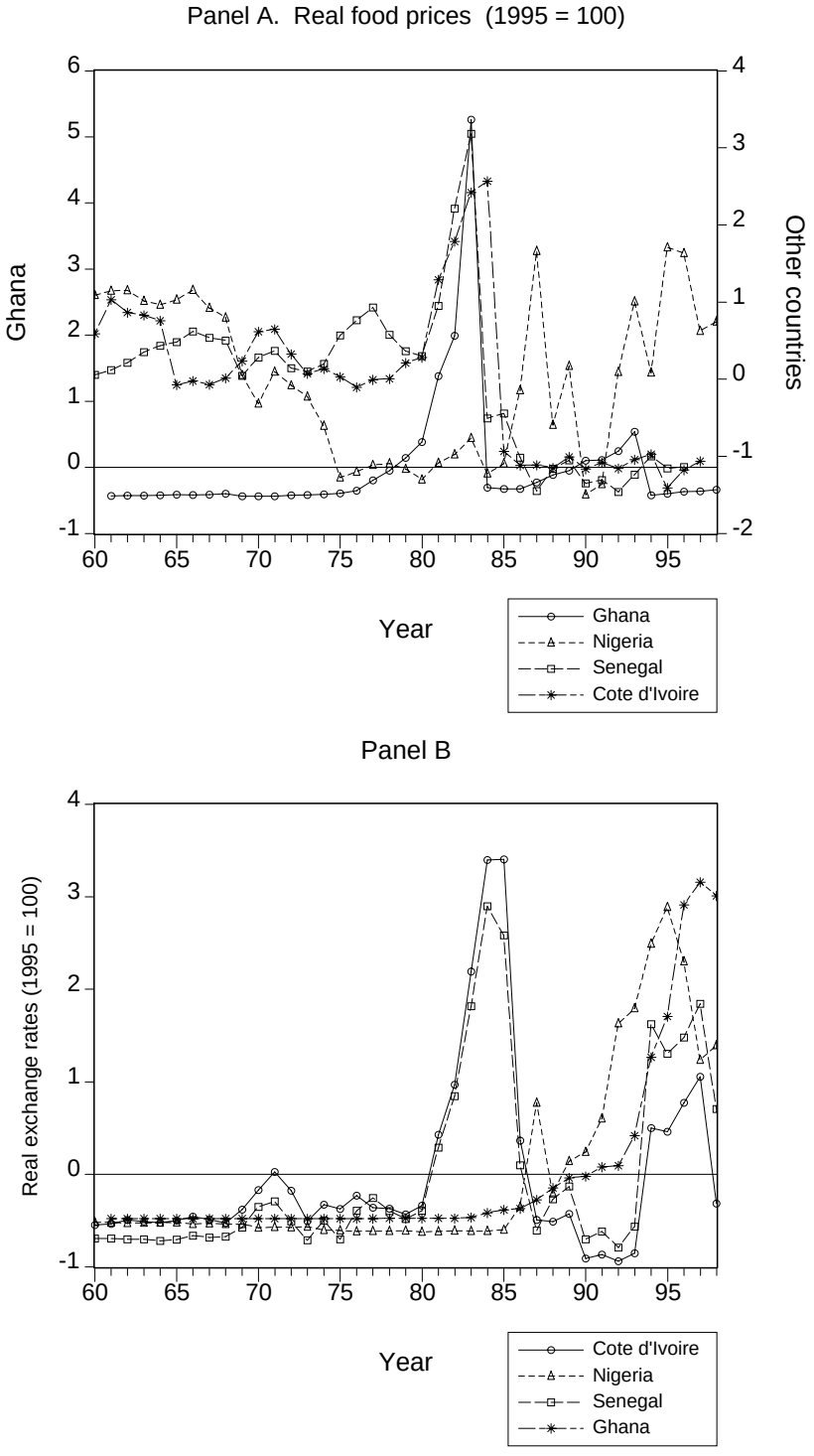

Figure 1: Real food prices and exchange rates in West Africa, 1960–1998

Even though real food prices declined significantly in Ghana, Cote d'Ivoire and Senegal; Nigeria experienced an annual increase of 7.1 percent over the 1980-1998 period (panel A).[1] The food prices in Panel A reflect the prevailing market prices since implementation of policy reforms has basically dismantled all price control agencies, and the boom in parallel markets show the futility of government control efforts over the years (Kargbo, 2000). The movement of the food component of the consumer price index (CPI) is different from that of the overall CPI. Food accounted for 30-73 percent of household expenditures in West Africa over the 1984-1997 period. Thus, food price increases have severe political implications because people buy food more frequently than any other item in the CPI. The non-food component of the CPI has increased significantly since the mid-1970s.

Food prices and inflation maintain a bilateral relationship as cost-push and demand-pull factors trigger adjustments in the economies. Tweeten (1980) argues that price shocks from oligopolistic non-agricultural sectors that are accommodated by an expansionary monetary policy cause inflation and puts the agriculture sector in a cost-price squeeze. Farmers in various parts of West Africa are becoming more dependent on purchased inputs (e.g. fertilizers, pesticides, machinery and labor) for agricultural production. The costs of farm inputs, along with costs incurred by agribusiness firms and individuals in the transportation, distribution and food marketing chain are rising. Such costs are passed onto farm products, thus, raising nominal food prices. Farmers respond to high food prices by increasing agricultural output to satisfy domestic food demands and increase exports to neighboring countries.

The behaviour of food prices present African policy makers with a problem that is not readily solved with traditional monetary and fiscal policies. Improvements in monetary and fiscal management is crucial during macroeconomic adjustment to restore balance in the current account and contain inflation. Moreover, the stabilization of macro prices is fundamental to the long-term restructuring of African economies. Whilst it s true that monetary policy has been more restrictive during policy reforms compared to the pre-reform period, clearly it has not been applied consistently. We use a broader measure of money (M2) in our analysis because the underdevelopment of domestic money/financial markets limits the impacts of discount rates and other monetary variables as instruments of monetary policy. According to the neutrality of money proposition, the quantity of money in circulation in the economy affects only the level of prices not output. However, money is not neutral in the short-run, thus, it stimulates production. The short-run non-neutrality of money is a basic feature of Keynesian monetary theory. It emanates from the proposition that, in an economy with

significant unemployment, prices and the quantity of money do not increase at the same rate. The resultant increase in the real quantity of money leads to a decline in interest rates, hence an increase in investment, level of income and output in the economy (Friedman, 1989).

Complementary monetary and fiscal policies are designed to sustain the impacts of exchange rate policies, in particular on relative prices. Exchange rates were fixed for prolonged periods in several West African countries, and inflation rates in some countries are generally higher than those of their major trading partners. Some studies, including World Bank (1986) and Kargbo (2000; 2003a,b; 2004) argued that the harmful impacts of inappropriate exchange rates on the economies, and resistance to devaluation during the 1960s through the early 1980s has led to the general consensus that domestic currencies were overvalued during this period. Figure 1, panel B shows the movements of real exchange rates in selected West African countries. The multilateral real exchange rate is a good proxy for measuring the external competitiveness of a particular country. Following the work of Edwards (1989), we use the formula below to construct the real exchange rate indexes:

$$MER_{kt} = \frac{\sum_{j=1}^{n} \alpha_j E_{jt} P^*_{jt}}{P_{kt}} \qquad (1)$$

where: MER_{kt} is the multilateral real exchange rate index in year *t* for country k, E_{jt} = index of the official nominal exchange rate between country *j* and country k in year *t*; α_j is the weight of partner *j* used in computing MER; P^*_{jt} = price index (wholesale price index, WPI) of partner *j* in year *t*, P_{kt} is the GDP deflator of the West African country for which the index is constructed, and j = 1, 2 ...., n refers to partner countries included in constructing the MER index. We used the top 10 trading partners for each country, and 1990 trade weights. These partners accounted for 71-78 percent of total trade for each West African country. Similar indexes constructed by the International Monetary Fund for the countries included in this study cover a shorter time period. An increase in the index implies real depreciation of the domestic currency, whilst a decline means appreciation of the local currency. Because of policy reforms, domestic currencies have depreciated significantly since the mid-1980s in Ghana and Nigeria; and following the devaluation of the CFA franc in Cote d'Ivoire and Senegal in January 1994. The depreciation of exchange rates have direct impacts on the agricultural sector by changing the prices of tradable and non-tradable goods, thereby changing the structure of prices in favour of the farmers.

Another indicator of exchange rate overvaluation is the black market premium, i.e. the percentage excess of the black market price of foreign currency over the official exchange rate. Black market activities for foreign exchange vary widely across African countries. According to various issues of the *World Currency Yearbook*, the average black market premia in Ghana, Nigeria and the CFA franc zone countries was 446.3, 87.3, and 3.4 percent over the 1960-1997 period, respectively. Kargbo (2003a; 2004) argues that the imposition of trade restrictions (e.g. tariffs and non-tariff barriers), capital and exchange rate controls facilitates the development of black market for foreign exchange to finance capital flight and portfolio decisions designed to hold foreign currencies as a hedge against political instability, high rates of inflation and other unforeseen circumstances in African countries. The overvaluation of exchange rates created a heavy tax burden on exports, rent seeking activities, and a huge parallel market for foreign exchange and other goods. Because of these distortions, exchange rate policies are very often the central focus of structural adjustment programmes. However, despite the implementation of these programmes for much of the past two decades, there is still no significant and sustained improvement in per capita domestic agricultural output and exports. In the short-run, cuts in government expenditures, such as removal of subsidies on farm inputs and food prices during adjustment programmes, coupled with increases in interest rates, result in reductions in capital investment needed to improve productivity in the domestic agricultural sector. Also, droughts, poor infrastructure and transportation networks, lack of credit facilities, and low investment in research and extension have all contributed to the volatility of food prices and slow increases (in some cases declining trends) in per capita domestic food production in West Africa. Food imports are increasing at the very time these countries are experiencing severe foreign exchange constraints and external debt burdens. Kargbo (forthcoming) reported that food import expenditures as a percent of total merchandise exports by West African countries ranged from 93 to 295 percent over the 1983-1996 period. Moreover, the debt-to-export ratios of West African countries were in the range of 109 to 1,150 percent in 1997. Budget pressures and policy shifts in donor countries reduces food aid to the region.

3. MODEL SPECIFICATION

Both monetary and non-monetary factors influence the behaviour of food prices in West Africa. Under competitive market conditions, equilibrium food prices are determined by the interaction of producers and consumers in the market. The relationship between market participants can be represented by a series of simultaneous equations representing supply, demand and equilibrium conditions. Let demand (Q_{dt}) = f (P_{ft}, Y_t, Z_t); supply (Q_{st}) = f(DP_t,

MER_t, $OPEN_t$, P_{ft}, P_{ft-s}). At equilibrium: $Q_{dt} = Q_{st} = P_{ft}$; where: P_{ft} is the real price of food , that is nominal food price deflated by GDP deflator. Y_t (measured as real per capita GDP) is real per capita income. DP_t is an index of per capita domestic food production, and it is affected by prices, technology, rainfall and other factors. MER_t is the real exchange rate, and Z_t represents other variables that influence demand. The subscripts: t = 1, 2, ..., n represents annual time periods, and s is the lag period. OPEN is an indicator for trade policy instruments, such as tariffs, quotas and export taxes in West African countries. Implementation of import-substitution and other restrictive trade policies contributed to the poor performance of the agriculture sector and high food prices in the region. Consistent data on tariffs and other taxes is lacking. It is difficult to construct a reliable series for trade policy over the estimation period due to pervasiveness of non-tariff barriers and parallel markets for goods and foreign exchange. Thus, OPEN is the ratio of the sum of exports and imports of goods and services over the country's GDP (Fajgenbaum *et al*, 2000).

An illusion-free individual is assumed to maximize his or her utility subject to a budget constraint, and is said to have demand functions that are homogenous of degree zero in prices and the quantity of financial assets, including money. Money supply and exchange rates enter the model by combining the theory of monetary equilibrium and exchange rate determination (see Dornbusch, 1984; Friedman, 1989). Let MV(r, Y)/P = Y; where: M is the nominal quantity of money demanded, assuming the money market is in equilibrium; V is the velocity of money and it is a function of interest rates (r) and other variables such as real income (Y); and P is the price level. We can rewrite the above equation as: P = MV(r, Y)/Y. Thus, an increase in M is expected to raise the price level in the same direction. Since food accounts for up to 73 percent of household expenditures in West Africa, P represents the price of food (P_f). The strict version of purchasing power parity states that domestic prices are equal to foreign prices (P*) converted at the exchange rate (e) - which is the domestic currency price of foreign exchange. Thus, P = eP*. Combining the above equations, we get: e = [(1/P*)V(r,Y)M]/Y. The equilibrium exchange rate is a function of nominal money, real output and velocity. Since policy reforms have been implemented for nearly two decades in West Africa, we argue that domestic prices are becoming fully flexible and are linked to world prices through the exchange rate. Food is imported to satisfy growing domestic demands.

From the above discussion, a six-variable vector error correction model (VECM) was specified. The variables included in the model were: real food prices (P_f), an indicator for trade policy (OPEN), real per capita income (Y), real exchange rates (MER), per capita domestic food production (DP), and the annual growth rate

(percentage change) of money supply (M2). We use growth rate of M2, instead of levels of the stock of money, to reflect its importance from the perspective of macroeconomic stability (World Bank, 2000:69).

The annual data for nominal food prices were obtained from various issues of the *Yearbook of Labour Statistics,* published by the International Labour Organization. Data for indexes of per capita domestic food production were from the FAO Agrostat data base. All other data series were from the World Bank Africa data base and various issues of the *International Financial Statistics Yearbook*, published by the International Monetary Fund.

4. COINTEGRATION AND VECM RESULTS

It is now a widely accepted fact that economic time series are generally nonstationary processes (Johansen, 2000; Davidson and MacKinnon, 1993). We used the Augmented Dickey Fuller (ADF) and Phillips-Perron tests in testing for the presence of unit roots. All tests were applied to the logarithm of each variable (except M2). The *Eviews 3.1* statistical package developed by Quantitative Micro Software (1998) was used in this study. The results of the unit root tests show that all the series are *I(1)* - meaning stationarity was achieved after differencing the series once. Due to space considerations, results of the unit root tests are not reported here but are available upon request.

Next, we performed cointegration tests with the Johansen and Juselius (1992) method designed to test the restrictions imposed by cointegration on the unrestricted vector autoregression (VAR) model. The VAR model is estimated with the method of full information maximum likelihood, and the procedure has the advantage of permitting the joint determination of variables in the system, it takes into account the short-run dynamics of the variables, whilst permitting the system of variables to return to long-run equilibrium. The variables to be tested can be written in vector error correction form as:

$$\Delta P_t = \sum_{i=1}^{k-1} \Gamma_i \, \Delta \, P_{t-1} \; + \; \prod P_{t-k} \; + \; D_t \; + \; \nu_t \qquad (2)$$

where: P_t is an m-dimensional vector of variables in the system, D_t refers to the matrix of deterministic variables, such as intercept and time trend, k is the number of lags, and v_t is the error vector, it is multivariate normal and independent across observations. According to the Granger representation theorem, if the coefficient matrix, $\mathbf{\Pi}$ has reduced rank $r < m$, then there exists m x r matrices $\boldsymbol{\alpha}$ and $\mathbf{\Phi}$ each with rank such that $\mathbf{\Pi = \alpha \Phi'}$ and $\mathbf{\Phi' P}$ is stationary (Engle and Granger, 1987). The elements of $\boldsymbol{\alpha}$ are called the adjustment parameters in the vector error correction model, and r is the cointegrating rank.

Each column of **Φ** is the cointegrating vector. We used the *likelihood ratio (trace) test statistic* for testing the hypothesis of at most *r* cointegrating vectors for each country. An alternative test statistic is the *maximum eigenvalue statistic*. See Johansen (2000) and the *Eviews 3.1 User's Guide* for details.

Table 1 presents the results of the cointegration tests. The Akaike Information criterion was used in choosing the lag order of the VAR. The results suggest there is a single cointegrating relationship between the variables in all countries, except Ghana which has 2 cointegrating vectors. The existence of more than a single cointegrating vector implies there are several equilibrium relationships that link the variables in the system, thus, forming an equilibrium sub-space. The higher the number of cointegrating vectors, the stronger the relationship between the variables in the system.

Table 1: Johansen cointegration test for selected West African countries

Country	Number of lags & DT	Hypo-thesized # of CE(s)	Eigenvalue	Trace (LR) test tatistic	5% critical value	1% critical value	Rank (r)
Cote d'Ivoire	1, CT	r = 0	0.761	124.188**	114.90	124.75	r = 1
N = 33		r ≤ 1	0.565	76.984	87.31	96.58	
		r ≤ 2	0.530	49.553	62.99	70.05	
		r ≤ 3	0.311	24.592	42.44	48.45	
		r ≤ 4	0.247	12.272	25.32	30.45	
		r ≤ 5	0.086	2.951	12.25	16.26	
Ghana	2, CT	r = 0	0.974	226.481*	114.90	124.75	r = 2
N = 35		r ≤ 1	0.650	99.07*	87.31	96.58	
		r ≤ 2	0.469	62.254	62.99	70.05	
		r ≤ 3	0.453	40.074	42.44	48.45	
		r ≤ 4	0.358	18.961	25.32	30.45	
		r ≤ 5	0.094	3.464	12.25	16.26	
Nigeria	2, C	r = 0	0.781	117.789*	94.15	103.18	r = 1
N = 34		r ≤ 1	0.495	66.153	68.52	76.07	
		r ≤ 2	0.464	42.876	47.21	54.46	
		r ≤ 3	0.352	21.652	29.68	35.65	
		r ≤ 4	0.155	6.895	15.41	20.04	
	-	r ≤ 5	0.034	1.160	3.76	6.65	
Senegal	1, CT	r = 0	0.805	139.653*	114.90	124.75	r = 1
N = 32		r ≤ 1	0.655	87.283	87.31	96.58	
		r ≤ 2	0.454	53.216	62.99	70.05	
		r ≤ 3	0.427	33.842	42.44	48.45	
		r ≤ 4	0.281	16.019	25.32	30.45	
		r ≤ 5	0.157	5.446	12.25	16.26	

Notes:
A constant (C), or constant and trend (CT) were included in each cointegrating equation (CE).
* Denotes rejection of the hypothesis at 1.0% significance level.
** Denotes rejection of the hypothesis at 5.0% significance level.
The number of lags were determined by minimizing the Akaike information criterion and Schwarz criterion.

Table 2 presents the normalized long-run parameters for variables in each country. There are parameter estimates for each cointegrating vector. Normalizations are on variables with the coefficient 1.000. As is generally expected, an increase in money raises food prices in Cote d'Ivoire and Senegal, whilst the implementation of trade policy reforms that open up the country to international trade would tend to lower real food prices. Increases in domestic food production lowered real food prices in Cote d'Ivoire and Nigeria. However, food prices increased with rising domestic food production levels in Senegal. This is probably because food production levels were rising from a very low base. An examination of the data shows that Senegal has experienced declining trends in per capita agricultural production during the past four decades.

Table 2: Vector error correction estimates for West Africa, 1964–1998

Country	Variables							
	P_f	M2	OPEN	Y	MER	DP	Constant	Trend
Cote d'Ivoire (1965-1997)a	1.000	0.044 (3.848)b	-1.619 (1.603)	-0.353 (0.713)	-0.117 (0.587)	-8.436 (2.364)	33.967	0.053 (3.388)
Ghana (1964-1998)	1.000	0.018 (3.062)	0.108 (0.343)	0.000	0.175 (0.966)	6.585 (8.347)	-36.860	-0.038 (2.822)
	0.000	-0.002 (2.837)	0.189 (4.600)	1.000	-0.164 (6.940)	-0.394 (3.831)	-3.625	0.012 (7.045)
Nigeria (1964-1997)	1.000	0.125 (1.480)	-7.673 (1.366)	-8.517 (1.368)	1.356 (1.303)	-26.697 (1.620)	159.450	--
Senegal (1965–1996)	1.000	0.011 (5.020)	-1.475 (13.372)	-0.022 (0.256)	-0.039 (0.805)	0.451 (3.279)	-8.484	0.040 (15.627)
Adjustment coefficients for Ghana								
(1)	-0.582 (2.097)	-6.939 (1.336)	-0.114 (1.486)	-0.089 (4.562)	-0.358 (1.893)	-0.042 (1.460)	--	--
(2)	-0.187 (0.218)	0.456 (0.028)	-0.549 (2.300)	-0.107 (1.773)	5.211 (8.879)	0.035 (0.382)	--	--

Notes:
a. Refers to estimation period.
b. Refers to absolute t-statistic.
-- Not available.
The coefficients normalized to 1 and others that are not identified do not have standard errors (see QMS, 1998, p 512). The numbers (1) and (2) refer to the 1st and 2nd cointegration equation, respectively.

The adjustment coefficients capture the changes in food prices and other variables required to remove past departures from the equilibrium levels.[2] Table 3 presents the short-run estimates and adjustment coefficients for countries with r = 1. Shocks to food prices trigger rapid adjustments towards equilibrium levels as more than 50 percent of the deviation from equilibrium is corrected within a year in Cote d'Ivoire and Senegal. All of the deviation from long-run equilibrium is corrected within a year in Nigeria. Real exchange rates and per capita income seem to bear the brunt of the adjustment towards

long-run equilibrium in Ghana, even though other variables did play a significant role (see Table 2).

Table 3: Short-run estimates of food price behaviour in West Africa

Variables	Country		
	Cote d'Ivoire (1964–1997)a	**Nigeria (1963–1998)**	**Senegal (1966–1996)**
Constant	0.072 (1.692)	-0.201 (2.109)	0.056 (0.901)
ΔP_f	0.576(-1)b (3.732)*c	0.591(-1) (3.277)*	0.063(-2) (0.531)
M2	-0.005(-1) (2.097)**	0.007(-1) (2.205)**	-0.009(-2) (1.891)***
ΔOPEN	1.267(-2) (2.904)*	-0.441(-1) (1.687)***	0.681(-2) (2.076)**
ΔY	0.690(-1) (1.313)	-1.373(-1) (3.550)*	-0.134(-2) (2.795)**
ΔMER	0.021(-1) (0.162)	0.250(-1) (1.256)	-0.114(-2) (1.057)
ΔDP	-2.172(-1) (3.222)*	-1.362(-1) (1.351)	-0.175(-1) (2.038)***
Ect	-0.523(-1) (3.742)*	-1.145(-1) (5.022)*	-0.529(-1) (2.711)**
R^2	0.608	0.563	0.417
Adjusted R^2	0.503	0.454	0.206
SER	0.170	0.326	0.190
D-W statistic	1.849	1.637	1.809
F-statistic	5.767*	5.156*	1.974***
LM: χ^2 (p)	(1) = 0.323	(2) = 3.264	(1) = 0.538
LB Q-statistic	(16) = 11.133	(16) = 6.754	(16) = 13.304
ARCH: χ^2 (1)	0.833	0.333	0.189
WHET: χ^2 (15)	23.912**	9.446	23.337***
JB statistic	2.745	7.841**	0.153
RESET	F(1,26) = 34.23*	F(1,28) = 0.017	F(1,23) = 13.66*
Chow test	(1985) = 4.786*	(1987) = 4.69*	(1990) = 6.587*
No. of observations	34	36	32

Notes:

a. Refers to estimation period.
b. The negative number in parentheses refers to number of lags which were determined by minimizing the Akaike information criterion.
c. The number in parentheses refers to the absolute t-value.

* Significant at the 1.0% level.
** Significant at the 5.0% level.
*** Significant at the 10% level.

The regression for Senegal was corrected for autocorrelation, with the autocorrelation coefficient being 0.583. LM is the Lagrange multiplier test of residual serial correlation. ARCH and WHET are tests for heteroscedasticity based on Engle (1982) and White (1980), respectively. L-B Q-statistic is a test on the correlograms of the squared residuals to check for ARCH in the residuals. The number of lags are in parentheses. J-B statistic tests for normality in the residuals. RESET is a test for specification error. The breakpoint Chow test is used to verify whether the coefficient vector is constant over the sub-samples, with the year used as a breakpoint being in parentheses. The degrees of freedom for the other tests are in parentheses adjacent to the distributions. Ect is the lagged residual from the cointegration regression, and Δ is the first difference operator.

4.1 Impulse response analysis

The impulse response functions trace the effects of a single standard deviation (S.D.) shock to each of the variables in the system over specific time horizons. To facilitate tracing the patterns of movement, we othogonalized the innovations by a Cholesky decomposition with the variables put in different orders. As Sims (1980) has argued, there is no unique way of ordering the variables. Due to space considerations, we do not report herein the graphs containing the responses of variables to shocks over an 8-year horizon. The graphs are available from us upon request.

The own and feedback effects of food price shocks show very significant and persistent impacts on variables in all four countries. Food prices respond immediately to money supply shocks in Ghana, Cote d'Ivoire and Senegal. There is a delayed response (up to 2 years) of food prices to money innovations in Nigeria, and thereafter, food prices increase for the next 3 years. Even though, the empirical evidence is mixed, the graphs show that monetary policy and real exchange rate shocks have some impacts on food prices and domestic food production (DP) in these four West African countries. The pattern of food price responses to various shocks in Nigeria are different from the patterns of food price responses noticed in the other countries included our study. Shocks to the various variables elicit fairly significant changes in food price responses throughout the forecasting horizon in Nigeria. On the other hand, the responses of food prices to shocks of variables in other countries become fairly constant after the 5th year. This pattern does not change much even when we alter the ordering of variables in the system and used nominal food prices. It is worth noting that Ghana was the first West African country to embark on wide ranging structural adjustment programmes in the early 1980s with support mainly from the World Bank and International Monetary Fund.

Shocks to OPEN, introduced by the implementation of trade liberalization policies have significant impacts on real food prices in all the countries, except Ghana. Trade reforms in Cote d'Ivoire and Nigeria reduces real food prices throughout the forecasting horizon. However, trade reforms in Senegal increases food price inflation up to the third year, and then they followed a declining trend.

4.2 Variance decompositions

The variance decompositions presented in Tables 4 through 7 provide us with information about the relative importance of each random innovation to

variables in the system. The higher the variance accounted for by cross-variable innovations, the stronger the interactions amongst variables in the system. The variable for real food prices has more than 60 percent of its variance accounted for by own-innovations for the entire forecasting horizon in Nigeria, Ghana, Senegal and Cote d'Ivoire. The feedback between food prices and the other variables suggest that shocks to real food prices and domestic food production are a major source of macroeconomic instability in West Africa. For most countries, shocks to food prices have the most explanatory power for macro variables, such as per capita income, real exchange rates, and trade policy reforms (OPEN), and domestic food production (DP), with relatively little explanatory power for money supply in Cote d'Ivoire and Senegal. Also, the fairly significant feedback between food prices and money supply in Nigeria and Ghana suggests that the country's monetary authorities are willing to accommodate food price inflation. Furthermore, the fairly strong feedbacks between real exchange rates and other variables in the system suggest that exchange rate shocks are effective in changing the structure of relative prices in some of these West African countries.

Table 4: Decomposition of forecast error variance k-years ahead in Nigeria

Forecast error in	k-years	S.E.	Shocks to					
			P_f	M2	MER	OPEN	Y	DP
P_f	1	0.285	100.000	0.000	0.000	0.000	0.000	0.000
	3	0.490	71.571	0.364	3.781	6.822	12.890	4.570
	6	0.662	58.774	0.972	9.082	16.959	8.977	5.235
	8	0.772	60.170	1.027	7.418	19.477	6.639	5.268
M2	1	11.334	4.404	95.596	0.000	0.000	0.000	0.000
	3	20.348	2.275	71.448	15.214	4.622	2.330	4.110
	6	25.784	3.584	65.916	17.171	7.027	2.442	3.861
	8	29.222	3.189	63.614	19.125	7.661	2.504	3.908
MER	1	0.274	0.061	0.092	99.846	0.000	0.000	0.000
	3	0.477	0.872	0.795	92.680	1.721	3.734	0.194
	6	0.780	1.379	1.239	85.518	2.015	9.346	0.502
	8	0.963	1.353	1.477	84.404	2.736	9.509	0.520
OPEN	1	0.213	0.043	6.782	15.853	77.321	0.000	0.000
	3	0.357	2.545	7.229	14.867	71.086	0.681	3.591
	6	0.538	1.716	8.107	21.345	64.806	1.343	2.681
	8	0.640	1.246	7.519	26.215	60.537	2.088	2.391
Y	1	0.124	0.239	20.221	1.129	0.256	78.153	0.000
	3	0.259	9.686	11.219	18.278	2.501	55.940	2.375
	6	0.371	8.735	11.706	23.792	1.296	52.519	1.951
	8	0.431	7.961	12.623	22.570	1.024	53.974	1.847
DP	1	0.041	0.326	28.229	1.520	13.124	8.604	48.191
	3	0.071	1.927	19.065	2.689	24.728	18.193	33.397
	6	0.116	5.708	7.718	5.421	34.120	24.814	22.219
	8	0.146	6.660	4.970	7.403	36.042	25.854	19.071

Table 5: Decomposition of forecast error variance k-years ahead in Ghana

Forecast error in	k-years	S.E.	Shocks to					
			P_f	Y	MER	M2	DP	OPEN
P_f	1	0.753	100.000	0.000	0.000	0.000	0.000	0.000
	3	1.176	89.546	0.084	1.867	5.625	2.850	0.026
	6	1.561	82.341	0.252	5.372	8.862	3.161	0.031
	8	1.766	80.718	0.247	6.116	9.622	3.269	0.026
Y	1	0.053	0.001	99.999	0.000	0.000	0.000	0.000
	3	0.108	17.530	61.606	3.020	3.323	12.942	1.578
	6	0.155	23.982	52.268	5.622	2.324	14.667	1.134
	8	0.180	25.600	50.315	5.848	1.986	15.156	1.093
MER	1	0.513	29.466	0.479	70.054	0.000	0.000	0.000
	3	0.861	16.255	12.305	57.796	7.190	4.096	2.356
	6	1.211	13.800	18.633	51.126	8.531	6.034	1.904
	8	1.402	13.401	19.795	49.558	8.790	6.686	1.769
M2	1	14.103	1.020	2.953	9.181	86.845	0.000	0.000
	3	23.255	0.598	3.677	6.776	86.731	2.212	0.002
	6	33.763	0.509	4.549	4.226	88.084	2.617	0.019
	8	39.271	0.469	4.641	3.690	88.452	2.729	0.019
DP	1	0.079	50.943	2.763	11.859	4.049	30.384	0.000
	3	0.142	64.323	1.981	12.176	4.012	16.946	0.560
	6	0.200	67.444	1.491	13.888	2.125	14.605	0.446
	8	0.230	68.530	1.392	14.318	1.624	13.705	0.429
OPEN	1	0.208	1.779	4.334	35.582	0.538	24.257	33.508
	3	0.364	22.395	5.617	37.461	1.031	11.756	21.739
	6	0.500	28.371	4.964	35.172	3.837	8.517	19.137
	8	0.571	30.352	4.690	34.570	4.598	7.547	18.242

Table 6: Decomposition of forecast error variance k-years ahead in Cote d'Ivoire

Forecast error in	k-years	S.E.	Shocks to					
			P_f	MER	Y	DP	OPEN	M2
P_f	1	0.185	100.000	0.000	0.000	0.000	0.000	0.000
	3	0.406	75.642	3.623	5.913	3.319	4.662	6.840
	6	0.563	73.370	5.601	4.575	2.089	4.480	9.887
	8	0.649	73.074	5.868	4.438	1.764	4.506	10.348
MER	1	0.214	14.203	85.796	0.000	0.000	0.000	0.000
	3	0.503	36.181	57.530	0.944	2.075	2.617	0.652
	6	0.762	44.256	47.512	1.245	1.412	5.182	0.392
	8	0.890	45.478	46.223	1.175	1.345	5.487	0.290
Y	1	0.039	6.135	1.954	91.909	0.000	0.000	0.000
	3	0.082	5.738	3.779	71.357	1.014	7.539	10.572
	6	0.147	11.527	5.704	63.996	2.222	4.419	12.129
	8	0.178	12.641	5.843	63.283	2.314	3.941	11.975
DP	1	0.037	9.696	0.773	15.461	74.070	0.000	0.000
	3	0.051	6.365	2.018	18.687	45.925	10.968	16.036
	6	0.064	12.737	1.780	12.545	37.709	11.889	23.339
	8	0.072	14.815	1.700	10.449	34.668	12.233	26.135
OPEN	1	0.068	2.655	18.276	0.793	1.755	76.518	0.000
	3	0.114	14.384	20.389	1.057	6.476	56.849	0.845
	6	0.155	22.452	20.042	0.799	6.866	47.532	2.306
	8	0.177	23.987	20.153	0.636	7.114	45.629	2.480
M2	1	13.896	0.096	29.790	0.769	1.299	14.896	53.149
	3	17.957	1.448	30.290	0.599	1.137	19.399	47.126
	6	21.533	1.081	28.767	1.041	2.906	23.095	43.108
	8	22.711	0.903	28.192	1.199	3.428	24.533	41.742

Table 7: Decomposition of forecast error variance k-years ahead in Senegal

Forecast error in	k-years	S.E.	Shocks to					
			P_f	M2	MER	Y	DP	OPEN
P_f	1	0.186	100.000	0.000	0.000	0.000	0.000	0.000
	3	0.299	91.862	0.823	0.285	0.746	0.034	6.248
	6	0.396	90.993	0.642	0.566	0.712	0.079	7.005
	8	0.448	90.435	0.574	0.612	0.767	0.062	7.559
M2	1	5.878	1.223	98.777	0.000	0.000	0.000	0.000
	3	10.520	3.204	57.909	4.451	7.870	6.631	19.932
	6	13.748	2.081	60.389	3.702	8.812	5.757	19.258
	8	15.506	1.720	60.522	3.846	8.347	5.258	20.304
MER	1	0.238	25.827	1.881	72.292	0.000	0.000	0.000
	3	0.458	39.367	1.101	53.868	0.205	0.068	5.388
	6	0.674	43.352	1.033	51.066	0.223	0.160	4.164
	8	0.788	44.353	1.023	50.161	0.193	0.170	4.099
Y	1	0.276	9.261	0.111	0.513	90.113	0.000	0.000
	3	0.381	7.285	0.069	7.601	83.496	1.096	0.452
	6	0.503	4.645	0.074	10.637	82.630	1.056	0.957
	8	0.570	3.873	0.065	11.292	82.700	0.960	1.107
DP	1	0.153	1.608	7.650	9.670	5.676	75.394	0.000
	3	0.253	18.586	2.897	4.092	3.537	37.643	33.243
	6	0.317	20.030	2.072	2.680	3.234	39.406	32.577
	8	0.354	21.564	1.736	2.184	3.092	39.190	32.232
OPEN	1	0.115	13.777	17.761	1.137	0.400	4.020	62.936
	3	0.198	36.530	13.329	2.442	3.676	5.622	38.400
	6	0.283	37.157	11.892	2.768	4.236	5.735	38.213
	8	0.329	38.008	11.729	2.572	4.082	5.804	37.623

An examination of the forecast error (S.E) of each variable shows it increases steadily with the length of forecasting horizon, and reaches some upper bound for all of the variables in each country. It confirms the existence of stationary processes in the variables. The source of the forecasting error is the variation in current and future values of the various innovations.

5. CONCLUSIONS

African countries have been experiencing significant increases in food prices over the past couple of decades. Since food accounts for up to 73 percent of household budgets in some African countries, food price increases have severe political implications because people buy food more frequently than any other item in the CPI. Food price volatility increases the uncertainty faced by farmers and affect their investment decisions. This has important implications for the farm debt, farm incomes and agricultural productivity. Thus, the stabilization of macro prices is fundamental to the long-term restructuring of African economies. Previous studies on structural adjustment programmes in Africa did not pursue the line of inquiry adopted herein. See for example, Jaeger and Humphreys (1988), Johnson (1994), and Kargbo (2000).

This paper used a vector error correction model in investigating the impacts of monetary and macroeconomic factors on food prices in four West African countries. The empirical results (even though mixed) suggest that shocks to money supply, exchange rates and trade policies have significant impacts on food prices, real incomes and per capita domestic food production. Moreover, our results show strong feedbacks amongst the variables, and rapid adjustment towards long-run equilibrium levels after shocks in the system. Thus, the implementation of monetary and macroeconomic policies have significant impacts on poverty reduction, food security issues and food consumption patterns in West Africa. Since declining food production, high food prices and foreign exchange constraints lower food consumption at the household level, we argue that food security at both the household and national levels is linked directly to improvements in agricultural performance, food policy management, increasing efficiency in the marketing system, and making food available at affordable prices.

Research has shown that inadequate diets inflict tremendous costs to families and the whole country because persistent hunger hinders a nation's productive capacity, thereby, making the people more vulnerable to diseases (Kargbo 2000, forthcoming). Also, there is some evidence that inflation puts agriculture in a cost-price squeeze. Because of the fairly strong linkages between the variables, we suggest that agricultural and macroeconomic policy makers should cooperate more closely in designing economic reform policies in West Africa. As Oden (1986) argued so eloquently, neither group of policy makers can ignore the impacts of their policies on agriculture and the macroeconomic environment within which the sector operates. Our paper contributes to the policy dialogue going on in Africa, and the empirical results reveal a wide variability amongst the countries. Thus, the policy formulation process in each African country must reflect the economic, social and political environment prevailing in that particular country.

FOOTNOTES

1. The graphs in panels A and B are normalized with mean zero and one standard deviation.

2. The error-correction model is specified as:

   $$\Delta \log P_{ft} = \alpha_0 + \beta_1 \Delta \log P_{ft-k} + \beta_2 \Delta \log Y_{t-k} + \beta_3 \Delta \log MER_{t-k} + \beta_4 \Delta \log OPEN_{t-k} + \beta_5 M2_{t-k} + \beta_6 \Delta \log DP_{t-k} + \gamma Ect_{t-1} + \varepsilon_t$$

   where: Ect_{t-1} is the lagged residual (error-correction term) from the cointegration regression, ε_t is the stochastic disturbance term, α_0 is a

constant, whilst β_1, β_2, …, β_6 are parameters representing elasticities, k is the length of lag, and γ is the speed of adjustment. Δ is the first difference operator.

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