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THE ECONOMIES OF AFRICA AND THE PRICES OF THEIR EXPORTS

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AND
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1 INTRODUCTION

The economic performance of sub-Saharan African countries over the three decades since independence has in general been poor compared with many other low-income economies.[1] Many of these countries have experienced sustained declines in their already low per capita incomes. A very large number have not met scheduled payments owed to their international creditors and have been involved in debt renegotiations; they are widely perceived by private lenders to be bad credit risks and no longer have access to voluntary lending. These observations raise many issues of cause and consequence, but in this study we seek to analyze only one dimension, the effect of export prices on various aspects of economic performance and the implications of the determinants of these prices for economic policy.

Primary commodities dominate the export earnings of the countries of sub-Saharan Africa, and the prices of primary commodities have been unusually low recently. In very many cases in 1986-87, a given amount of a primary commodity bought less than half what it bought on average during the preceding thirty-five years. The current situation therefore has large implications for many dimensions of the economic performance of these countries. The most important of these is that the decline in the international prices of primary commodities represents a very large cut in the purchasing power of these countries. On average, individuals in these countries find that their standard of living has fallen.

The way that declines in commodity prices affect various sectors of the economy within these countries depends critically on how governments intervene in commodity markets. In most African countries, governments collect a substantial portion of their revenues from exports. They tax trade flows or producers of exportables, or they set up marketing boards that control producer prices. When the government acts in these ways, changes in world prices do not result in one-for-one changes in the prices that producers face. Instead, changes in world prices affect both government reve-

We would like to thank Henry S. Bienen, Anne C. Case, Angus S. Deaton, Joshua Green, Jeff Herbst, and Howard Pack for their comments.

[1] Data permitting, our subject is all the countries of Africa, including such nearby islands as Madagascar and Mauritius but excluding the Arab countries of North Africa and the Republic of South Africa. We will use the term sub-Saharan Africa or just Africa to refer to these countries, and they correspond roughly to the countries encompassed by the Africa of the World Bank and other international organizations.

nues and producers' incomes, often with the greater impact on the government.

If falling commodity prices have a severe impact on a government's revenues, it cannot perform economic functions, and current production and future growth are impaired. Individuals who work for the government suffer. If, instead, the export sector bears the brunt of price declines, the standard of living of producers falls, and they respond by producing fewer exports. International loans and foreign aid can buffer the impact of price declines on these countries, but the servicing of past debts magnifies the threat to their economic performance. Furthermore, debt service is itself a dimension of economic performance that is affected by international prices, and that concerns many parties: the countries themselves, their official and private creditors, and institutions such as the International Monetary Fund and the World Bank.

Chapter 2 describes the composition of the exports of African countries. It shows which primary commodities have been important in their export earnings, and it looks for evidence of past change in the composition of exports or reasons to suppose that there will be change in the near term.

Chapter 3 describes the structure of commodity markets that are important to African countries. It begins by discussing the small-country assumption and its presumed applicability to Africa. Subsequent sections discuss qualifications of this assumption suggested by particular commodity markets where individual African producers may have large shares of world exports or production, international commodity agreements may be important, or the policies of the European Community (EC) and the United States may have an impact. This discussion leads to an assessment of the factors that determine the shadow prices of exports for African countries, an extremely important guide to pricing and investment policy.

Given the importance of commodity prices and given recent developments, the next question is whether these prices are likely to recover toward the average values that prevailed over the last thirty-five years, stay where they are, or decline even further. After a review of some rather inconclusive theoretical arguments concerning the prospects for commodity prices, Chapter 4 describes in some detail the evolution of commodity prices over the last three decades. Such a description tells what has happened, but not why or what it bodes in terms of the trend in these prices, their persistence, and their variability. A formal statistical analysis of the data is needed to answer these last two questions, and it is presented in section 4C. An understanding of the time-series properties of commodity prices is important for policymaking because they bear upon whether current shortfalls in income should be reflected largely in lower consumption

or in lower investment and on relations between African countries and international lenders.

The effects of international commodity prices on economic performance are considered in Chapter 5. It begins with an overview of the issues, then turns to the division of the initial impact of a change in export prices between the government and private sectors and their responses to it. Chapter 6 concludes by examining the relationships among export earnings, other elements of the balance of payments, and economic performance through an analysis of the sources and uses of foreign exchange.

Before turning to the analysis, it is useful to keep in mind the difficulties with respect to data that confront any inquiry into economic conditions and prospects in Africa. These countries are poor and lack sufficient resources to devote to the collection of statistics. As a result, information on their economies is limited in scope and quality and is not available in a timely fashion.[2] Not all African countries report on a regular basis in the standard international compendia of economic data. Nationally produced documents are late and sketchy. For these reasons, the tables and other information in this study cannot be comprehensive.

[2] See Yeats (1989) on trade data.

2 PRIMARY COMMODITIES OF IMPORTANCE TO AFRICA

A The Composition of Export Earnings

The export sectors of African economies are very important to the performance of their economies. Exports account for a very large fraction of total production in Africa, providing a quarter or more of the GNP in 14 of 27 countries (Table 1). Changes in the prices of exports can therefore have large effects on the total incomes of these countries. Similarly, growth in exports can contribute significantly to the growth of GNP as a whole. Of 29 African countries on which the United Nations Conference on Trade and Development (UNCTAD) reports (Table 2), 17 increased the quantity of their exports between 1960-73 and 1982-85, while 12 actually experienced a decline.

African countries depend predominantly on primary commodities for their export revenues: food products, agricultural raw materials, crude petroleum, and minerals. Furthermore, each African country exports an extremely narrow range of primary commodities. In 1982-84, for instance, 20 out of 33 African countries earned 50 percent or more of their total export revenues from just one primary commodity (Table 3), and nine of these earned 75 percent or more from just one commodity. All but four of the countries earned at least 50 percent of their export revenues from no more than three commodities. Three of the four exceptions (Kenya, Senegal, and the Seychelles) produce and export refined petroleum products based on imported crude; these exports are really more in the nature of re-exports.

Many primary commodities are important for more than one of the countries. Cocoa, coffee, sugar, tea, groundnuts, cotton, and animals and their products are significant agricultural exports for three or more countries. Crude petroleum, copper, diamonds, and iron ore are important for at least two countries.

B Developments in the Composition of Exports

Since independence, there has been no revolutionary continent-wide change in the reliance of African countries on primary commodities to generate export earnings. In 1966-73, 15 out of 32 countries depended on a single primary commodity for 50 percent or more of their export revenues. The situation is very much the same now. Nonetheless, there have been

some noteworthy changes in the composition of the exports of individual countries.

First, the post-independence period has seen the rise of crude petroleum as the dominant export of Angola, the Congo, Gabon, and Nigeria, and, to a lesser extent, Cameroon. A few other countries in Africa, such as the Ivory Coast, have some crude-petroleum reserves.

Crude petroleum was already of considerable importance in the Congo, Gabon, and Nigeria before 1973, but the increase in oil prices has meant that almost all the export revenues of these countries have come from this single source since 1973. Not only has the value of oil exports been so large as to dwarf traditional exports in relative terms, but traditional exports have declined even in absolute terms in some countries with oil revenues.

In the extreme, a country may become an importer of a commodity that it previously exported. Nigeria is a case in point, having gone from being an exporter of groundnut and palm oils even as late as the early 1970s to being an importer of these products by the late 1970s. Chapter 5 discusses the general-equilibrium mechanisms at work in this and other responses to changes in export opportunities.

Because crude petroleum is an exhaustible resource, its relative importance in the exports of these countries will diminish in the future. In fact, at rates of production prevailing in 1987, current proven reserves at the end of 1987 would last only 9 years in Angola, 8 years in Cameroon, 17 years in the Congo, 11 years in Gabon, and 35 years in Nigeria (*Oil & Gas Journal*, Tulsa, December 1987). Of course, proven reserves do not measure the maximum amount of petroleum that can be extracted, because additional reserves can be proved through exploration. Nonetheless, it is clear that some African countries are exhausting their proven reserves at rates that are high relative to oil producers elsewhere, particularly many of the Arab producers. Furthermore, if oil prices remain low relative to the recent past, the incentives to add to proven reserves in Africa will be small even if it is possible to do so.

A second change in the composition of the exports of some African countries has been an increase in the processing of traditional export commodities. The Ivory Coast exported 18 percent (by value) of its cocoa products in the form of cocoa paste and cocoa butter in 1985; in the early 1960s it exported only unprocessed cocoa. Ghana also processes some of its cocoa prior to export, but to a lesser extent. Senegal has increased its exports of groundnut oil and groundnut cake relative to its exports of unshelled groundnuts to the point that most of its output is exported in processed form. Nevertheless, most primary products are still exported in an unprocessed state or after the minimum processing required to prevent deterioration or obtain gross reductions in weight prior to export. Nor are there

TABLE 1

BASIC ECONOMIC INDICATORS FOR AFRICAN COUNTRIES, 1984

Country	GNP per Capita [a]	Percent Growth of Real GNP per Capita [b]	Percent Exports in GNP [c]
Benin	$ 270	1.0	18
Botswana	960	8.4	61
Burkina Faso	160	1.2	18
Burundi	220	1.9	9
Cameroon	800	2.9	32
Cape Verde	320	...	...
Central African Republic	260	−0.1	25
Congo	1,140	3.7	64
Ethiopia	110	0.4	12
Gabon	4,100	5.9	...
Gambia	260	1.0	...
Ghana	350	−1.9	11
Guinea	330	1.1	25
Guinea-Bissau	190	...	...
Ivory Coast	610	0.2	46
Kenya	310	2.1	26
Lesotho	530	5.9	...
Liberia	470	0.5	40
Madagascar	260	−1.6	16
Malawi	180	1.7	27
Mali	140	1.1	23
Mauritania	450	0.3	48
Mauritius	1,090	2.7	48
Niger	190	−1.3	22
Nigeria	730	2.8	16
Rwanda	280	2.3	...
Sao Tome and Principe	330	−1.6	...
Senegal	380	−0.5	29
Sierra Leone	310	0.6	17
Somalia	260	...	...
Sudan	360	1.2	10
Tanzania	210	0.6	...
Togo	250	0.5	31
Uganda	230	2.9	11
Zaire	140	−1.6	...
Zambia	470	−1.3	37
Zimbabwe	760	1.5	22

[a] 1984, in U.S. dollars.

[b] 1965-84.

[c] 1984.

NOTE: ... indicates data not available.

SOURCE: World Bank, *World Development Report, 1986*, Washington, 1986.

TABLE 2

UNCTAD INDEXES OF EXPORT QUANTITIES AND TERMS OF TRADE
(1960-73 = 100)

Country	Export Quantities			Terms of Trade		
	1974-79	1980-81	1982-85	1974-79	1980-81	1982-85
Benin	85	100	81	85	62	57
Burkina Faso	159	189	157	102	89	92
Central African Republic	97	135	133	143	119	104
Cameroon	115	111	127	108	118	113
Chad	89	65	73	133	121	123
Congo	63	109	132	379	610	590
Ethiopia	106	131	128	105	59	62
Gabon	147	111	116	323	551	535
Gambia	149	71	109	100	85	97
Ghana	78	71	60	150	106	81
Ivory Coast	159	154	146	131	116	118
Kenya	106	90	79	113	93	90
Liberia	172	166	141	63	43	45
Madagascar	114	82	74	98	79	82
Malawi	165	213	178	94	74	90
Mali	210	288	278	105	93	97
Mauritania	177	196	290	66	53	53
Mauritius	139	163	210	135	83	75
Niger	335	795	487	85	60	55
Nigeria	161	123	87	332	583	526
Rwanda	185	224	313	133	113	91
Senegal	91	71	92	159	112	101
Sierra Leone	69	67	51	95	69	68
Somalia	166	198	150	72	64	70
Sudan	72	63	68	121	110	98
Togo	108	156	128	234	141	124
Uganda	67	39	55	122	106	104
Zaire	100	82	79	84	64	60
Zambia	102	94	78	75	50	42

SOURCE: UNCTAD, *Handbook of International Trade and Development Statistics*, Geneva, 1982 and 1986 Supplements. The data reported in 1986 run from 1972 to 1985 and have a base year of 1980. The data reported in 1982 run from 1960-80 and have a base year of 1975. Export quantities from 1972 on were taken directly from the 1986 data source. Export quantities from 1960 to 1971 were rebased, by computing the average ratio between the 1972 and 1973 numbers from the 1975-based and 1980-based series and scaling the 1960-71 numbers by this ratio. After rebasing, average export quantities and terms of trade were computed for the subperiods 1960-73, 1974-79, 1980-81, and 1982-85. The averages for the latter three subperiods were then divided by the 1960-73 averages.

TABLE 3

SHARES OF COMMODITIES IN COUNTRIES' TOTAL EXPORTS

(in percent)

Country	1966-73	1974-79	1980-81	1982-84
Benin:				
Cocoa	12	15	11	5
Cotton	17	24	23	19
Palm products	32	23	33	20
Total	61	62	67	44
Botswana:				
Meat	...	27	13	12
Diamonds	...	36	51	64
Copper-nickel matte	...	23	22	10
Total		86	86	86
Burkina Faso:				
Animal & p	47	30	22	10
Cotton	20	31	42	51
Total	67	61	64	61
Burundi:				
Coffee	82	88	89	87
Cameroon:				
Cocoa	24	27	19	12
Coffee	25	28	19	15
Wood	8	9	8	6
Crude petroleum	0	9	35	43
Total	57	73	81	76
Central African Republic:				
Cotton	21	13	20	17
Coffee	19	30	31	36
Wood	10	24	35	25
Diamonds	42	28	36	28
Total	92	95	122	106
Congo:				
Wood	53	15	8	5
Crude petroleum	6	75	99	95
Diamonds	17	3	...	...
Total	76	93	107	100
Ethiopia:				
Coffee	53	56	61	62
Hides	11	10	12	10
Total	64	66	73	72
Gabon:				
Crude petroleum	31	74	76	77
Manganese	21	8	6	5
Total	52	82	82	82

TABLE 3 (*Continued*)

Country	1966-73	1974-79	1980-81	1982-84
Gambia:				
Groundnuts & p	92	84	54	50
Ghana:				
Cocoa	55	60	56	57
Wood	11	8	3	3
Aluminum	8	8	20	...
Total	74	76	79	60
Ivory Coast:				
Cocoa & p	21	27	32	30
Coffee & p	32	30	20	20
Wood & p	26	18	16	11
Total	79	75	68	61
Kenya:				
Coffee	18	26	21	25
Tea	11	12	11	19
Petroleum products	12	19	32	22
Total	41	57	64	66
Liberia:				
Rubber	15	14	17	16
Iron ore	70	64	57	63
Diamonds	9	6	5	4
Total	94	84	79	83
Madagascar:				
Cloves	7	14	14	13
Coffee	29	38	44	39
Vanilla	8	7	7	19
Total	44	59	65	71
Malawi:				
Sugar	1	10	19	8
Tea	21	18	13	17
Groundnuts & p	11	5	6	1
Tobacco	31	47	42	53
Total	64	80	80	79
Mali:				
Animals & p	28	15	22	...
Groundnuts & p	16	14	4	1
Cotton	28	47	43	40
Total	72	76	69	41
Mauritania:				
Fish	7	11	29	48
Iron	81	81	71	52
Total	88	92	100	100

TABLE 3 (*Continued*)

Country	1966-73	1974-79	1980-81	1982-84
Mauritius:				
Sugar	92	76	63	64
Niger:				
Animals & p	14	14	9	4
Groundnuts & p	48	4	0	0
Uranium	9	70	82	83
Total	71	88	91	87
Nigeria:				
Cocoa	14	4	2	2
Crude petroleum	52	92	96	100
Total	66	96	98	102
Rwanda:				
Coffee	53	69	50	67
Tea	5	9	10	12
Tin	24	8	10	10
Total	82	86	70	89
Senegal:				
Fish	7	11	21	17
Groundnuts & p	44	32	9	17
Petroleum products	3	9	23	19
Phosphates	9	17	15	9
Total	63	69	68	62
Seychelles:				
Cinnamon bark	36	7	2	2
Copra	30	17	14	7
Petroleum products	19	48	71	75
Total	85	72	87	84
Sierra Leone:				
Cocoa	3	10	11	14
Coffee	5	11	13	8
Diamonds	61	56	52	36
Total	69	77	76	58
Somalia:				
Animals	49	67	102	75
Bananas	28	13	5	7
Total	77	80	107	82
Sudan:				
Groundnuts & p	8	14	10	4
Sesame	8	9	10	9
Cotton	58	53	32	41
Gum arabic	9	7	8	8
Total	83	83	60	62

TABLE 3 (*Continued*)

Country	1966-73	1974-79	1980-81	1982-84
Swaziland:				
Sugar	25	39	42	38
Pulp	17	18	15	18
Total	42	57	57	56
Tanzania:				
Coffee	16	29	27	34
Cotton	15	13	11	14
Sisal	9	9	6	4
Total	40	51	44	52
Togo:				
Cocoa	30	19	13	15
Coffee	17	11	8	7
Petroleum products	...	4	14	1
Phosphates	39	58	46	51
Total	86	92	81	74
Uganda:				
Coffee	50	85	99	92
Cotton	21	7	1	...
Total	71	92	100	92
Zaire:				
Coffee	6	12	14	20
Cobalt	8	16	18	5
Copper	62	44	43	39
Diamonds	5	7	6	16
Total	81	79	81	80
Zambia:				
Copper	93	89	96	89

NOTES: For "& p" see Appendix B under "Country Data." Country totals above 100 reflect problems in the IMF data. Average shares are computed over the years 1966-84 for all countries except Benin, Cameroon, Congo, Mauritius, Niger, Rwanda, and Zaire (1966-83); Botswana (1974-84); Seychelles (1970-84).

SOURCE: IMF, International Financial Statistics data tape, 1987, with modifications discussed in Appendix B.

signs of increased processing in Africa, or reasons to expect them. It is widely believed that the structure of protection in developed countries favors the export of unprocessed commodities, although African countries enjoy the preferential access to these markets granted to developing countries, in general, and by the European Community to its associated members, in particular (Yeats, 1984).

A final development in the composition of the exports of some African

countries is the appearance of, or relative increase in, manufactured exports. This phenomenon, however, is limited. The notable examples are Mauritius for clothing (22 percent of exports in 1982-83), Benin for shoes (38 percent of exports in 1982-83), and Kenya, Senegal, and the Seychelles for refined petroleum products.

C Intra-African Linkages

Generally, African countries can be seen as exporting their primary products to non-African markets, and the prices that they get for their exports are largely determined in world markets. There are, however, some economic linkages among African countries, with the consequence that there may be secondary effects on one country of changes in the prices of commodities exported by its neighbors.

Labor migration creates a very considerable economic linkage among many African countries. For example, agricultural workers in the Ivory Coast come from Burkina Faso and elsewhere. Expulsions of Ghanaians from Nigeria in the 1980s have underlined the importance of migration into Nigeria and its risks. The countries of southern Africa send large numbers of temporary workers to the South African mines. These and other migrants, their dependents back home, and others in their home countries are affected by the prices received for exports by the African countries to which they migrate.

Some African countries are important markets for other African countries. Nigeria, with its large population, is a local market of importance to its neighbor, Niger. In the 1980s, Niger earned between 10 and 20 percent of its total export revenues from sales to the Nigerian market, a very large fraction of its export revenues from commodities other than uranium. Niger's exports to Nigeria depend on economic conditions in Nigeria, and therefore on the price of crude petroleum, a commodity Niger does not export at all.

Finally, there are important linkages among African countries through the smuggling of primary commodities that are later exported from the receiving country. This is another mechanism by which an African country is affected by movements in the international prices of commodities that it does not necessarily produce. There are some notorious examples. The Congo produces no diamonds, and yet diamonds smuggled from Zaire to the Congo accounted for 17 percent of the value of the Congo's exports in 1966-73. Cocoa is smuggled from Ghana to the Ivory Coast, and coffee is smuggled out of Ethiopia and Uganda to neighboring countries. In each case, movements in the prices of smuggled commodities in international markets, relative to the markets of origin, affect the countries into which the commodities are smuggled.

3 STRUCTURE OF INTERNATIONAL COMMODITY MARKETS RELEVANT TO AFRICA

A *The Small-Country Assumption and Shadow Pricing in the African Context*

The preceding chapter documented the preponderance of primary commodities in the exports of sub-Saharan Africa and identified the commodities of importance to individual countries. This chapter discusses how the structure of international commodity markets determines the marginal benefit to African countries from an extra unit of exports. The marginal benefit or shadow price is important in decisions on many matters, including tariffs, exchange rates, agricultural prices, and investments in specific projects. Our discussion starts with a review of the concept of the small country and the relevance of this concept to the countries of sub-Saharan Africa.

In the theory of international trade, the small country is defined by the assumption that it can trade as much as it might plausibly wish without affecting the prices at which its transactions take place. A country in this position faces invariant valuations of the benefits from an additional unit of an exportable or importable good, equal to the international price of that good. This assumption gives rise to such classical prescriptions as free trade and the modern corollary, the use of international prices as shadow prices in project evaluation.

The small country is usually contrasted with the large country, which imports so much from some market or exports so much to some market that increases in its activities, within plausible limits, affect the price at which it trades in that market. All African countries are economically small in terms of their per capita incomes, and, with the exception of Ethiopia, Kenya, Nigeria, the Sudan, Tanzania, and Zaire, have fairly small populations. They might therefore be expected to be economically small in the markets from which they import, and probably in the markets to which they export, although there are exceptions, which are discussed in section 3B.

In actuality, smallness in per capita income and in population comprise only one set of factors suggesting that a country satisfies the assumptions of the small-country model, especially in its export markets. International agreements govern several of the markets to which African countries export, and in section 3C we assess their effect on the export opportunities of African countries and the implications for economic policy, as reflected in the calculation of such variables as shadow prices. In section 3D, moreover,

we examine the ways in which large importing countries or groups of countries, such as the United States and the European Community, restrict their purchases from many of the markets to which African countries export, because they may not leave intact the small-country assumption.

To the extent that African countries are not small in the markets to which they export, it is incorrect to equate shadow prices to international commodity prices. Furthermore, it is inappropriate to attribute movements in the share of individual countries in world trade in particular commodities solely or primarily to domestic incentives to export. For instance, a country such as Kenya that always exports more coffee than its quota under the International Coffee Agreement faces fundamentally different coffee-producing opportunities from a country that often does not meet its quota.

B The Importance of Africa in World Markets

Can any single African country exert market power to influence profitably the price it receives for its commodity exports in world markets? Such power provides the classic argument for a government's restricting its country's participation in international trade, the theory of the optimal tariff. A country has more monopoly power the lower is the absolute value of the elasticity of demand for its exports. A sufficient condition for a country to gain from export restriction is that the elasticity of demand for its exports is less than 1. In this case, the revenue it loses by contracting the volume of its exports is more than offset by the revenue it gains by selling at higher prices.[1]

The role of this elasticity can best be understood by starting with the identity that expresses the demand for a country's exports, d, as the difference between the total demand for a commodity in all other countries, D_{OT}, and the sum of two supplies: the supply of the commodity that enters world trade from other exporting countries, S_{OT}, and the supply that does not enter world trade, S_{NT}. Thus,

$$d = D_{OT} - S_{NT} - S_{OT} . \tag{1}$$

If the absolute value of the elasticity of d with respect to the world price, p, is defined to be e_d, the elasticity of D is e_D; the elasticity of S_{OT} is ϵ_{OT}; the elasticity of S_{NT} is ϵ_{NT}; the share of d in world exports, $d + S_{OT}$, is μ; and the share of world exports in total world supply, D, is σ, then

$$e_d = [e_D + \epsilon_{NT}(1 - \sigma) + \epsilon_{OT}(1 - \mu)\sigma] / \mu\sigma . \tag{2}$$

[1] Of course, an added benefit from export restriction is the reduction in the cost of providing the exports. Revenues net of costs rise if $e_d(1 - c'p) < 1$ (where c' is the marginal cost of a unit of exports and p is the price received), the necessary condition for a profitable restriction of exports, and one that is less stringent than $e_d < 1$.

The special case in which all production is exported ($\sigma = 1$ and $\epsilon_{NT} = 0$) and foreign supply is constant ($\epsilon_{OT} = 0$) is favorable to a country that wishes to exercise monopoly power. The sufficient condition for profitable export restriction ($e_d < 1$) is then equivalent to $\mu > e_D$, and so the country's share of world exports, μ, is critically important. The value $e_D = 0.1$ seems to be rather small in practice, so that the country must have a market share greater than 0.1 to face an inelastic demand for its exports.

Most countries of sub-Saharan Africa do not individually provide a significant share of world exports of their export commodities, so that μ is typically low. There are some important exceptions, however, where the shares of individual African countries have exceeded 10 percent of world exports for certain commodities listed in Table 3. In the case of cocoa, the Ivory Coast averaged a 26 percent share of world exports from 1981 to 1983, while Ghana had 16 percent and Nigeria 12 percent. Madagascar had a 60 percent share of world exports of natural vanilla and was also important in cloves, while Kenya had 21 percent of world sisal exports and Tanzania had 25 percent. Senegal had a 24 percent share of world exports of groundnut oil. Among the mineral exporters, Guinea had 28 percent of world bauxite exports, Zambia 12 percent of copper, Gabon 28 percent of manganese. Botswana and Zaire were important exporters of diamonds.

By contrast to the theoretically favorable case, the share of world exports in world production, σ, usually falls substantially short of 1, which increases the elasticity of demand for a country's exports, e_d, and reduces its market power. Importing countries are often substantial producers, and non-African exporting countries are themselves significant consumers of some commodities. The African countries, however, are not significant consumers of the commodities they export relative to their own production. For these reasons, the share of African production in world production is well approximated by $\mu\sigma$, and it is less than the share of African exports in world exports, μ, for most African export commodities. In other words, σ is significantly less than 1. This is the case for Senegal's production of groundnuts, which was less than 5 percent of world production in 1981-83, and for Zambia's production of copper and Gabon's production of manganese, each of which was less than 10 percent of world production.

Some African countries, however, have significant shares of world production in selected commodities. Cocoa is the most prominent case: in the early 1980s Ghana had approximately 12 percent, the Ivory Coast 25 percent, and Nigeria 10 percent of world production. Tanzania had 18 percent of world production of sisal, and Kenya had 11 percent, while Madagascar is important in vanilla. In the minerals, Guinea had 15 percent of world production of bauxite, Botswana had 18 percent of industrial-diamond and 12 percent of gem-diamond production, and Zaire had 28 percent

of industrial-diamond production. As equation (1) indicates, it is the producer's importance relative to world production, and not relative to world trade, that determines how the price it receives for a commodity responds to variations in its own output. Exceptions may exist if such large countries or groups of countries as the United States and the European Community isolate a sizable part of world demand (their own consumers) from external supply, so that African exporters have a substantial share of the residual market. Another exception may exist if the African country has favored access to a protected market, such as the European Community, that it would not jeopardize by acting as a monopolist. But such cases seem farfetched.

Even for these very restricted combinations of countries and commodities, moreover, high values of the foreign elasticities of supply (the ϵ) might undermine the market power suggested by large market shares. Analysis of this issue is complicated by the nature of the commodities involved. Vanilla and cocoa are perennials that do not yield crops for some years after planting and then continue to yield for a considerable time. Mineral production also requires investments of long gestation and duration, and it is subject to decisions about the timing of exploitation as well. The response of foreign supply may therefore be more forceful with the passage of time, as existing producers in other countries expand production in response to a restriction in output by one of the African countries, and as new producers enter. Certainly, for most of the tropical agricultural commodities, Asian and South American countries have agroclimatic conditions that make them actual or potential competitors with African producers. For instance, Malaysian cocoa production went from 23,000 metric tons (1.5 percent of world supply) at the time of the 1977 cocoa boom to a projected 255,000 (over 10 percent of world supply) for 1989-90 (Gill & Duffus, *Cocoa Market Report*, London, October 1989).

Observations of this sort lead to the kind of model used by Repetto (1972) and Imran and Duncan (1988), in which a restriction of supply leads to high profits in the short run that are eroded over time as other producers expand their output. These formulations understate the complexity of the problem, however, by assuming that the restricting exporter makes a once-and-for-all decision about output. Furthermore, other producers are assumed to expand their production in a mechanical way in response to the gap between the prevailing price and their costs. The larger the restriction, the greater is this gap and the faster is the entry of other producers and the erosion of profits. Therefore, the policy of the restricting exporter is determined by a tradeoff of the current value against the present value of future profits.[2]

[2] Purchasers of the export may also respond gradually, as they find ways to shift to substitute products over time; in this case, the elasticity of demand in the short run is less than in the long run. This consideration also leads to a balancing of current gains in revenues against future

The basic problem facing the restricting exporter is strategic: Can it deter other producers from expanding their output by credibly threatening to increase its own output in response to their entry? What form will conflict between old and new producers take if new producers enter, and does the expectation of conflict deter new entrants? There might be scope for preemptive investment in productive capacity to deter entry by other producers, including even investment in capacity that is kept idle in the absence of entry (Dixit, 1980; Bulow *et al.*, 1985; and Gilbert, 1986 and 1989). These considerations may be relevant to exporters of primary commodities that have large market shares, chiefly perennial crops and minerals, in which investments are durable. It is possible for the established producing country to earn excess returns without necessarily generating opportunities for profitable entry.

There are, however, no empirical studies that apply notions of entry deterrence to African countries or to exporters in analogous situations. As a result, we can only conjecture that there are some, albeit few, commodities for which export-restricting policies by individual countries might be profitable. Yet even the Ivory Coast failed miserably when it tried to restrict its exports of cocoa to raise prices in 1979-80 (Gbetibouo and Delgado, 1984), and its more recent attempts seem to have been no more successful, perhaps in part because they took the form of restriction without entry deterrence.

C *International Commodity Agreements*

Some of the commodities important to Africa have, at various times, been covered by international commodity agreements intended to affect the price of the commodity on either a long-term or short-term basis. International commodity agreements have been in effect in the 1980s for cocoa, coffee, sugar, natural rubber, and tin. In addition, the Organization of Petroleum Exporting Countries (OPEC) is dedicated to maintaining producer prices, and that affects African exporters of petroleum.

Each of these commodity agreements has attempted to maintain prices in a specified range, although they have differed in their strategies. The coffee agreement has used a system of export restrictions, allotting to each exporting country a fixed number of bags of coffee that can be exported to importing member countries. Coffee can also be sold to nonmember importers, usually at lower prices (see Box 1 on the International Coffee Agreement). The agreements covering cocoa and natural rubber have used

losses. The determinants of this tradeoff are likely to be less strategic than those arising from the interaction with other suppliers. Nonetheless, the exporting country may have to worry about purchasers' actions in anticipation of a possible restriction of supply. Certainly, oil-importing countries took steps to protect themselves from future movements in the price of petroleum.

BOX 1

The International Coffee Agreement

The International Coffee Organization (ICO) tries to stabilize the price of coffee through a system of export quotas. One of the most important features of the ICO is that most countries that export or import coffee are members. Importing members account for about 90 percent of total world coffee imports, and exporting members produce 99 percent of the world's supply of coffee (EIU, 1987). There have been four agreements, dated 1962, 1968, 1976, and 1983. Although the details differ, all function on the same three principles: (1) Importing countries agree to limit imports from nonmember exporters (based on historical levels of imports from those countries). (2) Prices paid by importing members to exporting members are maintained within a target range through the use of a global quota. The global quota specifies the total amount of coffee that exporting members can sell to importing members. The global quota is set annually but may be adjusted during the year to keep prices in the specified range. (3) Each agreement allocates to each exporting member (with the exception of small exporters) a basic export quota. The basic export quota determines the exporting member's share of the global quota, a share that generally remains constant during the agreement. Small exporters have been treated somewhat differently. The 1976 and 1983 agreements defined as small those countries that exported fewer than 400,000 bags, and earlier agreements defined them as those exporting fewer than 100,000 bags. Before the 1983 agreement, small exporters were exempt from basic quotas; they were given initial quotas that would automatically increase by 10 percent per year provided they were filled. After 1983, small exporters, as a group, were given 4.2 percent of the global quota, and the automatic expansion of their quotas was eliminated. Bates and Lien (1985), Lien and Bates (1987), Gilbert (1987), Mwandha et al. (1985), EIU (1987), and Marshall (1983) provide more detailed descriptions of the ICO.

Although the ICO has operated since 1962, the quota system has not been in force in every subsequent year. When the 1968 agreement lapsed in 1972, the economic provisions of the agreement were not extended (although other provisions were), mainly because exporting countries could not agree on the allocation of quotas. The 1976 agreement reinstituted the quota system, but prices were high enough relative to targets that quotas were not required until October 1980. Quotas were suspended from February 1986 through October 1987, initially because of high coffee prices but later because there was disagreement about quotas (George Gordon Patton & Co., *Coffee Annual*, 1986 and 1987). As of September 1989, the 1983 agreement had expired without negotiation of a new one.

The quota system of the ICO has resulted in a dual market for coffee. When the quota system operates, the price received by exporting members for exports to member countries has been higher than the price received for exports to nonmember importing countries. The divergence between the quota and nonquota prices has varied considerably from year to year. The percentage difference went from 10 in 1980 to more than 50 by 1984 (EIU, 1987). The divergence between prices paid by members and nonmembers is a current source of conflict in the ICO. Under pressure from importing members, exporting members have officially agreed to sell coffee to nonmembers only at

prices comparable to quota prices. This provision would have the effect of extending the quota system worldwide. Enforcement of this provision is difficult, however, and a dual market still existed at the end of the last agreement.

All African coffee exporters are members of the ICO, and they export the bulk of their coffee to member countries. The table shows export quantities (in thousands of bags) to quota and nonquota markets for African exporters according to the ICO definition of country size.

Country Size	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87
Large:						
Quota	13,760	13,294	14,503	13,827	15,203	12,306
Nonquota	1,703	2,062	1,185	616	563	886
Small						
Quota	1,128	1,514	1,522	1,585	1,863	1,829
Nonquota	58	128	63	35	87	68

SOURCE: ICO, *Quarterly Statistical Bulletin*, London (various issues).

The share of nonquota exports in total exports ranges from 11 percent to 3.6 percent for the large exporters and from 7.8 percent to 2.2 percent for small exporters. The numbers for the small countries mask the fact that many small exporters sell no coffee to the nonquota market. In contrast, all large exporters with the exceptions of Tanzania and Uganda (in some years) export some coffee to the nonquota market.

The method of setting quotas employed by the ICO complicates the computation of shadow values for African coffee exporters (Gersovitz and Paxson, 1990). If quotas were fixed and there was no uncertainty about the size of the harvest, the shadow price for coffee would equal the nonquota price for countries exporting more than their quotas, the marginal cost of producing the quota for countries just exporting their quotas, and the quota price for countries exporting less than their quotas. Furthermore, randomness in the size of the coffee harvest means that a country may not know in advance whether it is likely to fill its quota or not. If the country does not hold stocks against the possibility that its harvest will fall below its quota, the shadow price is a weighted average of the quota and nonquota prices. If the country does hold stocks for this purpose, calculation of the shadow price is more complicated. An additional consideration is that basic quotas may be affected by historical exports and currently verifiable stocks. Thus, the value of increasing coffee production may exceed the nonquota price if expansion leads to a future increase in a country's basic export quota. Finally, there may be quality differences between the coffee sent to quota markets and that sent to nonquota markets.

an international buffer stock, an actual physical stockpile that is built up or drawn down, depending on market conditions. The sugar and tin agreements have used both export quotas and a buffer stock to maintain prices in a fixed range (Gordon-Ashworth, 1984).

It is doubtful that any of these agreements, with the possible exceptions of those for coffee and petroleum, has been able to control prices successfully over long periods of time. This is the position of Ghosh *et al.* (1987). In the early 1980s, conditions in the international markets for primary commodities made it especially difficult for buffer-stock managers to maintain prices. For example, even though the buffer stock for the International Rubber Agreement increased from 50,000 to 375,000 tons over the 1981-85 period, the nominal price of rubber declined from 50.9 to 34.4 U.S. cents per pound (IMF, 1986.) In 1986, the buffer-stock managers for the International Tin Agreement did not have the resources to purchase enough tin to maintain prices, and buffer-stock operations were suspended. Similarly, in the 1980s, the International Cocoa Agreement had to curtail buffer-stock operations owing to lack of funds, and the International Sugar Agreement has also typically been unable to maintain prices when it has been in operation.

These negative experiences are consistent with the theoretical appraisal of buffer-stock schemes. For instance, Salant (1983) argues persuasively that buffer-stock schemes are inherently subject to speculative attacks when previously inactive speculators suddenly purchase the entire buffer stock. There comes a point at which the goal of price stabilization combined with the size of the stock implies the likelihood or even the certainty that all stocks will be sold; profit-maximizing speculators who realize this buy in anticipation of the consequent price increase, causing the scheme to collapse. As Salant points out, many simulation exercises that purport to demonstrate benefits from stabilization schemes neglect this crucial role of speculators (see also Newbery and Stiglitz, 1981).

D *Import Restrictions in the United States and the European Community*

In general, import restrictions by developed countries have had little effect on African exports of primary commodities, for the simple reason that most commodities exported by African countries are not produced in temperate climates. In a few instances where commodities exported from Africa *are* produced in the United States and the European Community, however, they have been subject to import restrictions. Both the United States and the European Community support the prices for sugar obtained by their domestic producers, through quotas (for the United States) or tariffs (for the

European Community) on imports. The European Community has a similar policy to support the price of beef.

Price-support policies by large countries or groups of countries have several effects on the structure of international prices. First, they increase the prices paid to domestic producers in the importing country as well as to foreign producers granted preferential rights to sell to the importing country. Second, they may lower the free-market price for the commodity, since they increase supply and reduce demand within the price-supporting country. In some instances, price supports have caused countries to switch from being net importers to net exporters. For example, the European Community went from being a net importer of both sugar and beef in the early 1970s to being a net exporter in the 1980s. Low free-market prices for these commodities in the 1980s have been attributed to the expansion of EC exports. The high variability of the free-market prices of sugar and beef has also been attributed to EC policies.

The effect of import restrictions on African exporters depends critically on whether African countries are given preferential rights to export to the price-supporting countries. In the case of sugar, both the United States and the European Community have given preferential rights to groups of developing countries (see Box 2). In the case of beef, the Lomé Convention granted to a group of African countries (including Botswana, Kenya, Madagascar, Swaziland, and Zimbabwe) the right to export fixed quantities of beef to the European Community at reduced tariff rates. The banning of imports from regions with hoof and mouth disease has made it difficult for some countries to fill their quotas.

The result of U.S. and EC import restrictions, combined with preferential import systems, is that African exporters receive very different average prices for their exports. The *average* price received by a country is a weighted average of the supported price and the lower free-market price, with the weights depending on the fraction of total exports going to the price-supporting countries. Since the supported prices for sugar and beef have been higher and much more stable than the free-market prices, countries with large preferential quotas receive prices higher on average and more stable than countries with little or no preferential access.

The effect of the U.S. and EC preferential import systems on the *shadow* prices of African exports depends on whether total exports of the commodity in question exceed the preferential quota and whether preferential quotas are tied to the total level of exports of African countries. If export quotas do not depend on total exports, the shadow price will be (1) the free-market price when total exports are greater than the preferential quota, (2) the marginal cost of producing the quota when total exports are just equal to the

BOX 2

THE INTERNATIONAL SUGAR MARKET

Sugar is one of the few commodities that is produced in most countries of the world. The market for sugar is substantially affected by the sugar policies of the United States and the EC, which have price-support policies for beet and cane sugar. These price supports are maintained with the help of import quotas (for the United States) and import levies (for the EC), both being specific to individual exporting countries: The United States has maintained a domestic price for sugar of approximately 20 cents per pound since 1981, and the EC has maintained a price of approximately 17 cents per pound. In the 1980s, these supported prices were far higher than the free-market price, which fell steadily in nominal terms from 16.9 cents per pound in 1981 to 4.1 cents per pound in 1985. In the early 1980s, the free market accounted for about three-quarters of the sugar that entered international trade.

Because the EC and the United States support their domestic sugar price, African exporters receive a price that depends on the extent to which they have been granted preferential rights to export to the United States and the EC. The United States has typically given the bulk of these rights to the Philippines and Caribbean and Central American countries, although small import quotas have been granted to the Congo, the Ivory Coast, Malawi, Mauritius, Swaziland, and Zimbabwe. Most of the major African exporters receiving preferential treatment obtain it from the EC under the provisions of the Lomé Convention.

	1981	1982	1983	1984	1985	1986
Ethiopia	100	100	100	100	100	100
Gabon	100	100	100	100	100	100
Malawi	84	69	82	76	85	82
Mauritius	0	9	9	5	4	22
Swaziland	65	63	63	72	60	76
Zambia	100	100	100	100	100	100
Zimbabwe	100	91	83	89	85	78

SOURCE: International Sugar Organization, *Sugar Yearbook*, London, 1986.

The table shows the percentages of total export quantities that are exported to the free market by selected African countries. For all countries except Mauritius, the averge price received for sugar is dominated by the free-market price, and it is the changes in this price that affect their export earnings. Since export quotas to the United States and the EC are fairly stable, the marginal price received by all countries for additional exports is the free-market price.

quota, or (3) the supported price when total exports are less than the preferential quota.[3] If African exporters receive increased preferential quotas when their total exports increase, the shadow price will be a weighted average of the free-market and supported prices, with the weights depending on the responsiveness of export quotas to total export levels.

For African exporters of sugar and beef, the shadow price is probably the free-market price. First, African sugar and beef exporters usually export to nonpreferential markets. Second, the U.S. and EC quotas are not explicitly linked to the recipients' total exports, and there is no casual evidence suggesting that African exporters are able to negotiate higher quotas when their total exports increase. Nonetheless, the Congo lost its EC sugar quota in 1980 after failing to fill it (Radu and Somerville, 1989, p. 209). In general, though, it is reasonable to assume that African exporters of sugar and beef are small, in the sense that shadow prices are not affected by output levels but are instead equal to free-market prices for these commodities.

[3] When there is uncertainty at the time production decisions are taken as to how much will be produced relative to the quota, the shadow price will be a weighted average of the preferential and nonpreferential prices, depending on the distribution of the random variable. When output cannot be stored, the shadow price is the same as that derived in Gersovitz (1986), with processing capacity redefined to be the quota. When storage is an option, see Gersovitz and Paxson (1990).

4 THE BEHAVIOR OF INTERNATIONAL PRICES

A Hypotheses

The concentration of each African country's exports in one or a few primary commodities means that the prices each country obtains are determined in a small number of international markets. The ratio of an index of the country's export prices to the prices of the goods that it imports defines its net barter terms of trade. The net barter terms of trade measures how many units of imports are received for a unit of exports and is thus a key determinant of various dimensions of the country's economic status. As Table 2 indicates, the terms of trade of many African countries have been depressed in the 1980s, not just in comparison to the period 1974-79, in which there was a general commodity boom, but also in comparison to the earlier period 1960-73. Of the 29 countries on which UNCTAD reports, only 10 had higher terms of trade in 1982-85 than in 1960-73, and crude petroleum was crucial for 3 of these 10. Furthermore, the 7 gainers that did not depend primarily on petroleum had smaller gains on average than the absolute losses of the losers.

Each African country imports a different basket of goods, so that the prices of imports vary from country to country. It is not possible to analyze each African country's terms of trade, because these data are available for only a relatively short period, reflecting the recent independence of most African countries. But African countries are generally importers of manufactured goods, and so it makes sense to study the behavior of the ratios of prices of individual commodities to an index of prices for manufactured goods. This ratio is termed the *real* price of the commodity.

There are longstanding debates about the trend in real prices of primary commodities (see, e.g., Spraos, 1980; Sapsford, 1985; MacBean and Nguyen, 1987; Scandizzo and Diakosawas, 1987; Grilli and Yang, 1988; and Cuddington and Urzua, 1989). Some analysts argue that these prices will rise over time, and there are several theories that support this argument.

One such theory applies to the prices of exhaustible resources, such as minerals and petroleum, which become scarcer as time passes. The simplest model of a market for an exhaustible resource assumes that owners of the resource stock are competitive and that extraction is costless (Dasgupta and Heal, 1979). Price is predicted to rise at the rate of interest, because otherwise owners will not ration the fixed supply between current and future consumption. If price does not rise at least at the rate of interest, owners of

resource deposits will prefer to extract and sell everything immediately, investing their proceeds to earn the rate of interest.[1] Conversely, if price rises faster than the rate of interest, owners will prefer to keep their stocks indefinitely rather than sell anything at all. Therefore, neither of these two alternatives produces a supply of the resource over time that is consistent with the demands of consumers. A price that rises at the rate of interest *can* achieve this if suppliers establish an initial price that, in combination with this rate of increase, leads to the exhaustion of the resource just as the price reaches the level at which consumers no longer want to consume the resource.

A similar argument has been made for the prices of inexhaustible commodities that can be stored to await the profit to be made from future price movements (Labys and Granger, 1970). Individuals holding stocks of such a commodity for profit must anticipate that the price will rise by the rate of interest plus any physical costs of holding stocks. It might therefore be concluded that the price of such a commodity would also rise continuously, which in turn seems inconsistent with a determination of average price by the costs of production. The view that the price rises continuously, however, ignores the existence of stockouts, when speculators do not hold stocks. In the period just after a stockout, the price tends to fall as new harvest production replenishes supplies. Taking periods when stocks are held and the price rises on average with periods following stockouts when the price tends to fall, the price shows no overall tendency to change, being determined by the long-run costs of production (Danthine, 1977, and Samuelson, 1972).

The fact that production comes from more and more marginal deposits, causing costs of extraction to rise with the passage of time, also suggests an upward trend in mineral prices. Similar arguments apply to agricultural products or timber when increased demand pushes production onto poorer or less accessible land or forces producers to add more inputs to a fixed amount of land.

At some times, as in the 1970s, consumers have feared the formation of producer cartels, with a one-time increase in the price of each primary commodity as it is successfully monopolized. Changes in the number and effectiveness of international commodity agreements or in the intensity of protection in the United States and the European Community could have similar effects.

[1] Countries may face a shadow rate of interest above the world rate of interest if their opportunities to borrow at the world rate of interest are restricted. We argue in section 6B that many African countries are in this situation. In that case, they have an incentive to extract a natural resource early on, if its price is rising only at the world rate of interest.

By contrast, arguments have been advanced that the terms of trade of primary producers will tend to decline. One such argument is that technological change in manufacturing tends continuously to reduce the demand for raw materials. Examples include the substitution of synthetics for natural fibers, of optic fiber for copper wire, and of electronic methods of transmitting information for the physical method of moving documents, which uses fuel. Another argument is that labor unions in developed countries tend to raise the prices of manufactured goods relative to those of primary commodities. It is not clear, however, why this or the exercise of other forms of monopoly power do not result in a higher level of prices for manufactured goods rather than a faster rate of increase in those prices.

B Recent Developments

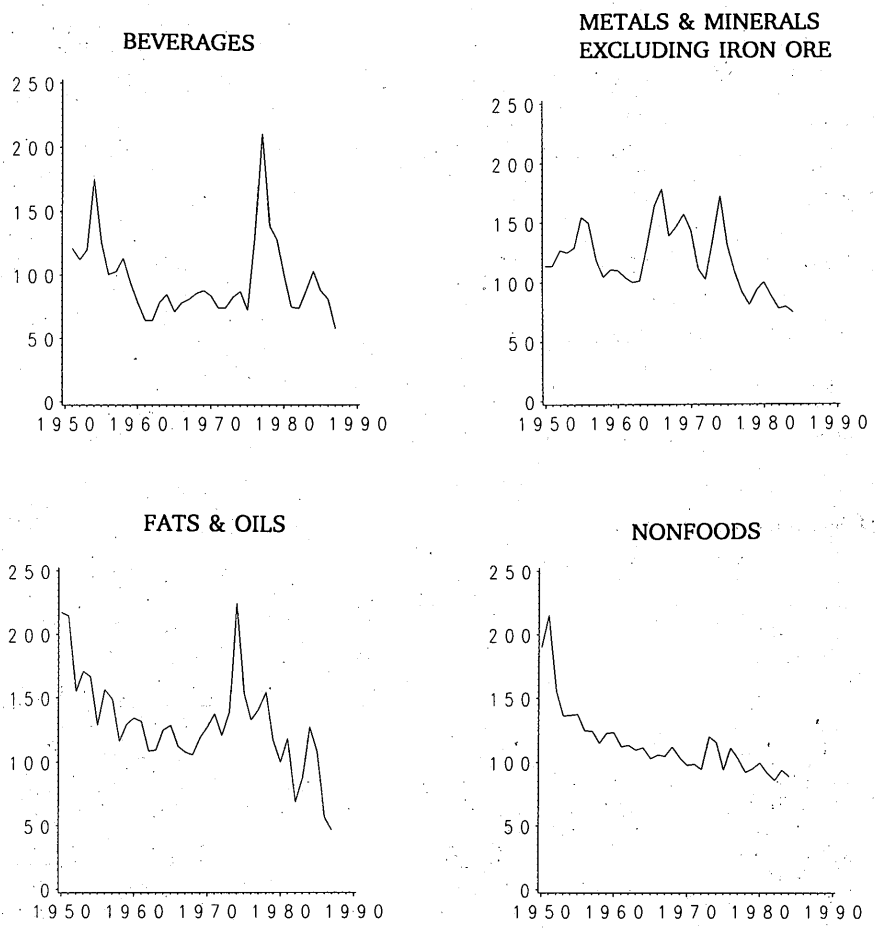
None of these explanations for the evolution of commodity prices is fully convincing on theoretical grounds, nor are the postulated mechanisms apparent in the evidence. Therefore, the best strategy for characterizing the prices that African exporters face is to examine the actual behavior of those prices. The indexes of real prices for several broad commodity groups, plotted in Figure 1, reveal several important aspects of commodity price movements.

First, each of these price indexes appears to trend downward over the period 1950-87. This tendency seems especially strong for edible fats and oils and for agricultural nonfood products (which include cotton, rubber, sisal, and tobacco). Although we will see later that this downward trend is not statistically significant for most individual commodity prices, it is evident that 1980-87 prices for these commodity groups (none of which includes petroleum) were substantially below their 1950-79 average levels. Furthermore, this result is not driven by exceptionally low prices for one or two commodities in each group in the 1980s. Average real prices for specific commodities are shown in Table 4 for subperiods between 1950 and 1987; the price for each subperiod is divided by the average real price for the whole period. For every commodity except bananas, tobacco, and crude petroleum, prices were markedly lower in 1980-85 than in 1974-79, and all commodities except cocoa, logs, crude petroleum, and tin had lower prices in 1980-85 than in 1950-73. Furthermore, all prices except for logs have declined in 1986-87 from their typically low 1980-85 levels. It should be noted that some of the series, especially beverage prices, have very notable spikes in the mid-1970s, pointing up the danger of judging current price levels by reference to this period in the recent past.

Second, these commodity groups exhibit considerable year-to-year variability. Many of the sharp price movements can be traced to unusual weather conditions. For example, the spike in beverage prices in 1977 par-

FIGURE 1

PRICE INDEXES FOR COMMODITY GROUPS, 1950-87



NOTE: The weights used to construct the price indexes are based on the average 1975-78 value of total African exports of each commodity within a commodity group. The following commodities were used: beverages (cocoa, coffee, tea); fats and oils (copra, groundnut oil); nonfoods (cotton, rubber, sisal, tobacco); and metals and minerals (copper, manganese, phosphates, tin). The metals and minerals index excludes iron ore, which is important to Africa but for which we were not able to obtain a consistent price series over the sample period. A modified index including iron ore from 1960 conforms closely to the graph above.

SOURCE: World Bank, *Commodity Trade and Price Trends*, 1986, as updated (Appendix B).

TABLE 4

DESCRIPTIVE STATISTICS: REAL COMMODITY PRICES

Commodity	Average Real Commodity Prices [a]				% Growth Rate		% Residual
	1950-73	1974-79	1980-85	1986-87	Mean	Std. Dev.	Variability
Food and beverages:							
Bananas	1.12	0.78	0.84	0.67	−2.3	9.4	9.9
Cocoa	0.93	1.46	0.93	0.70	−1.5	26.6	23.8
Coffee	0.95	1.33	0.93	0.78	−2.2	24.0	23.1
Sugar	0.95	1.58	0.85	0.38	−3.8	44.2	42.1
Tea	1.20	0.76	0.68	0.44	−3.2	19.4	19.8
Fats, meal, and oils:							
Copra	1.12	1.02	0.74	0.33	−4.1	35.5	30.1
Groundnut meal	1.14	0.92	0.69	0.47	−3.2	18.5	17.2
Groundnut oil	1.06	1.20	0.78	0.41	−4.1	22.7	21.8
Nonfoods:							
Cotton	1.12	0.94	0.77	0.49	−3.3	17.7	18.1
Logs	0.81	1.33	1.17	1.20	1.5	17.5	17.2
Rubber	1.20	0.73	0.64	0.46	−4.1	22.6	20.6
Sisal	1.06	1.13	0.77	0.58	−3.4	25.0	19.9
Tobacco	1.04	0.91	0.91	...	−1.0	10.6	9.2
Minerals and metals:							
Crude petroleum	0.52	1.41	2.50	1.04	1.5	22.5	22.6
Copper	1.16	0.87	0.64	0.51	−1.2	21.1	20.7
Iron ore	1.28	0.84	0.68	0.51	−4.5	9.8	8.1
Manganese	1.14	0.77	0.62	...	−2.9	12.5	12.1
Phosphates	0.96	1.37	0.92	0.60	−2.0	24.4	21.3
Tin	0.88	1.35	1.30	0.50	−1.4	19.6	19.2

[a] Subperiod price divided by average price for whole period.

NOTE: All prices run from 1950-87, except for tea (1951-87), logs (1956-87), iron ore (1960-87), and tobacco and manganese (1950-84). Average real commodity prices are divided by the sample mean for the full 1950-87 time period (or the actual time period for which data exist). Growth rates are measured as changes in the (natural) logarithm of real commodity prices. Measures of residual variability are based on the estimates of ARIMA models presented in Appendix A.

SOURCE: World Bank (1986), with modifications discussed in Appendix B.

tially reflects bad weather that cut coffee output in Brazil. Other sharp price movements are associated with changes in the policies of importing or exporting countries and the formation or disintegration of price-support arrangements. The 1985 collapse of the International Tin Agreement is an example of the latter.

While the graphs in Figure 1 reveal much about the experience of African commodity exporters in the recent past, a more precise method of analysis

is necessary. The graphs do not distinguish between what occurred by happenstance and what was instead consistent with a systematic dynamic process, let alone the characteristics of such a process. Only an analysis based on a formal statistical model can begin to answer these questions.

C *Statistical Analysis*

Our statistical analysis seeks to quantify three important characteristics of price movements: trend, intertemporal dependence, and variability.

Trend. Commodity prices may exhibit a systematic tendency to increase or decrease with time. We are interested not only in the magnitude of such a trend but whether or not it is measured precisely.

Intertemporal dependence. Commodity prices vary over time. These fluctuations may be entirely random (there is no relationship between current and past prices), or they may involve intertemporal dependence (the current price is related to past prices). If a shock makes prices intertemporally dependent, its effects may die out completely or may persist indefinitely. In the case of (indefinite) persistence, the ultimate effect of the shock may be greater or less than the initial shock. The nature of this intertemporal dependence is, in turn, an important determinant of how African governments and individuals should adjust to changes in commodity prices. Shocks that may be persistent include the formation or collapse of an international commodity price agreement, the discovery of a synthetic substitute for a natural product such as optic fiber for copper, or the discovery that an agricultural product contains a contaminant such as deadly aflatoxin in groundnut meal. A shock that may be temporary is bad weather in another important producing country, as in Brazil in the case of coffee.

Variability. Because prices are subject to random contemporaneous shocks, it is impossible to use knowledge of past prices to predict future prices accurately. The unpredictable element, often referred to as residual variability, is important because it indicates how much unpredictable variation to expect in the incomes of producers and governments that raise revenues from commodity exports. Other things equal, economic decisionmakers prefer stable rather than variable incomes; they are risk averse. They are therefore motivated to take all sorts of actions to transform unstable into stable incomes, even though many of these actions are costly and decrease the average income of the economy.

The prices of the nineteen commodities important to African exporters listed in Table 4 were subjected to formal statistical analysis. Appendix A outlines the time-series methodology used to analyze these data and describes in detail the statistical conclusions. We summarize these findings here.

As was suggested by the graphs of real commodity prices in Figure 1,

most of the nineteen prices analyzed have negative trends or mean growth rates (Table 4, column 5). Only logs and crude petroleum have positive trends over the 1950-87 period. With the exception of iron ore, however, none of these trends is statistically significant (in the ARIMA models of Appendix A). And the sample period for iron ore is very short and may be peculiar. Thus, the analysis does not provide support for either the hypothesis that commodity prices tend to rise over time or the converse hypothesis that they tend to fall.[2]

Even if prices do not exhibit trends, they may still exhibit intertemporal dependence. The statistical evidence strongly suggests that all commodity prices exhibit some degree of intertemporal dependence: prices do not vary from year to year in a random way around an average value. Nevertheless, it is difficult (given relatively short time series for prices) to quantify precisely the nature and degree of intertemporal dependence. We use two methods to assess persistence: parametric (ARIMA) models and nonparametric persistence measures. The ARIMA estimates may tend to overstate the degree of long-run persistence displayed by price shocks (see Appendix A).

The ARIMA estimates imply that most commodity prices exhibit strong intertemporal dependence. For bananas, coffee, sugar, tea, cotton, logs, crude petroleum, copper, and tin, statistical criteria suggest that the current price of the commodity can be expressed as a fairly high fraction of the price in the previous year plus a random shock. By implication, shocks to the prices of these commodities will tend to prevail into the future; currently low prices will tend to stay low, reverting slowly to average levels. The prices of groundnut meal, rubber, sisal, tobacco, and manganese also exhibit intertemporal dependence, and the expected prices of these commodities are thus close to current prices.

For all of these commodities, one cannot reject the simple (unit-root) hypothesis that shocks to prices persist indefinitely, so that there is no reason to believe that prices will revert to an average level. Indeed, for all but groundnut meal, rubber, sisal, tobacco, and manganese, we cannot reject the hypothesis that 100 percent of a shock persists indefinitely. Given what we believe about the economic structure of commodity markets, however, full persistence does not seem to be a realistic (null) hypothesis. For instance, even weather damage to perennial crops should dissipate with time. For many of these commodities, the ARIMA models are imprecisely estimated (Table A.1), and therefore a wide range of ARIMA parameters are consistent with the data.

The prices for cocoa, copra, groundnut oil, iron ore, and phosphates do

[2] Cuddington and Urzua (1987) come to similar conclusions.

not exhibit persistence. The ARIMA estimates indicate that the prices of cocoa, copra, groundnut oil, and phosphates can be expected to revert quickly to their average values. The price of iron ore can be expected to decline at an average rate of 4.2 percent per year. The results for both groundnut oil and iron ore are tentative, however. As noted above, the sample period for iron ore may be peculiar. There is evidence that the ARIMA model for groundnut oil may not have converged properly, and its results are in conflict with the nonparametric measure.

The nonparametric persistence measures may provide better estimates of the fraction of a shock to a price that will persist in the long run. In general, the nonparametric measures indicate that a substantial fraction of shocks to most commodity prices will persist far into the future.[3] However, the degree of persistence implied by the nonparametric measures appears to be lower, overall, than that implied by the ARIMA estimates. Only groundnut oil, crude petroleum, copper, and tin prices appear to be exceptionally persistent. Commodity prices that display little long-run persistence (less than 20 percent of the shock, Table A.3, column 2) include bananas, cocoa, logs, rubber, tobacco, iron ore, manganese, and phosphates. Although shocks to these prices may display strong intertemporal dependence in the short run (as indicated by the ARIMA results for bananas, logs, rubber, and tobacco), one can expect these prices to revert much of the way to their past levels.

The results in Appendix A indicate substantial residual variation in real commodity prices. The last column of Table 4 shows the degree of residual variation of each price, measured by the percentage range over which the actual price is likely to deviate from its expected value.[4] Cocoa, coffee, sugar, copra, groundnut oil, rubber, crude petroleum, copper, and phosphates exhibit high residual variability (over 20 percent), while bananas, tobacco, and iron ore exhibit low residual variability (under 10 percent).

These results regarding residual variability can be used in conjunction with the information in Table 3 on export shares by country to indicate how much uncertainty surrounds the export earnings of individual countries. For example, Burundi obtains 87 percent of its export earnings from coffee, and Uganda obtains 92 percent of its export earnings from coffee, so that both face important uncertainties about the future prices of their exports. A country like Liberia, by contrast, with 79 percent of its exports coming from iron ore and rubber, faces much more predictable prices, because each commodity has a residual variability lower than that of coffee. In addition, Liberia benefits from a further reduction in total residual variability to the extent that iron ore and rubber are not perfectly correlated. It should be

[3] These findings are consistent with Deaton and Laroque (1990).

[4] The figures for the residual variability of each commodity price are based on the ARIMA estimates shown in Table A.1.

noted that the extremely high residual variability of the sugar price (42.1 percent) overstates the true uncertainty facing those African sugar exporters who have permission to export to the United States and the European Community at relatively stable supported prices (see Box 2).

While the statistical analysis summarized above is useful for describing the behavior of commodity prices over time and directly confronts the issues of trends, intertemporal dependence, and variability, it does not yield much information about the structure of demand and supply in these markets and therefore about the sources of price movements. Changes in prices may be driven by supply-side changes, such as the adoption of new technology that lowers costs or shocks from weather that affect agricultural yields. Changes in demand affect prices too, and important fluctuations are induced by business cycles in developed countries. But the structural econometric models necessary to understand these markets in these ways are beyond the scope of our inquiry.

5 COMMODITY PRICES AND ECONOMIC PERFORMANCE

A *Introduction: Impact Effects and Ultimate Effects*

To a first approximation, the effect on economic performance of a fall in the international price of a primary commodity is a cut in the purchasing power of a fixed basket of the economy's output. This income effect depends on the size of the fall in the price and the importance of the export relative to the value of national output. Because African countries export a very large fraction of their GNP (Table 1), decreases in the prices they receive for their commodity exports represent large percentage cuts in their real incomes.

Different groups in the economy share to different degrees in this income effect, depending on the sources of their incomes. Indeed, individuals who earn their incomes in the nonexport sectors will experience an initial increase in the purchasing power of their incomes to the extent that they purchase some of the exportable goods, so that their share of the immediate income effect is negative. But, given the nature of most African exports, this consequence is likely to be small. The initial burden of a fall in export prices may also differ between the government and private sectors of the economy, a distinction we find to be extremely important in the African context.

In the discussion that follows, we use the term *impact* to include both the aggregate income effect just described and its distribution across the economy. We use the terms *secondary*, *ultimate*, or *general-equilibrium* to mean all the remaining consequences of a change in export prices for economic behavior, such as the effects on consumption, saving, and production patterns and on variables such as prices and incomes. Many of these effects are analyzed in the literature on the Dutch Disease (Corden, 1984, and Neary and van Wijnbergen, 1986). As is well known, it is theoretically possible for secondary adjustments of the economy to turn individuals who were losers in terms of the impact effect into net gainers, and vice versa.

To show how changes in the international prices of commodities may affect economic performance, the following sections deal in detail with the distribution of the aggregate impact effect, with the transmission of the changes to different parts of the economy, and with the responses of consumers, producers, and their governments to the stimulus of changes in export prices. Section 5C puts particular emphasis on the role of the government, arguing that it bears a disproportionate burden in many countries because its revenues decline markedly in the face of falling international

prices. The responses of governments are discussed in section 5D. Sections 5E and 5F trace the responses of producers of agricultural exports and of mineral exports, respectively. Section 5G focuses primarily on the general-equilibrium effects of export price changes on African economies.

Before turning to this detailed analysis, however, we present a purely statistical overview of the relationship between the terms of trade and two dimensions of economic performance, the level of GDP and its rate of growth.

B *Statistical Overview*

The level of GDP per capita and its rate of growth can both be influenced by the export prices a country receives, and this section presents some graphical and statistical evidence on the character of the relationships shown by African countries in the recent past.[1]

It is possible that there is a positive relationship between the terms of trade and the *level* of real GDP per capita, a measure of the economy's output rather than its income. (By contrast, an income measure naturally incorporates the effect of the terms of trade, our impact effect.) The theoretical arguments for this relationship are weak, however. When a country's export prices decline, farmers may not work as hard and immigrants from other African countries may go home or be sent home. Hence, labor input in the economy as a whole may fall, reducing total output. Furthermore, farmers may retreat into producing subsistence output that may not even enter the calculations of GDP, and the subsistence sectors of African countries are relatively large.

An overview of the economic performance of certain African economies gives some support to these suppositions. Zaire and Zambia are notorious for their dependence on copper, the price of copper has been depressed for fifteen years, and real GDP per capita has fallen in these countries during

[1] These issues are related to the literature on the relationship between exports and GNP or GNP growth (Michaely, 1977, 1979; Balassa, 1978; Heller and Porter, 1978; Tyler, 1981; Feder, 1983; and Jung and Marshall, 1985). An evaluation of these findings would be a digression from our main task, however. We present results that use the terms of trade rather than an export variable as the independent variable because we view exports as endogenous and as only a vague proxy for all sorts of incentives. By contrast, while the terms of trade is endogenous to the extent it is a unit value, it is at least a concept that could be exogenous, and its interpretation as an incentive at least at the national level is clear. Our negative results are consistent with the findings of this literature that (1) the effect of exports on GNP is more marked than on the growth of GNP; (2) when these authors split their sample into poor (generally including the African countries) and less poor countries, the correlation for the former group is weaker; and (3) there is no relationship when the terms of trade, rather than an export-volume variable, is used (Tyler, 1981, Table 1).

this period. Similarly, Cameroon, the Congo, and Gabon are petroleum exporters and grew very quickly when the price of oil was rising, although Nigeria did not do as well. Yet one cannot explain the very poor performance of Ghana and Uganda by their terms of trade; other cocoa and coffee exporters, such as the Ivory Coast, fared notably better.

Bivariate correlation analysis is a somewhat more systematic method for summarizing the relationship between the terms of trade and economic performance. Figure 2 examines the relationship for twenty-four African countries by plotting the average annual growth rate of GDP per capita for 1974-83 against the average annual growth rate of the terms of trade for the same period. If the level of real GDP per capita and the terms of trade are related, the growth rate of real GDP per capita should be related to the growth in the terms of trade.[2] Figure 2 shows that the positive correlation between these two growth rates is not statistically different from zero and is therefore probably the product of chance rather than a true economic relationship.

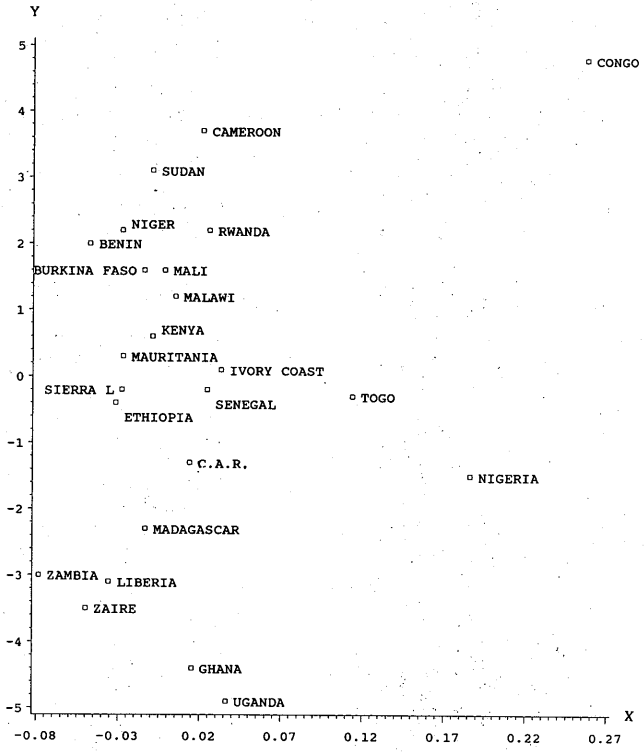
Another set of factors suggests that there may be a positive relationship between the rate of growth of a country's real GDP per capita and the *level* of its terms of trade. If foreign-exchange regulations and other interventions do not shelter investment goods fully, private and public purchasers find them more costly to import when export prices are low. Because the investment goods they buy are usually not produced domestically, purchasers cannot switch easily from imports to domestic substitutes. As a consequence, it is difficult to mitigate the effect of a fall in commodity prices on the cost of capital accumulation. When accumulation falls, so does the future growth in income (over the short term as opposed to in the steady state). Similarly, spare parts and other inputs needed to maintain the existing capital stock are more difficult to purchase, and productive capacity may actually contract. African governments, in particular, cannot raise the revenue to maintain roads and provide other types of support that are vital to the small, dispersed agricultural producers in their countries.

Figure 3 examines the relationship between the growth rate of real GDP per capita and the level of the terms of trade. Once again, the relationship is transformed by examining changes in these measures. Figure 3 plots the difference between average annual growth rates of real GDP per capita in 1974-83 and 1965-73 against percentage differences between the average terms of trade in these same two periods. The correlation is actually negative and very weak statistically, implying that countries experiencing

[2] This transformation to growth rates is needed because the levels of the terms of trade involve different commodities for different countries. As a result, the levels of the terms of trade cannot be compared across countries, while the percentage changes can be compared.

FIGURE 2

TERMS OF TRADE AND GDP, 1974-83



NOTE:

Y axis = 1974-83 average annual growth rate of real GDP per capita.

X axis = 1974-83 average annual growth rate of real terms of trade.

Correlation (X,Y) = 0.26 (not significant).

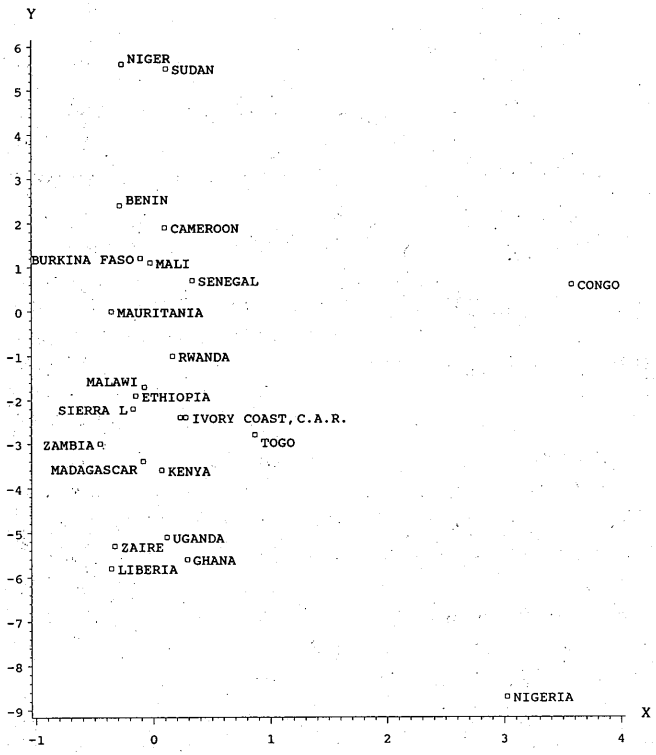
SOURCE: GDP data are from the World Bank, *World Development Report 1985*, Washington, 1985; the terms-of-trade data are from Table 2.

improvements in their terms of trade do not necessarily experience an increase in their growth rates.

The correlations represented by Figures 2 and 3 are very crude. They do not control for other factors or reflect any structural mechanism by which the posited relationships are presumed to operate. If errors are made in measuring the terms of trade, moreover, the calculation of differences in the variables is likely to increase the noise-to-signal ratio in the explanatory variable and thus attenuate any relationship. Nevertheless, Figures 2 and 3 indicate that there are no simple and clear-cut relationships between the

FIGURE 3

GROWTH IN TERMS OF TRADE AND GROWTH OF GDP, 1965-73 COMPARED WITH 1974-83



NOTE:

Y axis = difference between 1974-83 and 1965-73 average annual growth rates of real GDP per capita.

X axis = % difference between 1974-83 and 1965-73 average real terms of trade.

Correlation $(X,Y) = -0.20$ (not significant).

SOURCE: GDP data are from the World Bank, *World Development Report 1985*, Washington, 1985; the terms-of-trade data are from Table 2.

prices of the commodities exported by African countries and the countries' overall economic performance.

This finding may reflect great diversity across countries in how changes in world prices are transmitted through their economies. The effect on economic performance of a decline in the price of a specific commodity depends (1) on how the price decline is divided between producers' incomes and the government's revenues, (2) on whether the government responds by reducing expenditure on consumption or on investment when its revenues

are affected, (3) on whether and how quickly producers reduce production of the export commodity when their prices are affected, (4) on whether the country borrows abroad to compensate for the reduction in foreign-exchange earnings or must make payments to its creditors, and (5) on whether donors provide more foreign aid in response to the price decline. Furthermore, such noneconomic factors as political instability, internal strife, and war play a role in economic performance in Africa—in Angola, Chad, and Uganda, to cite some examples among many. We now turn to a more detailed analysis of the economic factors at work in determining how African economies respond to cuts in export prices.

C *Division of Impact Effects between Government and Private Sectors*

As we have noted, movements in the international prices of Africa's exports do not translate one-for-one into movements in the prices received by producers of exports. African governments take a share of the export earnings of their economies, and so mediate between domestic producers and international markets, with two extremely important effects. First, the revenues that African governments raise directly and indirectly from exports bulk very large in their fiscal accounts, so that changes in international prices have important effects on these governments, on individuals whose incomes depend on governments, and on individuals who are affected by government investment programs. Second, these actions by governments buffer producers from changes in world markets, reducing their incentives to respond to changes in international prices.

Export sectors in Africa contribute far more to government revenues than is indicated by conventional tabulations. The most narrow measure of the contribution is the yield from export duties. These are usually *ad valorem* taxes (fixed fractions of the value of exports), though some are specific taxes (fixed amounts per unit exported).

Because there is a very close connection between export earnings and the value of imports, a change in export prices also results in a change in the revenues from import tariffs. When asking how changes in international prices affect government revenues, it is therefore appropriate to think of all tax revenues from trade as responding to export prices.

As Table 5 makes clear, most African governments rely on export and import duties for high proportions of their tax revenues. Of the 40 countries covered in Table 5, 11 raised more than 50 percent of their tax revenues from international trade, while an additional 18 raised between 25 and 50 percent in this way. Generally, export taxes contribute far less than import duties.

Other revenue sources are also responsive to export prices, however. These include corporate income taxes, royalties, the profits of public cor-

TABLE 5

RELATIONSHIP BETWEEN TRADE AND GOVERNMENT REVENUES
(in percent)

Country	Share of		
	Trade Taxes in Total Revenues	Export Taxes in Total Exports	Import Duties in CIF Imports
Benin (1979)	61	5	25
Botswana	38	0	17
Burkina Faso	38	3	18
Burundi (1981)	27	3	18
Cameroon	21	5	26
Central African Republic (1981)	44	14	37
Chad (1986)	52	...	...
Comoros	82	...	...
Congo (1980)	17	0	14
Djibouti (1980)	5	...	...
Ethiopia (1981)	36	29	18
Gabon	22	1	27
Gambia (1982)	76	4	25
Ghana	46	25	15
Guinea (1983)	57	...	...
Guinea-Bissau	32	...	...
Ivory Coast	40	5	24
Kenya	23	1	16
Lesotho	80	1	21
Liberia	31	0	18
Madagascar (1982)	23	5	16
Malawi	22	0	18
Mali	23	5	5
Mauritania (1979)	35	1	14
Mauritius	58	9	18
Niger (1980)	43	3	19
Nigeria (1978)	26	0	16
Rwanda (1980)	49	26	14
Senegal (1983)	38	1	16
Seychelles (1977)	48	1	13
Sierra Leone	42	3	18
Somalia (1978)	61	3	45
Sudan (1982)	62	7	32
Swaziland	69	0	21
Tanzania	7	0	7
Togo	31	1	15
Uganda	68	30	8
Zaire	35	12	16
Zambia	18	8	6
Zimbabwe	16	0	25

NOTE: Data are for 1984 unless indicated by date in parentheses.

SOURCE: Tax data are from IMF, *Government Finance Statistics Yearbook*, 1987, and trade data from IMF, *International Financial Statistics Yearbook*, 1987.

porations and public marketing boards, and the retained surpluses of these entities that may be spent on governmental activities.[3]

In Africa, many of the large corporations that are accessible to the government's tax collectors are exclusively in the business of exporting, usually minerals but sometimes processed agricultural goods. A decrease in export prices decreases their profits and the government's tax take. The most obvious cases are countries that export crude petroleum or minerals. Nigeria is an extreme example and is discussed in Box 3.

BOX 3

TAX REVENUES FROM OIL EXPORTS

The governments of African countries with petroleum reserves have perhaps the easiest time raising revenues. Nigeria is a good example. As the annual reports of its central bank show, the government raises most of its revenues from petroleum exports. Furthermore, it captures very high proportions of the value of petroleum exports as revenues.

Oil taxes as % of	1978	1979	1980	1981	1982	1983	1984	1985
Total taxes	65	77	81	72	67	69	73	73
Oil exports	79	...	91	80	80	99	93	100

These revenues are classified as petroleum-profits taxes, mining rents and royalties, and profits of the Nigerian National Petroleum Corporation. They are not recorded as export duties. Given the very high proportion of the value of exports resulting in tax revenues, any decrease in the price of petroleum exports translates almost one for one into a decrease in government revenues. A similar situation prevails for such oil exporters as Cameroon and the Congo (see IMF, *Government Finance Statistics Yearbook*, Washington (various years).

Traditionally, government revenues from export taxes do not include the profits of state marketing boards net of their payments to farmers (see Box 4).[4] These profits are not considered to be government revenues unless they are formally remitted to the government, and marketing boards often retain them. Nonetheless, some of these boards lend their funds in support of other government institutions without expecting repayment, as in Ghana, or use them to undertake activities on behalf of the government. Furthermore, these funds will never be remitted to the government if they are used

[3] Of course, these sources differ from export duties in the particular ways that they affect incentives and deadweight loss.

[4] The activities of marketing boards are discussed in Arhin *et al.*, eds. (1985).

BOX 4

GOVERNMENT REVENUES FROM BEVERAGE-CROP EXPORTS

Cocoa and coffee are among the most important exports of Africa as a whole, and governments have fastened on them for tax revenues. The percentage division of the coffee export price in Uganda for recent years was:

	1972	1973	1974	1975	1976	1977	1978	1979	1980
Farmer	39	27	32	19	15	28	31	52	46
Huller	10	7	8	5	4	6	6	9	7
Marketing board	11	8	10	7	6	6	20	13	15
Government	40	58	50	69	75	60	43	26	32

SOURCE: World Bank (1982).

For cocoa in Ghana, the Ivory Coast, and Togo, the farmer's percentage of the export price was:

	1976	1977	1978	1979	1980	1981	1982	1983	1984
Ghana	29	13	23	40	85	254	175	...	...
Ivory Coast	49	40	38	44	51	66	60	62	42
Togo	37	29	29	30	39	47	42	46	30

SOURCE: For Ghana, World Bank (1984, p. 91). For the Ivory Coast and Togo, BCEAO, *Notes d'information et statistiques*, Dakar.

These percentages indicate the tendency for farmers to receive a relatively small share when the real price of their crop is relatively high; 1976-79 were boom years for cocoa and coffee. Correspondingly, the government's marginal share of export earnings exceeds its average share, so it loses disproportionately from a price decrease. In extreme cases, as in Ghana in 1981 and 1982, the government may actually subsidize exports, losing revenue on net, at least in terms of the local (often overvalued) currency. Apparently, this situation prevailed in the Ivory Coast, leading to the government's decision to cut the producer price of cocoa in July 1989.

The IMF (*Government Finance Statistics Yearbook*, 1986) reports that taxes on coffee exports accounted for between a quarter and two-thirds of tax revenues in Uganda between 1976 and 1985, and this apparently neglects the share of the marketing board. In Ghana (World Bank, 1984, pp. 135 and 181) cocoa was equally important as a source of government revenues up through 1980, while the marketing board actually had small losses. For the Ivory Coast, Akiyama (1988, Tables 1-4) shows that the Caisse de Stabilisation and, secondarily, the government received FCFA 131 billion in 1979-80 of the value of exports of coffee and cocoa (and FCFA 70 billion in 1980-81). By contrast, the IMF reports that the government received only FCFA 28 billion in general export duties in 1980, and total tax revenues of FCFA 454 billion. Exports of these two commodities seem to have provided far more resources to the government in these years than conventionally measured.

to pay the personnel of the marketing board, and yet such expenditures may not represent real marketing costs. Jobs with a marketing board can be provided as government patronage just like civil service jobs. Even when remitted to the Treasury, moreover, the profits of marketing boards may show up as special items, distinct from export taxes.

Some categories of tax revenue (e.g. income taxes) seem to be independent of exports. The existence of such revenue sources suggests that governments have meaningful alternatives to export-based taxes, but these sources are virtually paper transactions and ought to be disregarded in the African context. Many African countries report revenues from income taxation, but these do not derive from systems of comprehensive self-declared income taxation, as in the United States. Instead, the income tax is very narrowly based, falling largely on the incomes of government employees and the employees of the rather circumscribed group of large, modern, private firms. Such revenues do not confer much fiscal flexibility or independence from taxes that depend on export prices. The government cannot maintain the standard of living of its own employees by increasing income tax rates to fund raises for them, because the tax increases will fall largely on the incomes of those employees.

Finally, the overvaluation of the currencies of many African countries acts as an implicit tax on exports. Exporters who receive foreign exchange are forced to surrender it for an artificially low amount of domestic currency. This phenomenon is much less important in French African countries like the Ivory Coast, where they tie their currencies to the French franc via the FCFA, than in such countries as Ghana, where it has been decisive.

In Africa, a decrease in export prices will lead to a decrease in government revenues that is more than proportional to the associated fall in export earnings. This would not be the case if *ad valorem* export duties were the only revenue source affected. But marketing boards often keep the prices they pay to domestic producers relatively constant in real terms, so that they may bear almost the full amount of a fall in the real export price. Furthermore, marketing boards must meet marketing costs that are largely independent of international commodity prices, a factor that by itself would suggest that the variation of producer prices relative to its mean (its coefficient of variation) should exceed that of the world price.

A policy of fixing producer prices may be optimal in some situations faced by African exporters. When an African country faces a quota in an export market with a prevailing price that would lead it to export more if it could, the price necessary to induce domestic producers to fill the quota is, by definition, below the quota price. The quota price can therefore fluctuate without requiring a revision in the producer price. If the producer price were set higher than necessary to induce an output equal to the quota, the

government would have to ration the right to export among domestic producers. Of course, when the country also has access to a nonquota market to which it can profitably export, the nonquota price is relevant for the setting of the producer price (see Boxes 1 and 2 on coffee and sugar).

Table 6 summarizes the relationships between producer prices and world prices for a number of countries and commodities. It suggests a classification of countries into three groups.

The largest group stabilizes the real prices received by producers. It includes Burundi, Cameroon, the Gambia, the Ivory Coast, Madagascar, Malawi, Niger, Nigeria, Rwanda, Senegal, and Togo. For these countries, the variation in real producer prices relative to their means (the coefficient of variation in Table 6) is much lower than the variation in international real prices. In some of these countries, there is some change in real producer prices when international real prices change. For example, the Ivory Coast (cocoa only), Burundi, Cameroon (cocoa only), Rwanda, Nigeria, the Gambia, and Senegal show significantly positive correlations between the world price and their respective producer prices (see the last column of Table 6). By contrast, Cameroon (coffee only) and the Ivory Coast (coffee only), Madagascar, Malawi, Niger, and Togo do not show strong correlations between world and producer prices. In sum, for the countries in this first group, government revenues from commodity exports fluctuate more than proportionally to international prices, and producers' incentives are correspondingly weakened.

In a second group of countries, producer prices exhibit large variations and are not positively related to world prices in a significant way. These countries are Ghana, Tanzania, and Uganda. In these countries, the variations in producer prices arise not because they fluctuate in sympathy with world prices but because their governments have been continuously lowering the real prices paid to their producers regardless of international conditions. Producers faced with a persistent deterioration in profitability have responded by abandoning production for export, and government revenues have borne the effects of fluctuations in international prices.

Finally, a third small group of African governments move producer prices in proportion to international prices. The examples in Table 6 are Burkina Faso, Kenya, and Sierra Leone. Their producer prices exhibit both high variability relative to their means (comparable to those of the international prices) *and* a high correlation with international prices.

Figure 4 displays graphs of real world prices and selected producer prices for cocoa and coffee from the early 1960s to the mid 1980s. They illustrate the different ways in which producer prices were set in different countries in this period. Sierra Leone (cocoa) and Kenya (coffee) have allowed producer prices to track world prices. Ghana (cocoa) and Uganda (coffee) have

TABLE 6

RELATIONSHIPS BETWEEN PRODUCER AND WORLD PRICES: COCOA, COFFEE, GROUNDNUTS, AND COTTON

Commodity	Year	Coefficient of Variation [a]		Correlation of World and Producer Prices
		Producer Price [b]	World Price [c]	
Cocoa:				
Cameroon	1962-80	17.9	43.7	0.67*
Ghana	1961-82	36.7	43.0	−0.34
Ivory Coast	1961-85	15.9	40.2	0.67*
Nigeria	1961-85	21.5	40.2	0.48*
Sierra Leone	1961-85	41.3	40.2	0.81*
Togo	1963-85	15.1	39.7	0.28
Coffee:				
Burundi	1965-85	24.6	38.1	0.79*
Cameroon	1962-85	11.1	38.5	0.15
Ivory Coast	1961-85	9.2	39.6	0.38
Kenya	1961-85	34.1	39.6	0.93*
Madagascar	1964-85	23.7	37.4	−0.11
Rwanda	1966-85	16.2	38.3	0.64*
Sierra Leone	1962-85	42.7	38.5	0.77*
Togo	1963-85	10.1	37.4	−0.16
Uganda	1961-78	42.4	46.2	−0.58*
Groundnuts:				
Gambia	1961-77	17.7	25.5	0.73*
Malawi	1968-80	15.0	28.4	0.13
Niger	1963-85	21.3	31.6	0.41
Senegal	1967-85	13.0	34.7	0.68*
Cotton:				
Burkina Faso	1961-85	15.6	15.5	0.45*
Tanzania	1965-69 1971-80	23.6	14.7	−0.26
Uganda	1961-78	41.1	13.4	−0.15

* Significantly different from 0 at a 5 percent level or better.

[a] Standard deviation of the price divided by the sample mean, expressed as a percentage.

[b] Deflated by each country's consumer price index.

[c] Deflated by the Manufacturing Unit Value Index (see Appendix B). Variation across countries is due entirely to differences in years used in the calculations; the reported CV of the world price of a commodity for a given country is computed using only those years for which data on producer prices are available for that country.

SOURCES: Producer prices, see Appendix B. World prices (except groundnuts) from World Bank (1986). World prices of groundnuts and the consumer price indexes from IMF, International Financial Statistics data tape, 1987.

continuously reduced producer prices regardless of changes in world prices. Togo (cocoa) and the Ivory Coast (coffee) have maintained fairly stable producer prices.

The extreme sensitivity of government revenues to international prices for countries that export agricultural products also prevails for those that export minerals and crude petroleum. Costs of production are relatively independent of export prices, at least in the short run, so that declines in export prices mean more than proportional declines in the profits of the producing companies. These declines in profits are then reflected in the government's revenues from corporate taxes and the profits of state-owned companies.

Because copper prices have been very low since 1974 relative to the preceding decade, Zaire and Zambia are good examples of countries that have continued to earn export revenues from minerals but have suffered collapses in export-related government revenues. In the two years 1970 and 1974, Zaire earned a total 15,519 million real 1980 zaires from its copper exports, but in the four years 1975-78, it earned a total of only 7,761 million. The percentage of earnings kept as government revenue declined from 61 to 44 between these two periods. In Zambia, government revenues from minerals fell from 30 percent of total copper export earnings in 1965-74 to 2 percent in 1975-82.[5] The oil exporters, discussed in Box 3, present a similar picture.

D The Responses of Governments and Consequences

When their revenues fall because of lower commodity prices, governments that cannot get resources from abroad respond by spending less. As we argue in the next chapter, African governments have very limited scope for offsetting lost revenues with resources from abroad. Government spending is therefore one link between international prices and overall economic performance. When spending is cut, government functions are performed less well unless the cuts can be offset fully by increased efficiency. Some of the decrease in expenditure, moreover, may have immediate effects on production, including production in the export sectors. Small farmers may get fewer inputs and marketing services from the government agencies that support them. Other effects on the economy take more time; cuts in expenditures on roads, ports, and other infrastructure and on education affect the growth of the economy over the medium term.

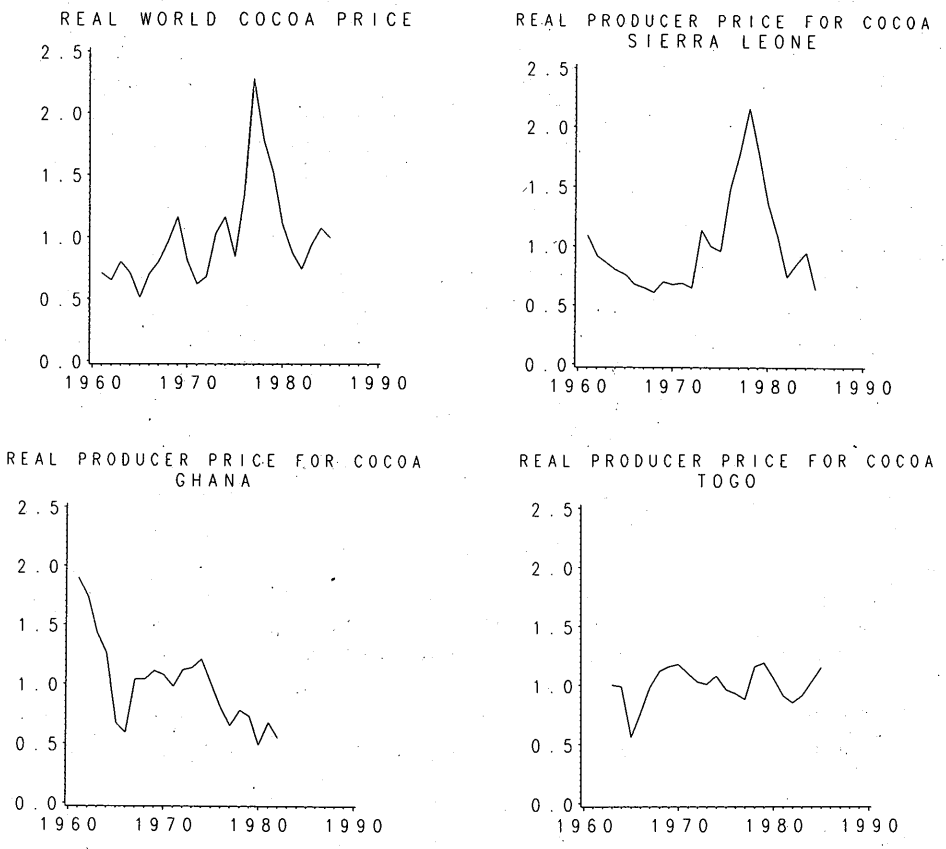
Exactly how reductions in government revenues and expenditure affect current and future economic performance depends on which expenditures are cut disproportionately. Unfortunately, this type of information is diffi-

[5] Nominal revenue figures are from World Bank (1979, p. 59) and Bell (1983, pp. 55-76). Real figures are derived by dividing by the CPI obtained from the IMF *International Financial Statistics Yearbook*.

FIGURE 4

WORLD AND PRODUCER PRICE INDEXES FOR COCOA AND COFFEE, SELECTED COUNTRIES

A. Cocoa

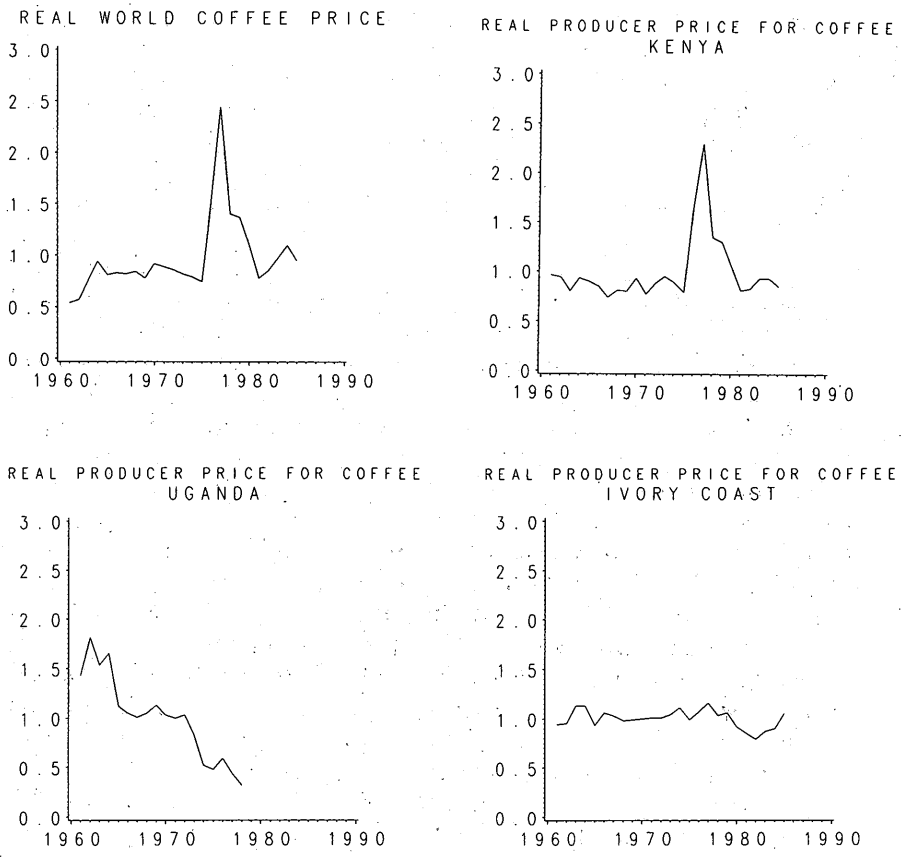


cult to obtain. The classifications of expenditures provided by governments may be relatively arbitrary, and there are no readily available statistics on the take-home pay of civil servants of a standard grade. The only systematic study of cutbacks in expenditures (Hicks and Kubisch, 1984) concludes that governments in developing countries tend to cut capital expenditures relative to current expenditures. Within both capital and current budgets, moreover, governments tend to cut infrastructure and production activities while protecting general administration, defense, and social programs.[6]

[6] The discussions of resource booms in Davis (1983), Gelb (1986), and Devarajan and de Melo (1987) are consistent with this view.

FIGURE 4 (*Continued*)

B. Coffee



SOURCE: See Table 6. Years as given in Table 6.

Scattered evidence from Africa seems consistent with this pattern. During the oil boom from 1978 to 1980, capital expenditure by the Nigerian government was more than twice its current expenditure. In the next few years, capital expenditure was little more than current expenditure, and by 1984 it was only two-thirds of current expenditure. The Nigerian government cut back its efforts to build a new capital at Abuja and reduced its expenditure on other large-scale projects, many of which might have had little effect on production, although they were classified as investments. After the fall in copper prices, the Zairien government contracted its capital

expenditure from 60 percent of current expenditure in 1974 to only 31 percent in 1977. It appears that Zaire's infrastructure has been deteriorating because of lack of maintenance, with adverse implications for the productivity of agriculture and its ability to produce exports. In an interesting econometric study, Hill (1989) discusses various strategies for dealing with temporary and permanent shocks to government revenue from diamond exports in Botswana. She concludes that Botswana's government has managed to avoid excessive increases in expenditures during revenue booms. Instead, it has built up financial reserves that could be drawn down when the booms ended.

Despite the information summarized in Figures 2 and 3, we infer from the available evidence that declines in commodity prices can have serious negative effects on future growth. Lower commodity prices result in disproportionate cuts in government revenues and expenditure, and investment expenditure is cut by more than other items. Of course, this strategy may be optimal if declines in commodity prices are seen as temporary. In that case, it makes sense to maintain consumption at the expense of investment. The statistical analysis in Chapter 4 suggests, however, that some price shocks may take time to fade away and that some may even be permanent.

The distinction between investment and current expenditure provides one classification for assessing the implications of governments' responses to declining revenues; additional insights are obtained by comparing expenditures on tradables and nontradables. This distinction is emphasized in the literature on the Dutch disease (Corden, 1984, and Neary and van Wijnbergen, 1986). To the extent that a government cuts its purchases of nontradables, the prices of those goods fall relative to importable goods, hurting factors of production that are intensively or exclusively employed in producing nontradables. During the oil boom, Nigeria's government emphasized investments in infrastructure that pushed up the relative price of the output of the construction industry (Gelb, 1986); the subsequent retrenchment presumably reversed these effects.

Low commodity prices in the 1980s and their impact on government revenues may have prompted the experiments by some African governments with retrenchment of the public sector, and especially with privatization. Governments no longer have the revenue base to support certain types of activities. If this is the main reason for retrenchment and privatization, then a rise in commodity prices may increase government willingness to expand publicly owned corporations and parastatals, reversing their recent actions. This view contrasts with one that says governments have come to a more or less permanent view that large-scale state involvement in production is unattractive on efficiency or equity grounds, and that they have reached new conclusions on the desirable balance between state and private eco-

nomic activity. Whichever interpretation is correct, the fact remains that the steep drops in commodity prices have put these governments under pressures that could abate.

E Producer Incomes and Price Response in Agriculture

We have just seen that many African governments do not automatically pass on changes in international prices to domestic producers of agricultural exports. Instead, they absorb the changes by varying their own revenues and the revenues of agricultural marketing boards. When international price changes are absorbed rather than transformed into corresponding changes in producer prices, producers have no immediate reason to respond. In such cases, the story of the impact of changes in international prices features the response of governments rather than of producers. In other cases, such as Kenya and Sierra Leone, governments have not interfered, or at least not to the extent of near absolute stabilization of producer prices.

When governments allow producer prices to respond to international prices, the standard of living and the production choices of African farmers are affected. Even countries that in the past have kept producer prices nearly constant cannot be expected to persist in the face of dramatic declines in international prices and, consequently, in government revenues. The Ivory Coast cut its price to cocoa producers from FCFA 400 per kilogram to FCFA 250 in July 1989 after resisting for months, and then announced a price for the 1989/90 season of only FCFA 200. Senegal dropped the price to producers of groundnuts to FCFA 70 per kilogram for the 1988-89 season after keeping it at FCFA 90 for three seasons. It therefore makes sense to consider possible producer responses in these countries as well as in countries whose governments have traditionally passed on international price changes. The size of a shift in crop output in response to a price change depends (1) on the alternatives farmers have to producing the crop, (2) on the nature of the crop, and (3) on the nature of the price change.

1. How producers respond to a price drop depends on the alternatives they have to avoid a decline in their standard of living. Farmers in regions where several crops can be grown may be more responsive to price changes. A good example is the substitution of millet for groundnuts once farmers are convinced of a change in the relative harvest prices of these two crops. This was an important component of the decline in Senegalese groundnut production in the late 1960s, termed the *malaise paysan*. Even if good substitute crops are not available, output may still fall when the price declines. Farmers who use hired labor may reduce the amount they employ. Furthermore, farmers may choose not to work as hard themselves if they find they get fewer consumer goods in exchange for their export crops. Of course, it is possible that farmers without alternative crops will actually raise

output in response to a price decline. This would be the case if the only use of a farmer's labor was to produce the crop in question and the labor-supply function sloped backward.

2. The nature of the crop plays a significant role in the response of output to a price change. Outputs of annual crops like cotton or groundnuts can be varied quickly, but the outputs of tree crops take longer to change. This factor is certainly operative in the production of cocoa, coffee, and tea, the perennial crops of such importance to so many African countries. Cocoa takes eight years to mature, while coffee and tea take about four years, delaying the response to a price increase (although the use of pesticides and more intensive harvesting can raise yields even within the year). The response to a price decrease may likewise be drawn out if farmers decide not to uproot aging trees they would have replaced if prices had not fallen, or not to maintain their orchards, while they continue to harvest most of the cocoa pods or coffee beans produced by the existing trees. The long decline of Ghana as a cocoa exporter, which took three decades, reflects this gradual mechanism. Typically, therefore, the short-run elasticity of supply (the response within one year to a change in price) is less than the long-run elasticity (after all responses have run their course), but to a degree that varies with the crop.

3. The responsiveness of farmers' output of perennial crops will depend also on the perceived permanence of a price change. The output of a perennial crop is determined largely by the stock of plants in place, and profit-maximizing farmers can be expected to choose that stock on the basis of expected future prices as well as the current price. A temporary price change will therefore have a much smaller output effect than a change that is perceived to be permanent. Even cultivators of annual crops may respond less to temporary price changes. If planting decisions must be made before the current year's market price is known, farmers will make these decisions on the basis of the expected price. Thus an increase in last year's price that is expected to persist will result in more planting, but a temporary increase in last year's price will not.

Common sense, supported by casual evidence, suggests that farmers will respond to price increases by raising output. But predictions of the size and timing of the supply response for particular crops and countries call for the construction and estimation of econometric models of agricultural supply, and this task has proved to be difficult, especially for perennials. The implementation of such models often requires a vast amount of data of a type that is generally difficult to obtain in African countries.

Most empirical studies of agricultural supply, for both annuals and perennials, are based on a model first developed by Nerlove (1956, 1958). Although there are many variants of that basic model, it has two distin-

guishing characteristics. First, it is assumed that price expectations are formed adaptively, the expected price in any period being a weighted average of past prices. Second, it is assumed that farmers adjust output (or acreage, or number of trees, etc.) gradually, so that actual output can be represented by a weighted average of desired output and previous output. These two assumptions result in supply equations that typically specify output (or acreage, etc.) as a linear function of lagged prices, lagged output, and other exogenous variables affecting supply. Applications of the basic model to perennials have entailed using longer lags on prices to account for the time between planting and bearing.

Estimates of Nerlovian models of agricultural supply have been criticized on several grounds. First, the reliability of supply elasticities depends critically on whether price expectations are formed in an adaptive way. By contrast, if farmers have rational expectations, they use knowledge about the structure of the economy to make predictions about prices, and these predictions may differ from those implied by adaptive expectations. Eckstein (1984) recently used a rational-expectations approach in a study of Egyptian cotton supply. By simultaneously modeling the time-series behavior of cotton prices (relative to wheat prices) and the area planted in cotton, Eckstein was able to distinguish between the effects of transitory and permanent price changes on area planted.

Very little research on sub-Saharan Africa has examined how estimates of supply elasticities are affected by assumptions about the formation of price expectations. Some research estimating supply models using different adaptive-expectations rules (see, e.g., Ady, 1968, and Gwyer, 1971) indicates that results are not very sensitive to these alternative assumptions about the formation of expectations. But rational-expectations approaches have not been used on data from sub-Saharan African countries, and it is not possible to assess whether the choice between rational and adaptive approaches has a substantial effect on estimates of supply elasticities for crops important to African countries.

Another problem with the simple Nerlove model concerns its application to perennial crops. The Nerlovian assumption that actual output cannot be adjusted immediately to equal desired output makes sense for perennials, since there is a long lag between planting and bearing. However, the ad hoc assumption of partial adjustment masks the fact that the long-run adjustment of output to price changes is the result of a complicated set of decisions regarding new planting, uprooting, and replanting.

Ideally, one would want to construct and estimate supply models that explicitly include the effects of price changes on all aspects of farmers' investment decisions. In practice, data on changes in the age structure of trees are often unavailable, so most research on perennials simply estimates

reduced-form output equations that specify output (or the change in output) as a function of lagged prices, with the lags chosen to take account of the time between planting and bearing (Bateman, 1965; Ady, 1968; and Behrman, 1968). This specification makes it difficult to sort out the effects of price changes on harvest and investment decisions. More recent research has attempted to estimate the effects of price changes on planting and uprooting decisions (see Hartley et al., 1987). However, little research of this type has been done for African countries because it requires data on the age structure of trees. For example, Stern's (1965) study of cocoa supply examines the effects of price changes on total acreage devoted to cocoa in Nigeria from 1919 to 1944, but lack of data on new plantings precludes a determination of the way price changes affect the vintage structure of cocoa trees. Akiyama and Trivedi (1987) estimate a structural model for new planting, area planted, and output of tea in Kenya, but the study is based on very short (ten- to sixteen-year) time series. Further improvements in the estimates of African perennial supply will have to await improvements in the quality of data.

Despite the problems associated with the econometric estimation of supply elasticities, formal econometric studies have concluded overwhelmingly that African farmers do respond to prices to a degree that is economically significant (for a recent survey, see Bond, 1983). First, there appears to be no econometric evidence that African farmers have cash-income targets (which would cause them to cut output when prices rose and made it easier to achieve income targets). Second, as expected, long-run supply elasticities are considerably higher than short-run elasticities. For example, estimates of the short-run price elasticities for cocoa are 0.68 for Cameroon and 0.39 to 0.87 for Ghana, while the estimates of long-run elasticities are 1.81 for Cameroon and 0.71 to 1.06 for Ghana (Bateman, 1965, and Behrman, 1968). Coffee and tea also show long-run supply elasticities that are typically twice as large as short-run elasticities (Maitha, 1970; Ford, 1971; Akiyama and Duncan, 1982; and Akiyama and Trivedi, 1987). Evidence on cotton and groundnuts, both annuals, also indicates that long-run supply elasticities are larger than short-run elasticities. In brief, declines in the producer prices of export crops will induce declines in output and, other things equal, declines in the volume of exports.

For several reasons, however, the export response may not be equal to the output response. This divergence reflects the strategies farmers adopt to sidestep the effect on their standard of living of decreased producer prices.

First, some crops are consumed domestically; price declines will raise domestic consumption as well as lower production, resulting in a drop in exports that exceeds the drop in output. For example, declines in official

producer prices for groundnuts in Senegal have led to increased domestic consumption of groundnut oil produced by small artisanal processors outside the state sector.

The possibility of smuggling can also lead to a divergence between export and output responses. Farmers have an incentive to smuggle crops into a neighboring country if its producer price exceeds the price at home. Accordingly, a decline in the producer price in the home country may have little effect on that country's output, because farmers respond to the lower price by smuggling more rather than producing less. In this case, of course, the response of *legal* exports to a price decline may be much larger than the output response. This phenomenon can be important. The borders of African countries are porous, and some crops are of high value in relation to their weight and transport costs. Cocoa and coffee are often smuggled from countries that pay low producer prices to those that pay more, for example from Ghana to the Ivory Coast and Togo. Even a relatively low-value crop like groundnuts has been smuggled across African borders, for example from Senegal to the Gambia and Guinea.

Finally, it should be noted that the responsiveness of the value of total exports of all crops to a change in the price of one crop depends not only on the output response of that crop, but also on the output responses of all other exportable crops. A decline in the price of coffee in the Ivory Coast may have relatively little impact on total exports, since it stimulates the production and export of cocoa. By contrast, in Senegal, where a decline in the price of the export crop (groundnuts) results in increased production of a nonexported crop (millet), the impact of a price decline on total exports may be larger. Furthermore, movements in the producer price of one crop alone may be unusual if international commodity prices move together; for the data in Table 4, the simple correlation coefficient of the real cocoa and coffee prices is 0.86.

In summary, both econometric studies of African agricultural sectors and impressionistic evidence show that farmers try to protect themselves from falling prices for their exports. Their responses result in lower outputs and exports, or at least in lower outputs and exports that governments can tax, explicitly or implicitly. These producer reactions dissuade governments from transmitting declines in international prices to agriculturalists via reductions in producer prices.

Not all changes in African agricultural exports are attributable to price changes. In a continent where agriculture is largely rain-fed and irrigation is rare, weather is often a critical factor in export performance. This is most notably true for the Sahelian countries, for producers of groundnuts in Mali, Niger, and Senegal, and for producers of cotton in the Sudan and elsewhere. Cocoa production is also sensitive to weather. Pests and disease

affect exports significantly, as in the Ghanaian cocoa industry (Nyanteng, 1980). Exports will decline if government agencies fail to maintain transport or to provide inputs or marketing services to producers. The provision of hybrid planting material may increase yields over time. For agriculture, as for all types of exports, political anarchy can cause severe disruption, as in Uganda or Chad. All these factors play a role, although it is not possible to sort out their relative importance. Nevertheless, strong evidence points to producer prices as a fundamental determinant of the performance of African agricultural exports.

F Response of Mineral Production

The other main source of African export earnings is the mineral sector. In fact, minerals (including crude petroleum) are predominant in the continent-wide value of export earnings. Agricultural exports are important because they predominate for the largest number of (mostly small) countries, and because most Africans are small farmers who depend on their farms for cash incomes, even in countries like Nigeria.

There could hardly be a greater contrast between mining and smallholder agriculture in Africa. Mining operations require large investments, both on site and in ancillary infrastructure, such as transport. These investments have long gestation periods and are largely irreversible, so that they endure for years. Most mineral production is very capital-intensive, and the response to price changes is therefore very slow. In contrast to agriculture, there is at least the possibility of producing without selling, since mined ores can be stored.

Mine sites are large production units, and there may be no more than one company owning all the mines for each mineral produced in an African country. Almost without exception among the major mineral-producing countries, the government is either the sole owner of the mining companies or owns a majority share.[7] If there are any other owners, they are foreign, usually large multinationals with operations in many countries. Their role is to provide expertise in production and management and sometimes to provide funds for investing in the expansion of capacity. Therefore, governments contribute directly to the decision to change production in response to a change in international prices.

Despite the importance of mineral production in many African countries, the labor force in the sector is small. Employment in the mining sector was reported in 1984 as follows: Liberia (iron mining only), 29,500; Mauritania, 6,000; Niger (uranium only), 3,700; Nigeria, 60,000; Senegal (phosphates

[7] The U.S. Department of the Interior (1984) is the source for statements in this and the next paragraph.

only), 3,000; Togo (phosphates only), 3,000; Zaire, 59,000; and Zambia, 61,000. It is doubtful that mining employment exceeds 15 percent of total formal wage employment in any of these countries, the highest proportion being in Zambia. Employment is clearly tiny relative to that in smallholder agriculture.

In mining, moreover, workers are hired for wages. They come from great distances to the mines, acquire skills, and are not easily laid off, dispersed, and reassembled. These characteristics of employment, combined with the geographical concentration of mining operations, have made the minerals sector one of the few in Africa in which there is some possibility for labor organization, either spontaneous or unionized.

The structure of the mining sector suggests a low short-run supply response to a change in international prices, and that is what Table 4 reveals. For instance, the real price of copper declined by 41 percent between 1974-79 and 1980-85 and by another 20 percent between 1980-85 and 1986-87. In the face of this considerable decline in price, exports of the copper industry in Zambia fell by 30 percent from 1976 to 1984, employment in mining went from a peak of 65,110 in 1974 to 58,470 in 1984, and the real wage in mining fell by 53 percent from 1970 to 1984.[8] Thus the response has been limited and slow but certainly not negligible. Econometric evidence for Zambia seems consistent with this view (see Obidegwu and Nziramasanga, 1981, and Tan, 1987). In Liberia, the government failed to pay its workers for about six months at one iron mine rendered unprofitable at least in part by low international prices. This mine had been responsible for about 15 percent of Liberia's iron ore production. Finally, the government closed the operation entirely. Thus, adjustments do occur in African mining when international prices fall, even in government-run mines and even when they affect workers.

Diamond production is the one part of the mining sector that resembles smallholder agriculture. Small-scale diamond miners are of some significance in many African countries, although their activities are often illegal and result in smuggling. At times, Sierra Leone has been an exception in reserving a large proportion of its diamond fields to small-scale miners. Small-scale miners may be much more responsive in the short run to price changes than large-scale mining enterprises, but there are no econometric studies of supply response in this industry.

Finally, for the two oil-producing countries that are members of OPEC, Gabon and Nigeria, externally determined production ceilings can play an important role in limiting the volume of exports. Nigeria's oil quota since

[8] Data on employment and the money wage are from the International Labour Organisation *Yearbook of Labour Statistics*; data on the consumer price index and the export index are from the IMF *International Financial Statistics Yearbook*.

1981 has been perhaps only half of previous peak production, probably still a good measure of its minimum production capacity.

G *Further Adjustment to Commodity Price Changes*

In the preceding discussion, we briefly mentioned the spillover effect of a change in an export price on the production of a closely related commodity. One example was the effect of a fall in the price of groundnuts, an exported crop, on the Senegalese production of a nontradable, millet.

Such spillovers need not be so direct, however. A change in the price of an export leads to further adjustments in response to the change in incomes and the resultant change in expenditures. Like the government, consumers must decide how to allocate changes in expenditure between tradables and nontradables. The more changes in expenditure fall on nontradables, the larger the change in the prices of nontradables relative to prices in the import-competing sector and in their production. Similar general-equilibrium effects can occur in the case of one export when the price of another changes. An example of the complexity of general-equilibrium effects is provided by Nigeria. When its petroleum revenues rose and therefore incomes rose, domestic demand increased for edible oils, an export. But at the same time domestic production of these oils had to compete for inputs, especially labor, with nontradable sectors like construction, the prices of which had risen in response to increased demand. This led to a decline in the absolute volume of edible oil exports.

Consumers facing a fall in income must also decide whether to cut consumption or savings, which in turn affects the demand for investment goods. The presumption is that consumers will prefer to decrease savings if they perceive a decline in export prices to be temporary, and thus investment will fall. Investment goods may or may not have a relatively high nontradable component compared with consumption goods, with consequences for the prices of nontradables relative to importable goods and for the incomes of factors employed intensively in these sectors.

Bevan et al. (1987) use a simulation model to argue that Kenyan coffee producers, who experienced an increase in world prices in the late 1970s, chose to save a large part of the resulting increase in their incomes because they perceived the price increase to be temporary. As a result, the higher demand for investment goods, which have an important nontraded component, raised the prices of those goods and transferred a significant part of the initial increase in producers' incomes to the factors employed in the domestic investment sector.

Price changes have implications for the incomes of factors of production employed in the export sectors and elsewhere. The initial impact of a price decline is, of course, to lower the incomes of factors in the export sector.

Some of these factors can be reallocated relatively easily to other sectors, where they lower the returns of factors for which they are perfect or close substitutes, although they recoup some (or even more than all) of their own initial losses and raise the returns of other complementary factors.

In general, however, we have very little information with which to establish the general-equilibrium effects of a decline in export prices.

6 FURTHER ISSUES AND CONCLUSIONS

A Summing Up

After identifying the commodity exports of importance to sub-Saharan African economies, we discussed the structure of the international markets in which these commodities are traded. We also looked at the behavior of the real prices of these commodities up to the end of 1987. We found that (1) these prices are highly variable, (2) they are highly dependent over time, (3) an important proportion of the shocks to some prices may persist indefinitely, although the persistence of these prices is generally difficult to measure, and (4) there is virtually no evidence of statistically significant trends in these prices. We then discussed the domestic responses of the African economies to international price changes, emphasizing the distinction between the government and the private sector.

In the sections that follow, we turn to two other components of the international economic relations of these countries, debt and aid, and ask about their relationship to commodity exports.

B Commodity Prices and International Debt

There have been important shifts in Africa during the last three decades in both the sources and the uses of foreign exchange, although the nature and the extent of these shifts differ greatly among African countries. African countries have borrowed abroad to supplement the funds they earn from exports, and the servicing of these debts is a call on their available foreign exchange. Interconnections between international commodity prices and the international indebtedness of African countries raise important questions:

1. Which, if any, African countries will borrow abroad in the coming years? Those that do may mitigate the impact of decreased export earnings from lower prices for primary commodities, at least in the short run. Those that do not must cope with both decreased export earnings and a decreased capital inflow relative to the 1970s, when many African countries were borrowing.

2. Which, if any, African countries will use some of their foreign-exchange earnings to service their past debts? Those that do (and do not also borrow) will experience a capital outflow in addition to low prices for their export commodities. Those that do not may be subject to sanctions imposed by their creditors.

In the 1970s and the first years of the 1980s, many African countries borrowed from foreign lenders, in some cases from private foreign lenders—mainly commercial banks. Most of the countries that borrowed from private lenders had relatively high incomes, for example, the Congo, the Ivory Coast, Kenya, and Nigeria, but borrowers were not restricted to this group, as evidenced by the important case of Zaire, which owed 72 percent of its debt to private lenders in 1975. Other countries accumulated very little debt to private creditors but significant amounts to official creditors. In 1986, 18 of the 43 countries in Table 7 owed 10 percent or less of their total long-term foreign debt to private creditors; only 5 owed more than 50 percent. For sub-Saharan Africa as a whole, public or publicly guaranteed long-term debt to private creditors comprised 28 percent of total debt; for Latin America, the corresponding figure was 76 percent.

TABLE 7

SOME DEBT INDICATORS

Country	*D*	*%PD*	*%D/GNP*	*%NT/X*	*PT*
Benin	780	45	54	+	−31.7
Botswana	355	11	36	−1.3	0.7
Burkina Faso	616	6	42	25.5	− 9.0
Burundi	528	5	44	43.8	−7.9
Cameroon	2,267	19	21	−0.9	−66.0
Cape Verde	107	3	69	+	0.5
Central African R.	393	6	40	30.5	−1.4
Chad	172	20	21		0.0
Comoros	156	0	96	76.0	−0.2
Congo	2,861	56	144	29.0	178.8
Djibouti	119	4	...	+	−2.5
Equatorial Guinea	141	8	...	+	0.0
Ethiopia	1,989	14	36	17.5	−36.9
Gabon	1,095	64	37	3.6	10.0
Gambia	228	12	132	30.7	−1.4
Ghana	1,413	5	25	14.7	−8.0
Guinea	1,421	14	...	+	−2.1
Guinea-Bissau	294	28	182	57.1	−3.5
Ivory Coast	6,500	54	73	−11.8	−361.2
Kenya	3,438	19	52	8.0	147.1
Lesotho	182	4	29	2.4	−0.8
Liberia	1,002	18	99	3.3	−1.7
Madagascar	2,635	14	106	+	−32.0
Malawi	910	7	...	4.0	−45.8
Mali	1,566	4	96	55.4	−0.9
Mauritania	1,637	9	218	29.6	−1.4
Mauritius	427	21	32	−0.4	−6.8
Niger	1,026	20	51	13.6	−17.8

TABLE 7 (*Continued*)

Country	*D*	*%PD*	*%D/GNP*	*%NT/X*	*PT*
Nigeria	21,496	61	45	−5.2	−615.9
Rwanda	412	2	22	23.8	−5.7
Sao Thome & Principe	74	1	172	+	−0.01
Senegal	2,456	12	69	+	−7.2
Seychelles	67	16	...	3.9	0.1
Sierra Leone	459	36	40	5.7	−0.1
Somalia	1,415	5	75	33.0	−3.5
Sudan	7,057	13	97	18.5	−15.0
Swaziland	208	5	46	0.2	−2.2
Tanzania	3,650	11	85	25.2	0.5
Togo	882	10	93	−10.0	−31.0
Uganda	929	7	...	11.6	0.0
Zaire	5,430	13	97	−6.7	−91.2
Zambia	3,575	16	241	6.7	−3.0
Zimbabwe	1,712	52	32	−3.0	−115.2

D = debt outstanding and disbursed in millions of U.S. dollars.
%PD = % of D owed to private creditors.
%D/GNP = % that D is of GNP.
%NT/X = % that net transfers from all creditors to the country are of total exports. (+ means *X* is unavailable but *NT* is positive.)
PT = transfer from private creditors in millions of U.S. dollars.

SOURCE: World Bank (1987).

As early as 1976 in the case of Zaire and by 1982-83 for very many African countries that had borrowed from private lenders, there was a change in the relationship between debtors and private creditors. Countries did not make payments on their debt as scheduled, entering instead into rescheduling agreements with their lenders (IMF, 1983 and 1985). The indebtedness of these countries grew less quickly than before, and the new lending was termed involuntary to reflect the belief that lenders were relending much of the principal and interest that debtors paid them so as to avoid not being paid at all. But even with rescheduling and involuntary lending, in 1986 private creditors reduced their exposure to 33 of the 43 countries in Table 7.

Nevertheless, most African countries had positive net transfers from their private and public creditors taken together, as Table 7 also makes clear. Public creditors may see the debtor countries' payments to private creditors as a condition for lending them funds, while the debtors may see the provision of public funds as a prerequisite for making the payments.

Another and very significant way in which private creditors are reducing their exposure in Africa is by invoking the guarantees of agencies in their home countries, such as the Eximbank in the United States. These guaran-

tees were made when the loans were originally granted, often in the 1970s when concerns about default were much less widespread and public agencies were willing to make guarantees. There is consequently a transfer of debt from private to public creditors without any direct involvement of the debtor country.

In all these ways, private lenders have had some remarkable successes in reducing their exposure, reflecting their view that loans to African countries are, almost without exception, too risky. One such success was the reduction in Zaire's debt to private creditors from U.S.$1.6 billion in 1980 to U.S.$0.73 billion in 1986 (World Bank, 1987).

The most recent phase in the breakdown of relations between African debtors and their creditors was the IMF's refusal to make further loans to African governments that had ceased to service their earlier drawings on the IMF. In early 1988, the list of African countries in this situation comprised Liberia, Sierra Leone, Somalia, the Sudan, and Zambia. Furthermore, the World Bank made provisions in 1988 against losses on loans to Liberia, Sierra Leone, and Zambia.

Lending to foreign governments poses difficulties for private and public lenders that lending to private firms in the developed countries does not. Debtor governments may choose to renege on their foreign debts, either explicitly through overt repudiation or, more likely, through a continuous series of reschedulings accompanied by token payments. There are no courts to which creditors can appeal to force these governments to pay if they are able. The only deterrents to default available to creditors are the threat to debtors of an embargo on future loans and the disruption to their foreign trade caused by the creditors' refusal to facilitate international transactions. (For example, after a breakdown in its relations with its creditors, Nigeria has had only limited access to trade credit.) These sanctions are extremely indirect, however, and can support limited lending to African countries if creditors expect to be repaid.[1] In general, the sanctions have the least deterrent value to debtors relative to the benefits of not servicing debt when international commodity prices are low and the debtor countries' incomes are therefore relatively low. Consequently, lenders are reluctant to lend to heavily indebted countries that are getting low prices for their exports. International organizations such as the IMF and the World Bank do not have sanctions much more powerful than those available to other creditors. Hence, if international organizations are to remain solvent themselves, they are limited in their ability to provide funds to offset the low commodity prices faced by African countries.

[1] Some of these ideas about international debt are developed further in Eaton and Gersovitz (1981), Gersovitz (1985), and Eaton et al. (1986).

Even if African debtors want to service their debts, some have such large debts that they may not be able to do so, given current low commodity prices. Many of the countries in Table 7 have debt equal to or higher than their GNPs. A country with debt equal to its GNP paying a 10 percent interest rate must pay 10 percent of its GNP per year even if it does not amortize any principal. Such a payment might be possible if the country as a whole were the debtor in a meaningful way. But, in actuality, it is the government that owes these debts, and many governments do not raise revenues larger than 10 percent of GNP and may not be able to do so. Furthermore, to raise revenues the government must incur collection costs, so one must think at the very least of these governments' ability to raise revenues net of collection costs. Thus, the levels of debt may exceed not only what the governments are *willing* to service but also what they are *able* to service.

Countries that renege on their debts and break with their international creditors find their access to foreign exchange tied closely to what they can obtain from exports, aid, and remittances, but they no longer have to expend foreign exchange on debt service. On balance, it may be better for them not to service their debts, even if they can do so. (The Sudan may be in such a situation.)

By contrast, some countries with lower debts or a greater vulnerability to sanctions may choose to service their debts because the cost of not doing so is too high relative to the cost of repaying. They may nevertheless have limited access to new credit because potential foreign lenders see them as being too close to the threshold of default to justify more exposure. Such countries must continue to make net transfers to their creditors, exacerbating the problems they face as a result of low commodity prices. (The Ivory Coast may be in this situation.) There is probably no country in Africa in the favorable situation of, say, South Korea, to which international lenders still seem ready to lend large amounts on a voluntary basis. In 1986, however, Kenya managed to obtain a significant amount of credit from private lenders after years of making substantial net transfers to them.

African governments should not necessarily want to borrow very much in response to declines in export prices, even when they can. The statistical analysis of primary commodity prices in Chapter 4 suggests that the current low prices for several commodities (including crude petroleum, copper, and tin) could persist for a long time. Borrowing to maintain a level of expenditure in the face of such a decline in export prices is not a viable strategy: it may lead to an even greater decrease in expenditure in the future when debts must be serviced and export prices may not have recovered. The only justification for borrowing in such circumstances is when there are costs of adjusting expenditure rapidly, perhaps because investment projects would be left unfinished and unproductive. It may then be desirable to move

slowly to the permanently lower level of expenditure mandated by lower export prices. By contrast, if a shock is transitory it makes sense to borrow with the expectation of servicing the debt when income from exports has returned to its normal level. Of course, these principles presuppose that debts will be serviced. Although this may not be the case for debts contracted in the 1970s, creditors are unlikely to lend in the 1990s if they do not expect to be repaid in the normal way.

In June 1988, France proposed reductions in the debts of African countries that were owed to, or guaranteed by, the governments of developed countries. By July 1989, these proposals had been accepted by many other developed countries, including the United States. But they may represent little more for most African countries than a formalization of the earlier situation, in which the debtor countries did not make payments as contracted in the original loan agreements and the creditor governments imposed few sanctions.

C *Foreign Aid for Africa*

Africa does receive official aid from international donors. In fact, African countries on balance benefit more from aid than do other developing countries. For instance, among all the countries with per capita incomes of less than U.S.$380 in 1984 that are reported in Table 7 of the World Bank's *World Development Report*, 1986, the African group received U.S.$21.4 per capita in aid, equal to 9.0 percent of GNP, compared with averages for all countries in this income group of U.S.$4.6 and 1.7 percent. Again, in the group of countries with per capita incomes between U.S.$450 and U.S.$1,620, the African figures were U.S.$10.9 and 1.5 percent, compared with the group averages of U.S.$10.8 and 0.9 percent.

Furthermore, aid represents resources that almost always come under the control of governments. Therefore, aid can directly replace government revenues lost when commodity prices decline. Because the disbursement of these funds is often tied to projects, however, governments are not always free to use them as they wish. Nevertheless, money can be moved around; the financing of particular projects with aid can free funds for other purposes.

Foreign aid provides some relief, but most countries cannot anticipate increases in aid large enough to offset the decline in their export earnings. In many cases, indeed, the declines in export earnings are comparable to or exceed current levels of aid. In most cases, there is no formal relationship between the amount of aid available to these countries and shortfalls in their export earnings. The exception is the STABEX program of the European Community, which provides a degree of automatic compensation for decreases in export earnings resulting from a drop in international prices or other causes (Box 5). The funds disbursed under this program are available

BOX 5

STABEX AND EXPORT EARNINGS

African associate members of the EC are eligible for transfers from the STABEX fund. The program seeks to stabilize export earnings (1) from agricultural commodities and wood, but not minerals, (2) to the EC, (3) on a commodity-by-commodity basis, and (4) in nominal rather than real terms.

The first step in determining a transfer is the calculation of a reference value equal to the average of earnings in the preceding four years from the export of a particular commodity to the EC. Subject to a number of conditions, the transfer per unit exported to the EC then equals the excess of the reference value over the actual current value of the corresponding exports, if positive.

Among the most important conditions are: (1) The actual level must be at least 6.5 percent below the reference level. (2) Export earnings from the commodity to all destinations must have been at least 6.5 percent of total export earnings in the preceding year. (3) The shortfall must not result from actions of the exporting country. Diversion to non-EC markets typically reduces the transfer; diversion to domestic consumption or domestic processing, or various production and marketing problems, may lead to a reduction. (4) There must be a sufficient balance in the STABEX account, which may not be the case if other countries have also made large requests; requests are then prorated.

Application for, approval of, and disbursement of the transfer take time, divorcing the timing of the payout from that of the drop in earnings, but there are provisions for expedited partial payout. Expenditure of the transfer is unrestricted as to purpose, effectively adding to general government revenues. The less poor recipients must repay the transfer (without interest) over a number of years if their exports recover.

African members have received the following sums in millions of U.S. dollar equivalents: 1980, $167; 1981, $175; 1982, $37; 1983, $40; 1984, $22; 1985, $132; 1986, $207 (EC, *General Report on the Activities of the European Communities*, Brussels, various years). In 1980, disbursements were apparently prorated at from 47.5 to 59.5 percent of actual exports and in 1981 at 43 percent. In 1984, African countries received approximately $80 million in additional payments as their share from extra funds disbursed to countries whose requests were prorated in 1980 and 1981.

Under STABEX, transfers cease after a while even if export earnings remain low; they must fall continuously to generate ongoing payments. At present, it seems unlikely that the price component of the reference-value formula will induce claims of the seze generated in 1980 and 1981, when the high prices of 1976 and 1977 still influenced the reference values. Nevertheless, the current prices of some, but by no means all, commodities important to African exporters are well below their average over the last four years, contributing to the possibility of payouts in 1988. The table shows prices (in cents per kilogram) for five commodities.

	Cocoa	Coffee	Cotton	Ground-nut Oil	Tea
1984-87 average	218	280	148	75	227
Jan.-April 1988	178	221	150	51	195

relatively rapidly after an export shortfall and are paid to the government without restriction on how they are used, but they come to an end unless export earnings fall continuously.

D Concluding Remarks

Low commodity prices in the 1980s have significantly diminished the economic resources available to African countries. Furthermore, there is good reason to believe that the incidence of the decline has been borne disproportionately by governments, through reductions in their revenues. The reductions in government revenues lead in turn to expenditure reductions that lower future incomes. Neither foreign aid nor borrowing abroad is likely to compensate for lost export revenues. And the scope for offsetting declining export prices by increasing the volume of exports may be limited by international commodity agreements, by EC and U.S. import restrictions, and by the relative importance of individual African producers in their main export markets.

There are certain offsetting elements in the current situation. First, the history of commodity prices suggests that there is no systematic tendency for them to continue to decline, and many prices may have a tendency to return to higher values. For a few commodities, the return to higher values can be expected to occur relatively quickly if the future behavior of these prices follows past behavior. Even for those commodities with highly persistent prices, a substantial fraction of the shocks that lowered prices can be expected to dissipate over time. Second, the discretion that African countries have in servicing their debts provides relief from what would otherwise be a major drain on their limited export earnings.

Recently, there have been some notable developments in commodity markets. Compared with their average values in 1987, in August 1989 the nominal price of sugar had risen by a factor of 2.07, of groundnut oil by 1.64, of copper by 1.55, and of tin by 1.30. By contrast, the nominal price of cocoa had fallen to 64 percent of its 1987 value and of coffee to 69 percent. Furthermore, negotiations to renew the International Coffee Agreement ended without success in September of 1989, so that coffee prices are no longer supported by quotas. None of these developments, however, changes our basic views on what is possible in these markets or on how these markets affect African countries.

APPENDIX A

Methodology and the Statistical Properties of Commodity Prices

Methodology

Our statistical analysis of commodity prices seeks to quantify three important characteristics of price movements:

1. Do prices exhibit systematic trends and, if so, are these trends measured precisely or imprecisely?

2. Do prices exhibit intertemporal dependence and, if so, how can future prices best be predicted from past prices?

3. What is the residual variability of price series? In other words, how precisely can future prices be predicted?

To characterize the prices of African commodity exports, we used the methods of time-series analysis. (Unless other references are indicated, these methods are described in more detail by Harvey, 1981.) We did not use the simpler method of fitting an exponential (constant growth rate) model because that model is a very special case of the more general method we do use; it can lead to the spurious estimation of a trend when none exists (Nelson and Kang, 1984).

In the time-series models we use, the behavior of a variable over time, with a value x_t at time t, is related to its own values in the past and to intertemporally independent unobservable shocks in the current and past periods. The shock at time t, the current period, is denoted by e_t. The basic autoregressive integrated moving-average (ARIMA) equation of time-series analysis is:

$$x_t = a + \sum_{i=1}^{p} b_i x_{t-i} + \sum_{j=1}^{q} c_j e_{t-j} + e_t \,. \tag{A.1}$$

If all the b's and c's are 0, then the series x_t is independent; while x_t varies from period to period, it does so in an entirely random way. In this case, the standard deviation of the variable relative to its mean is the measure of its randomness. If the b's and c's are not 0, the variable evolves in a way that is intertemporally dependent; shocks in one period carry over, at least to some degree, into the future. In this case, uncertainty about the variable depends on how far into the future one is interested in forecasting.

A test of whether the series is intertemporally independent is given by

the Box-Pierce statistic, as modified by Box and Ljung. If this statistic indicates that the series is not intertemporally independent, it makes sense to estimate the parameters of equation (1) and to use the estimated b's and c's to characterize the nature of the intertemporal dependence.

For any values of the lag lengths p and q, maximum-likelihood methods can be used to estimate the b's and c's. We used the ARIMA procedure of the SAS statistical package to estimate sixteen versions of equation (1), one for each possible combination of the values of p and q that are less than or equal to 3.[1] We then chose the best equation (pair of p and q values) using the likelihood-ratio test and the Akaike and Schwartz criteria.[2] Our method parallels the one used by Campbell and Mankiw (1987) to study the time-series behavior of U.S. GNP. The parameters for the best equation for each commodity price are presented in Table A.1, along with the standard errors of the coefficients.

An important property of a times series is its intertemporal dependence, the effect that a shock in one period has on values of the series in subsequent periods. In some cases, the intertemporal effects of a shock will die out completely and, in other cases, some fraction of the shock will persist indefinitely. In particular, a shock will persist if the time-series representation (equation A.1) has a unit root *and* $1 + \Sigma c_i \neq 0$. When $p = 1$ and $q = 0$, in the special case that corresponds to most of our estimated equations, a unit root means that $b_1 = 1$, and 100 percent of the shock persists. For those models with $q = 0$, we tested for unit roots using the method described in Dickey *et al.* (1986, section 4.3, paragraph 3). When the preferred model had $p = 1$, $q = 1$, we used the method of Said and Dickey (1984), with $k = 5, \ldots, 10$.

If the time series has a unit root, it may also have an underlying trend, or growth rate, if the parameter a is not equal to 0. When the hypothesis of a unit root cannot be rejected, we estimate the growth rate for the price series after imposing the hypothesis of a unit root, and we test whether the hypothesis of a zero growth rate can be rejected.

The final step in the modeling process is to test for the possibility that

[1] For higher values of p and q, the algorithm sometimes indicated possible problems with convergence, probably reflecting the difficulty of estimating up to six parameters with only thirty-eight observations. In these cases, when choosing our preferred equation we proceeded as though the results had converged. Table A.1, however, contains none of the problematical equations, except for groundnut oil. We also checked the SAS results with a program kindly given to us by John Campbell, and described in Campbell and Mankiw (1987), without, however, changing our preferred equations.

[2] When alternative models were nested or had the same number of parameters, we relied on the likelihood ratio to discriminate among them, using a 1 percent level of significance in the former case. In other cases, we used the Akaike and Schwartz criteria, which always agreed on the best specification.

TABLE A.1

ESTIMATES OF ARIMA MODELS FOR COMMODITY PRICE SERIES, 1950-87

Commodity	Standard Error	a	b_1	b_2	b_3	c_1	α
Bananas	0.0991	0.197	0.9486 (0.0622)				
Coffee	0.2307	1.559	0.7237 (0.1178)				
Copper	0.2075	1.334	0.8274 (0.0953)				
Cotton	0.1815	0.660	0.8784 (0.0846)				
Crude petroleum	0.2261	0.183	0.9208 (0.0575)				
Logs	0.1716	1.037	0.7961 (0.1075)				
Sugar	0.4209	1.007	0.6924 (0.1233)				
Tea	0.1984	0.574	0.8993 (0.0912)				
Tin	0.1924	1.922	0.7903 (0.1123)				
Iron ore	0.0808	3.602	0.2110 (0.2032)				−0.0418 (0.0023)
Tobacco	0.0919	2.574	0.3169 (0.1636)	0.3542 (0.1716)			
Groundnut meal	0.1719	0.237	0.7700 (0.1500)	−0.2529 (0.1935)	0.4400 (0.1699)		
Rubber	0.2063	0.201	0.9552 (0.1432)	−0.5098 (0.1953)	0.5159 (0.1456)		
Manganese	0.1209	0.571	0.8963 (0.0809)			−0.5883 (0.1475)	
Sisal	0.1991	3.049	0.5456 (0.1451)			−0.8930 (0.1239)	
Cocoa	0.2384	5.441				−0.7453 (0.1187)	
Copra	0.3010	6.385				−0.8129 (0.1126)	
Groundnut oil	0.2176	6.966				−1.000 (9.862)	
Phosphates	0.2132	3.771				−0.8015 (0.1181)	

NOTES: Prices in logarithms; standard errors in parentheses. Tea begins in 1951, logs in 1956, and iron ore in 1960. Tobacco and manganese end in 1984.

prices follow a linear trend. Specifically, when a unit root cannot be rejected, we test the model with a unit root against a model with a linear time trend. That model may be specified as:

$$x_t = a + \alpha t + \sum_{i=1}^{p} b_i x_{t-i} + \sum_{j=1}^{q} c_j e_{t-j} + e_t . \qquad \text{(A.2)}$$

Acceptance of the trend model implies that shocks to prices do not persist in the long run and that, on average, prices display a constant growth rate (either positive or negative) over time.

The estimates of the ARIMA models can be used to compute predictions of future prices. Two strategies are possible when computing predictions. The first is to base predictions on the estimates of the best ARIMA model (the equations of Table A.1), whether or not the hypothesis of a unit root is accepted. The second is to impose the restriction of a unit root when it cannot be rejected and to compute predicted values based on the restricted model. The two methods yield similar results for short-run predictions. As shown below, however, the decision to impose a unit-root hypothesis has strong implications for long-run price predictions.

To complement the estimates of ARIMA models, we also estimated nonparametric measures of the persistence exhibited by commodity prices. These recently introduced measures may have some advantages over the estimates of low-order ARIMA models (Cochrane, 1988, and Campbell and Mankiw, 1987). Estimates of low-order ARIMA models may indicate the presence of long-run persistence that does not actually exist. For example, suppose that shocks to prices die out completely but take a long time to do so. Estimates of low-order ARIMA models may indicate that prices are extremely persistent because they do not capture the negative correlations between the price today and prices in the far future.

The nonparametric persistence measure V^k equals $1/k$ times the ratio of the variance of k-period differences in prices to the variance of 1-period differences in prices:

$$V^k = \frac{1}{k} \frac{\text{var}(x_t - x_{t-k})}{\text{var}(x_t - x_{t-1})}, \qquad \text{(A.3)}$$

where the window width, k, is chosen arbitrarily. V^k measures the fraction of a price shock that can be expected to persist into the indefinite future. For example, if a price displays no persistence, then V^k goes to 0 at large values of k. If the price process is a random walk with drift (implying that price shocks persist forever), then V^k equals 1.

We used the estimator of V^k proposed by Cochrane (1988), which includes a correction for degrees of freedom. This estimator is unbiased if the true

process is a random walk with drift. We report results for $k = 5$ and $k = 20$. Small values of k should yield results similar to those of low-order ARIMA estimates, since correlations between prices far apart in time are not included in the calculation of V. Larger values of k produce less biased estimates of the degree of persistence of higher-order processes but less efficient estimates of the degree of persistence if the process is actually a low-order one.

Summary of the Statistical Results

The data analyzed are the real prices of nineteen primary commodities of importance to African countries: bananas, cocoa, coffee, sugar, tea, copra, groundnut meal, groundnut oil, cotton, logs, rubber, sisal, tobacco, crude petroleum, copper, iron ore, manganese, phosphates, and tin. All price series are on an annual basis and run from 1950 through 1987, except tea (1951-87), logs (1956-87), tobacco (1950-84), iron ore (1960-87), and manganese (1950-84). Information on real prices from 1950 to 1984 was obtained from World Bank (1986). The series were updated to 1987 using unpublished World Bank commodity price data. Real prices were obtained by deflating nominal prices by the Manufacturing Unit Value Index (MUV), an index of the prices of manufactured exports from industrial market economies to developing countries.

We transformed the data on the real prices of commodities by taking the natural logarithm, and all our results are presented for the transformed series. It is desirable to work with logarithms for at least two reasons: (1) In the case of relative price data, it removes the arbitrariness involved in deciding whether to study the price of the commodity divided by the price of manufactures or the inverse of that ratio. (2) Differences between the transformed variable and its value lagged one period are approximately equal to the percentage growth rate of the original series. (The standard deviation of the transformed series is approximately equal to the standard deviation of the original series divided by its mean, which measures the percentage variability in the original series.)

Calculation of the Box-Ljung statistic for a lag of six years indicated that none of the logarithmic price series listed in Table A.1 is intertemporally independent (at significance levels of at least 1.1 percent). Yet fairly simple models proved to be the best in capturing the dynamic behavior of these series, so that very few parameters were needed to estimate the ARIMA equations. For 10 of 19 series, the values $p = 1$ and $q = 0$ were best. In none of these cases were we able to reject the possibility of a unit root using the Dickey-Fuller test; it is therefore possible that 100 percent of a shock in one period may persist indefinitely. In many cases, however, the point estimates of the parameters are fairly distant from a unit root, so that persis-

tence may in fact be limited. For example, coffee has an estimated value for b_1 of 0.72, with a standard error of 0.12. The Dickey-Fuller test indicates that one cannot reject the hypothesis that b_1 equals 1, but this result is due to the large standard error for b_1 rather than the estimated parameter's actually being close to a value of 1.

For groundnut meal, rubber, and tobacco, the preferred equations have $p > 1$ and $q = 0$. For these prices, the hypothesis of a unit root could not be rejected, so that some fraction of shocks persist indefinitely, but it is less than for those prices with $p = 1$ and $q = 0$. When a unit root is imposed, the fraction that persists is 0.60 for groundnut meal, 0.63 for rubber, and 0.66 for tobacco.

Series for which a unit root could not be rejected were tested to determine if the linear-trend model was more appropriate. Using the Dickey-Fuller test, we were able to reject the hypothesis of a linear trend (equation A.2) for all commodities except iron ore. For this one commodity, the hypothesis of a unit root was rejected in favor of a model with a linear time trend and with $p = 1$ and $q = 0$. The value of b_1 for iron ore is fairly small, and the coefficient for the time trend indicates a growth rate of -4.2 percent per annum.

When the equations for which unit roots could not be rejected were reestimated under the assumption of a unit root, most exhibited a negative constant. In no case, however, was the estimated growth rate significantly different from 0. If the unit-root hypothesis is accepted, shocks to these series persist and the series give no evidence of trending.

Four commodities (cocoa, copra, groundnut oil, and phosphates) were found to be best characterized by a model with $p = 0$ and $q = 1$, and two (sisal and manganese) were found to follow $p = 1$ and $q = 1$. The estimates for groundnut oil should be treated with extreme caution; the fact that the parameter c_1 is estimated to equal -1 identically suggests that the estimates of the model may not have converged properly. For the rest of these series, the moving-average parameter is quite large, exceeding 0.8 in absolute value for three series. The results indicate that shocks to prices in the preceding period have large effects on the current prices of these commodities. For sisal and manganese, we could not reject the hypothesis of a unit root.

Turning to the variability in the series, the standard errors of the equations show that the series are quite variable even after correcting for the influence of earlier prices on current prices. For instance, the standard error of the tea equation indicates that the residual has a standard deviation equal to nearly 17 percent of the mean price over the period. The commodities exhibiting the highest variability are sugar (42 percent) and copra (30 percent).

Predicted values for 1988 and 1989 are presented in Table A.2 for series

TABLE A.2

PREDICTED (LOG) REALS PRICES, 1988 AND 1989

Commodity	Actual Mean 1950-87	Actual Values 1985	1986	1987	Predicted Values: Unit Roots Not Imposed 1988	Not Imposed 1989	Imposed 1988	Imposed 1989
Bananas	3.84	3.67	3.52	3.40	3.43 (0.10)	3.45 (0.14)	3.40 (0.10)	3.40 (0.14)
Coffee	5.65	5.62	5.66	5.19	5.31 (0.23)	5.40 (0.28)	5.19 (0.24)	5.19 (0.34)
Copper	7.80	7.30	7.10	7.26	7.34 (0.21)	7.41 (0.27)	7.26 (0.21)	7.26 (0.30)
Cotton	5.40	4.92	4.53	4.88	4.94 (0.18)	5.00 (0.24)	4.88 (0.18)	4.88 (0.25)
Crude petroleum	2.30	3.33	2.48	2.62	2.59 (0.23)	2.57 (0.31)	2.62 (0.23)	2.62 (0.32)
Logs	5.08	5.20	5.28	5.33	5.28 (0.17)	5.24 (0.22)	5.33 (0.17)	5.33 (0.25)
Sugar	3.28	2.23	2.46	2.48	2.72 (0.42)	2.89 (0.51)	2.48 (0.44)	2.48 (0.63)
Tea	5.80	5.33	5.14	4.91	4.99 (0.20)	5.06 (0.27)	4.91 (0.20)	4.91 (0.28)
Tin	9.23	9.43	8.53	8.60	8.72 (0.19)	8.81 (0.25)	8.60 (0.20)	8.60 (0.28)
Iron ore	3.54	3.16	2.97	2.87	2.91 (0.08)	2.89 (0.08)	[no unit root]	
Groundnut meal	5.63	5.01	4.98	4.86	4.92 (0.17)	4.99 (0.22)	4.90 (0.17)	4.94 (0.17)
Rubber	5.14	4.57	4.42	4.49	4.59 (0.21)	4.58 (0.29)	4.57 (0.23)	4.53 (0.23)
Sisal	6.71	6.47	6.29	6.19	6.40 (0.20)	6.54 (0.35)	6.25 (0.22)	6.25 (0.29)
Cocoa	5.44	5.46	5.21	5.07	5.30 (0.24)	5.44 (0.30)	[no unit root]	
Copra	6.39	6.00	5.16	5.51	6.27 (0.39)	6.38 (0.39)	[no unit root]	
Groundnut oil	6.97	6.85	6.22	5.99	6.70 (0.22)	6.97 (0.31)	[no unit root]	
Phosphates	3.78	3.57	3.41	3.21	3.44 (0.21)	3.77 (0.27)	[no unit root]	

NOTES: Estimates based on ARIMA models of Table A.1; standard errors in parentheses. Tobacco and manganese (shown in Table A.1) are not reported here because these series end before 1987.

with data for 1987. There are two sets of predictions. The first comprises predicted values based on the parameter estimates shown in Table A.1. The second imposes unit roots and zero growth rates on series for which these hypotheses could not be rejected.

The series for which $q = 1$ and $p = 0$ have predicted values for 1988 that are substantially higher than the actual values for 1987. For example, the predicted value for copra is 6.27 and the actual 1987 value is 5.51. Since the price series are in logarithmic form, this result indicates that the real price of copra is expected to be a full 76 percent higher in 1988 than in 1987. The predictions for other series with $q = 1$ are less dramatic. The expected increase for 1988 is 9 percent for cocoa, 71 percent for groundnut oil (again, to be treated cautiously), 20 percent for sisal, and 23 percent for phosphates.

The series for which unit roots could not be rejected (bananas, coffee, sugar, tea, groundnut meal, cotton, logs, rubber, sisal, petroleum, copper, and tin) have predicted values for 1988 and 1989 that are closer to 1987 values, whether or not unit roots are imposed. When unit roots are not imposed, the predicted values indicate small expected increases in commodity prices for each of these commodities except logs and crude petroleum. Imposition of the unit root produces predictions very close to 1987 values. For the series found to have $p = 1$, $q = 0$, a unit root, and a zero growth rate, the predicted values are of course identical to the 1987 values.

One may wonder why two sets of predicted values are necessary. The results in Table A.2 indicate that the decision about imposing a unit root makes only a small difference to short-run forecasts, but it makes a large difference to long-run forecasts. The decision *not* to impose a unit root implies acceptance of the hypothesis that prices will revert to a steady-state value over the long run. The decision to impose a unit root implies acceptance of the hypothesis that the price series has no steady-state value and that shocks to prices are permanent. As mentioned in section 4C, economic considerations suggest that a unit root in combination with $p = 1$ and $q = 0$ may not be a sensible null hypothesis, because it implies 100 percent persistence.

Estimates of the nonparametric measures V^5 and V^{20} are presented in Table A.3. The results indicate fairly high degrees of persistence (V^{20} greater than 0.60) for groundnut oil, crude petroleum, copper, and tin. For these commodities, one cannot reject the hypothesis that $V^{20} = 1$. Commodities with lower degrees of persistence (V^{20} less than 0.20) are bananas, cocoa, logs, rubber, tobacco, iron ore, manganese, and phosphates.

It appears that the ARIMA results may overstate the degree of persistence exhibited by commodity prices. The ARIMA estimates imply that for 9 of the 19 commodities the hypothesis that prices follow a random walk

TABLE A.3

PERSISTENCE MEASURES

Commodity	V^5	V^{20}
Bananas	0.564	0.176
	(0.227)	(0.070)
Coffee	0.626	0.347
	(0.252)	(0.139)
Copper	0.759	0.794
	(0.305)	(0.317)
Cotton	0.407	0.323
	(0.164)	(0.129)
Crude petroleum	1.327	0.685
	(0.534)	(0.274)
Logs	0.528	0.125
	(0.225)	(0.042)
Sugar	0.492	0.339
	(0.198)	(0.136)
Tea	0.440	0.335
	(0.179)	(0.131)
Tin	1.067	1.409
	(0.429)	(0.563)
Iron ore	0.323	0.105
	(0.143)	(0.028)
Tobacco	0.377	0.084
	(0.156)	(0.031)
Groundnut meal	0.402	0.476
	(0.162)	(0.190)
Rubber	0.370	0.179
	(0.149)	(0.072)
Manganese	0.825	0.093
	(0.341)	(0.035)
Sisal	0.885	0.407
	(0.356)	(0.163)
Cocoa	0.568	0.190
	(0.228)	(0.076)
Copra	0.205	0.205
	(0.082)	(0.082)
Groundnut oil	0.571	0.687
	(0.230)	(0.275)
Phosphates	0.469	0.169
	(0.189)	(0.068)

NOTES: V is the Cochrane (1988) measure of persistence. Asymptotic standard errors are in parentheses.

cannot be rejected, so that a shock persists fully. Using the nonparametric persistence measures, the same hypothesis cannot be rejected for only 4 commodities (groundnut oil, crude petroleum, copper, and tin). It should be kept in mind that most of the ARIMA estimates and the nonparametric persistence measures have large standard errors. This imprecision results at least partially from the fact that only thirty-five years of data are available for most commodities.

In summary, both the ARIMA estimates and the nonparametric persistence measures draw a picture of some persistence in price series. Although the ARIMA estimates may overstate the case for unit roots in price series, both the ARIMA and nonparametric estimates indicate that shocks to most commodity prices will not die out quickly.

APPENDIX B

Data Sources

Country Data

The data on export values are from the tapes of IMF, *International Financial Statistics*, 1987, unless otherwise noted. This basic source was extended whenever possible by reference to United Nations, *Yearbook of International Trade Statistics*, New York, and Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO), *Notes d'Information et Statistiques*, Dakar.

An attempt was made to provide data on all primary commodity exports that were significant between 1966 and 1985. When United Nations figures in U.S. dollars were used for components, the local-currency value of the export was derived by multiplying the share of the export in the dollar value of total exports by the local-currency value of total exports available from the IMF.

Wherever possible, figures are for the values of exports of unprocessed and processed agricultural exports when processing is minimal, as with production of cocoa butter or paste and of groundnut cake and oil. When it is known that the data include processed components, "& p" or the word "products" is appended to the commodity name.

In a very few cases, the IMF data for component export values sum to more than total exports. This is a well-known deficiency in the IMF data, and very little can be done about it.

Notes for Specific Countries

Benin: Cocoa in 1966, 1967, and 1981 set to 0, based on BCEAO and UN. Palm oil & p from BCEAO and UN.
Burkina Faso: Animals and meat from BCEAO and UN. Cotton value for 1984 corrected from BCEAO.
Cameroon: Petroleum from UN.
Central African Republic: Wood for 1966-69 from UN.
Congo: Diamonds from UN.
Ghana: Aluminum from UN.
Ivory Coast: Cocoa, coffee, and wood from BCEAO and UN.
Malawi: Sugar set to 0 in 1966 and 1967 based on UN.
Mali: Animals & p from BCEAO and UN.

Niger: Uranium set to 0 in 1966-70 based on BCEAO and UN. Animal and groundnut products from BCEAO and UN.
Senegal: Fish and petroleum products from BCEAO.
Togo: Petroleum set to 0 for 1966-76 based on BCEAO.
Uganda: Cotton for 1977-81 from UNCTAD (1986).

Price Data

The world prices and the MUV used to deflate these prices were, with the exception of the groundnut price, obtained from World Bank (1986) for the years 1950-84. These prices were updated to 1987 from unpublished data from the World Bank. Also, the World Bank has revised the 1982-84 values of the MUV. These revised values were used to deflate all world price series. The nominal price for groundnuts (used in Table 6) was obtained from the IMF, International Financial Statistics data tape, 1987. It was deflated by the MUV.

The World Bank's *Commodity Trade and Price Trends* provides several different price series for most commodities. The following list shows which series were picked, using the label that the World Bank gives to the series. Detailed descriptions of all price series can be obtained from the original source.

Bananas: Any origin
Cocoa: New York and London
Coffee: Angolan, an ICO price
Sugar: World, raw
Tea: Average, all tea
Copra: Philippines
Groundnut meal: Any origin
Groundnut oil: Nigerian
Cotton: "A" Index
Logs: West African
Rubber: New York market
Sisal: Kenyan/Tanzanian No. 3
Tobacco: Indian
Crude petroleum: Saudi Arabian
Copper: London Metal Exchange
Iron ore: Brazilian
Manganese: Indian
Phosphates (phosphate rock): Moroccan
Tin: London Metal Exchange

The producer prices for cocoa, coffee, groundnuts, and cotton were obtained from the following sources:

Cocoa

Cameroon:	1961-80:	Hesp (1985)
Ghana:	1961-72:	Hesp (1985)
	1973-82:	World Bank (1984, p. 90)
Ivory Coast:	1961-72:	Hesp (1985)
	1973-85:	BCEAO (various numbers)
Nigeria:	1961-68:	Hesp (1985)
	1969-85:	Central Bank of Nigeria, *Annual Report and Statement of Accounts*
Sierra Leone:	1961:	Hesp (1985)
	1962-85:	Sierra Leone Government, *Annual Statistical Digest*
Togo:	1961-72:	Hesp (1985)
	1973-85:	BCEAO (various numbers)

Coffee

Burundi:	1961-66:	Hesp (1985)
	1967-85:	Banque de La Republique du Burundi, *Bulletin Trimestriel*
Cameroon:	1961-80:	Hesp (1985)
	1981-85:	ICO, "Quarterly Statistical Bulletin," Nos. 26, 34, unpublished
Ivory Coast:	1961-72:	Hesp (1985)
	1973-85:	BCEAO (various numbers)
Kenya:	1961-85:	Central Bureau of Statistics, *Statistical Abstract*
Madagascar:	1961-74:	Hesp (1985)
	1975-85:	ICO, "Quarterly Statistical Bulletin," Nos. 26, 34, unpublished
Rwanda:	1966-69:	Hesp (1985)
	1970-82:	Banque Nationale du Rwanda, *Rapport d'Activités*
	1983-85:	ICO, "Quarterly Statistical Bulletin," Nos. 26, 34, unpublished
Sierra Leone:	1962-85:	Sierra Leone Government, *Annual Statistical Digest*
Togo:	1961-72:	Hesp (1985)
	1973-85:	BCEAO (various numbers)
Uganda:	1961-71:	Uganda, *Statistical Abstract*
	1972-73:	World Bank (1982, p. 151)
	1974-78:	ICO, "Quarterly Statistical Bulletin," Nos. 26, 34, unpublished

Groundnuts

Gambia:	1961-77:	Hesp (1985)
Malawi:	1961-80:	Hesp (1985)
Niger:	1961-73:	Hesp (1985)
	1974-85:	BCEAO (various numbers)
Senegal:	1961-85:	BCEAO (various numbers)

Cotton

Burkina Faso:	1961-73:	Hesp (1985)
	1974-85:	BCEAO (various numbers)
Tanzania:	1961-69,	1971-80: Hesp (1985)
Uganda:	1961-72:	Uganda, *Statistical Abstract*
	1973-76:	Hesp (1985)
	1977-78:	World Bank (1982, p. 151)

Each producer-price series was deflated by the country's consumer-price index (1980 = 100), obtained from the IMF, International Financial Statistics data tape, 1987.

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