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An Econometric Study of Primary Commodity Exports from  
Developing Country Regions to the World

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I. Introduction

The pressing need for highly indebted countries to accelerate the growth of their exports has drawn increased attention to the export performance of developing countries in recent years. This paper focuses on the performance with regard to primary commodities. Data on the flow of primary commodity (henceforth, for simplicity, "commodity") exports from selected regional groups of non-oil developing countries <sup>1/</sup> are presented and analyzed. Such data can be useful both for projecting exports and for formulating exchange rate and trade policies.

Foreign trade data points to substantial changes in the commodity structure of developing country exports over the past two decades. First, it shows from 1965 to 1980 a decline in the share of all developing countries in the commodity imports of industrial countries. Second, it shows that over the same period the Asian countries were the most successful in maintaining their market shares. Both demand-side and supply-side reasons for these changes are suggested. On the demand side the paper discusses the role played by commodity composition, proximity to markets, and industrial country policies. On the supply side it examines factors such as relative prices, domestic resource use, population growth, and the local endowment of natural resources, as well as the influence of domestic policies.

The export data is then analyzed econometrically in order to distinguish the relative impact of the world economic environment (demand) and the domestic environment (supply) on the volume of exports. The

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<sup>1/</sup> Non-oil developing countries are defined in this paper as in the IMF, 1986 World Economic Outlook, p. 174. It includes all developing countries except for the following major oil producing countries: Algeria, Indonesia, Nigeria and Venezuela. These countries are also OPEC members.

countries being studied are categorized into five geographical regions in order to distinguish interregional differences in demand and supply elasticities. The estimated price and income elasticities thus obtained are compared with estimated elasticities for individual commodities and groups of commodities obtained from other studies.

It was decided to base the study on groups of commodities and on regions, rather than on individual commodities and countries, in order to permit analysis of broad economic trends while at the same time allowing enough disaggregation so that differences in these trends among commodity groups and regions can be distinguished. The resulting elasticities provide important information on the extent to which particular types of exports of particular groups of countries respond to world growth and world prices.

The plan of the paper is as follows. Section II looks at the trends of commodity exports for developing countries as a whole and for the five selected regions; such trends reflect structural developments that have taken place over the past two decades. Section III presents a model that incorporates both the demand and supply determinants of commodity exports. Section IV discusses the results derived from this model. Section V presents a survey of empirical results from other studies and compares them with the results from this study. Section VI summarizes the conclusions.

## II. Trends in Commodity Exports of Developing Countries

This section of the paper discusses the trends in developing country trade in exports that took place over the years 1965 to 1980. 1/ The first subsection describes the growth in trade of commodity exports from developing countries in comparison with trade of similar exports from industrial countries; it describes how market shares between developing and industrial countries adjusted to changed economic conditions over the period examined. 2/ The second subsection describes the growth in trade of commodity exports, distinguishing among regions of the developing countries, identifying the relatively more successful regions and discussing the reasons for their success. The third and concluding subsection analyzes the causes of the above trends from both the demand and supply perspectives, focusing on the respective roles of the international economic environment, industrial country policies, and domestic policies of the developing countries. 3/

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1/ Although data for 1981 and 1982 were used in the empirical estimation they were excluded from the data used for this discussion on trends because they contain cyclical effects.

2/ A more detailed discussion of how these market shares changed can be found in the World Bank Development Report (1983).

3/ A wider focus on demand and supply factors in world non-oil primary producing commodity markets can be found in Chu and Morrison (1984, 1985).

1. Trends in developing country exports in comparison with industrial country exports 1/

Trade in commodity exports, especially agricultural commodities, is declining in relative importance for developing countries. From 1965 to 1980 developing countries lost market shares in world commodity imports. Over this period, commodity export earnings (in U.S. dollars) for industrial countries grew by 15 percent, compared to 11.7 percent for developing countries (Table 1). To some extent, this difference might be explained by the fact that over the same period 1965 to 1980 manufactured exports from developing countries grew faster (18.6 percent per annum) than such exports from the industrial countries (16.9 percent) (Table 1). These figures reflect the growing trend in developing countries of exporting processed food and raw materials formerly exported without processing. Despite this gain in exports of manufactures from developing countries, total exports (commodities plus manufactures) of the industrial countries grew at an annual average rate of 1.5 percent faster than growth of the developing country exports (Table 1).

While the developing countries increased their share of total manufactured exports in world markets, from 9.7 percent in 1965 to 11.9 percent in 1980, their share of total commodity exports fell from 32.4 percent in 1965 to 18.1 percent in 1980 (Table 2). This decline was particularly marked for agricultural commodities: the share of developing countries in total food exports fell from 30.4 percent to 23.0 percent; in total exports of beverages and tobacco, from 80.7 percent to 73.4 percent, and in total exports of agricultural raw materials from 39.5 percent to 28.5 percent. While these declines in world export shares, can in part be explained by their increased processing capacity, this explanation does not complete the picture. In both food and agricultural output, developing countries experienced higher growth rates than industrial countries between 1960 and 1980 (Table 3), but much of the increased agricultural output was consumed domestically rather than exported, as the population growth of these countries grew at much higher rates than the population growth in industrial countries during the 1960s and 1970s.

While the developing countries' share of world exports of energy and manufactures rose, this increase was by no means sufficient to offset the decline in their share of trade in primary products; consequently developing countries' share of total world exports fell from 17.2 percent in 1965 to 13.9 percent in 1980 (Table 2). By contrast, industrial countries' share of total world exports fell very little over the same period; this loss of shares for industrial countries was due to the small fall in the share

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1/ The data in the tables presented exclude data for IMF nonmember centrally planned economies.

Table 1. Exports of Commodity Group from Developing Country Regions, Industrial Countries, and OPEC to the World, 1965 and 1980

(In billions of U.S. dollars)

Region	Food		Beverages and Tobacco		Agricultural Raw Materials		Minerals		Energy		All Commodities		Manufactures		Total	
	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980
Africa (Annual average percent growth)	1.12 (8.5)	3.79	0.72 (7.1)	2.02	0.86 (5.1)	1.82	0.98 (10.1)	4.18	0.02 (45.0)	5.25	3.70 (10.7)	17.06	2.23 (17.0)	23.55	5.93 (13.7)	40.61
Asia (Annual average percent growth)	1.70 (13.0)	10.67	0.61 (7.5)	1.80	1.85 (10.7)	8.53	0.71 (13.2)	4.54	0.07 (36.5)	7.42	4.94 (13.5)	32.95	2.95 (22.3)	60.3	7.89 (17.9)	93.2
Europe (Annual average percent growth)	0.59 (12.3)	3.36	0.24 (5.3)	0.52	0.32 (11.1)	1.55	0.15 (13.1)	0.95	0.00 (0.0)	0.00	1.31 (11.1)	6.39	2.74 (15.9)	25.10	4.04 (14.6)	31.49
Middle East (Annual average percent growth)	0.29 (5.9)	0.69	0.00 (0.0)	0.00	0.45 (2.9)	0.69	0.03 (16.8)	0.31	0.03 (33.8)	2.36	0.80 (11.4)	4.06	0.69 (18.4)	8.75	1.49 (15.4)	12.8
Western Hemisphere (Annual average percent growth)	2.67 (11.2)	13.12	1.62 (10.9)	7.74	1.03 (6.6)	2.69	1.36 (11.2)	6.65	0.16 (19.3)	2.25	6.83 (10.9)	32.44	2.03 (16.4)	19.87	8.87 (12.5)	52.31
Total developing countries (Annual average percent growth)	6.36 (11.3)	31.63	3.19 (9.3)	12.08	4.51 (8.5)	15.28	3.23 (11.5)	16.63	0.28 (31.6)	17.28	17.58 (11.7)	92.90	10.64 (18.6)	137.57	28.21 (15.0)	230.47
Industrial countries (Annual average percent growth)	13.97 (28.2)	104.94	0.58 (12.7)	3.47	6.72 (11.7)	35.19	5.13 (14.6)	39.83	1.43 (25.3)	42.38	27.83 (15.0)	225.82	96.18 (16.9)	995.62	124.00 (16.5)	1221.44
OPEC (Annual average percent growth)	0.56 (3.8)	0.98	0.18 (11.3)	0.90	0.19 (20.5)	3.13	0.25 (13.4)	1.65	7.76 (23.6)	186.75	8.94 (22.7)	193.40	2.42 (14.6)	18.63	11.36 (21.5)	212.03
Average world (Annual average Percent growth)	20.89 (13.4)	137.55	3.95 (9.9)	16.45	11.42 (10.8)	53.60	8.61 (13.6)	58.11	9.47 (24.3)	246.41	54.35 (16.1)	512.12	109.24 (17.0)	1151.82	163.59 (16.7)	1663.95

Source: The World Bank Trade System.

Table 2. Exports of Commodity Group from Developing Country Regions,  
Industrial Countries, and OPEC to the World, 1965 and 1980

(As proportion of world exports, in percent)

Region	Food		Beverages and Tobacco		Agricultural Raw Materials		Minerals		Energy		All Commodities		Manufactures		Total	
	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980
Africa	5.3	2.8	18.2	12.3	7.6	3.4	11.4	7.2	0.2	2.1	6.8	3.3	2.0	2.0	3.6	2.4
Asia	8.1	7.8	15.4	10.9	16.2	15.9	8.3	7.8	0.7	3.0	9.1	6.4	2.7	5.2	4.8	5.6
Europe	2.8	2.4	6.1	3.2	2.8	2.9	1.8	1.6	0.0	0.0	2.4	1.3	2.5	2.2	2.5	1.9
Middle East	1.4	0.5	0.0	0.0	3.9	1.3	0.3	0.6	0.3	1.0	1.5	0.8	0.6	0.8	0.9	0.8
Western Hemisphere	12.8	9.5	41.0	47.0	9.0	5.0	15.8	11.4	1.7	0.9	12.6	6.3	1.9	1.7	5.4	3.2
Developing countries	30.4	23.0	80.7	73.4	39.5	28.5	37.6	28.6	2.9	7.0	32.4	18.1	9.7	11.9	17.2	13.9
Industrial countries	66.9	76.3	14.7	21.1	58.9	65.7	59.5	68.6	15.1	17.2	51.2	44.1	88.1	86.5	75.8	73.4
OPEC	2.7	0.7	4.6	5.5	1.6	5.8	2.9	82.0	82.0	75.8	16.4	37.8	2.2	1.6	7.0	12.7
Average world	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: The World Bank Trade System.

Table 3. Growth Rates of Agricultural and Food Output by Major World Regions (excluding China), 1960-80

Region	Agricultural output				Food output			
	Total		Per capita		Total		Per capita	
	1960-70	1970-80	1960-70	1970-80	1960-70	1970-80	1960-70	1970-80
Developing countries	2.8	2.7	0.3	0.3	2.9	2.8	0.4	0.4
Low-income	2.5	2.1	0.2	-0.4	2.6	2.2	0.2	-0.3
Middle-income	2.9	3.1	0.4	0.7	3.2	3.3	0.7	0.9
Africa	2.7	1.3	0.2	-1.4	2.6	1.6	0.1	-1.1
Middle East	2.5	2.7	0.0	0.0	2.6	2.9	0.1	0.2
Latin America	2.9	3.0	0.1	0.6	3.6	3.3	0.1	0.6
Southeast Asia	2.9	3.8	0.3	1.4	2.8	3.8	0.3	1.4
South Asia	2.5	2.2	0.1	0.0	2.6	2.2	0.1	0.0
Southern Europe	3.1	3.5	1.8	1.9	3.2	3.5	1.8	1.9
Industrial market economies	2.1	2.0	1.1	1.2	2.3	2.0	1.3	1.1
Total world	2.6	2.2	0.7	0.4	2.7	2.3	0.8	0.5

Source: World Development Report, 1983.

Note: Production data are weighted by world export unit prices. Decade growth rates are based on midpoints of five-year averages, except that 1980 is the average for 1969-71.

of manufactured exports. Of the developing countries only the Asian countries resisted this trend; their combined share in total world exports rose from 4.8 percent in 1965 to 5.6 percent in 1980.

2. Trends in commodity exports among different regions of the developing countries

The aggregates presented in Section I conceal substantial regional differences. Among regional groups of developing countries, Asia has experienced the fastest average rate of growth (13.5 percent) of commodity export earnings (Table 1, column 7). By contrast, the slowest rates of growth took place in Africa and the Western Hemisphere (10.7 percent and 10.9 percent respectively). Asia also experienced the fastest growth rate in manufactured exports, which grew at an annual rate of 22.3 percent, compared to an average of 18.6 percent for the developing countries as a whole. Total export earnings for the Asian countries thus grew at an annual average rate of 17.9 percent, compared to a rate of 12.5 percent for the Western Hemisphere and 13.7 percent for Africa. Since Asia also experienced one of the lowest growth rates in export unit values--7.5 percent per annum (Table 4)--the growth in the volume of its exports (over 10 percent per annum) was by far the largest such increase of any developing country region.

The decline in the relative importance of exports of food, beverages and tobacco, and agricultural raw materials for the developing countries as a whole (Table 5) conceals substantial differences between regions, particularly as regards food exports. In Asia, Europe, and Western Hemisphere, there was an increase in the annual per capita growth rates of agricultural output over the period and therefore very little decline in the relative importance of food exports. By contrast, the fall in the share of exports of agriculture for Africa is a reflection both of the decline in the annual growth rate of agricultural output, which fell from 2.7 percent in the 1960s to 1.3 percent in the 1970s, (Table 3), and of the acceleration in the rate of population growth. The implications of this decline are especially serious for the many African countries that remain highly dependent on agricultural exports as a source of foreign exchange earnings.

Not surprisingly, Africa also experienced the largest decline in agricultural exports as a proportion of world exports of agriculture (Table 2). Africa's share in world imports of food fell from 5.3 percent in 1965 to 2.8 percent in 1980, beverages and tobacco from 18.2 percent to 12.3 percent, and agricultural raw materials from 7.6 percent to 3.4 percent. At the other end of the spectrum, the Asian countries lost very little in world market shares of agricultural exports between 1965 and 1980.

Table 4. Exports of Commodities from Developing Country Regions,  
Industrial Countries, and OPEC to the World, 1965 and 1980  
Commodity Prices and Export Unit Values

(1980 = 100)

Region	Food		Beverages and Tobacco		Agricultural Raw Materials		Minerals		Oil		Export Unit Value Total	
	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980
Africa	19.55 (11.5)	100.0	20.65 (11.1)	100.0	26.03 (9.4)	100.0	44.56 (5.5)	100.0	4.64 (22.7)	100.0	29.34 (8.5)	100.0
Asia	31.12 (8.1)	100.0	39.77 (6.3)	100.0	26.58 (9.2)	100.0	32.07 (7.9)	100.0	4.64 (22.7)	100.0	33.73 (7.5)	100.0
Europe	35.40 (7.2)	100.0	41.59 (6.0)	100.0	21.95 (10.6)	100.0	34.66 (7.3)	100.0	4.64 (22.7)	100.0	34.84 (7.3)	100.0
Middle East (Non-Oil)	32.96 (7.7)	100.0	36.82 (6.9)	100.0	32.75 (7.7)	100.0	30.20 (8.3)	100.0	4.64 (22.7)	100.0	--	--
Western Hemisphere	26.97 (9.1)	100.0	25.07 (9.7)	100.0	29.01 (8.6)	100.0	47.17 (5.3)	100.0	4.64 (22.7)	100.0	24.14 (9.9)	100.0
Total indebted developing countries	--	--	--	--	--	--	--	--	--	--	29.59 (8.5)	100.0
Industrial countries	--	--	--	--	--	--	--	--	--	--	29.38 (8.5)	100.0
OPEC	--	--	--	--	--	--	--	--	--	--	5.34 (21.6)	100.0
World	28.61 (8.7)	100.0	25.29 (9.6)	100.0	36.04 (7.0)	100.0	41.39 (6.1)	100.0	4.64 (22.7)	100.0	23.46 (10.1)	100.0

Source: International Monetary Fund.

Table 5. Exports of Commodity Group from Developing Country Regions,  
Industrial Countries, and OPEC to the World, 1965 and 1980

(In percent of exports of all commodities)

	Food		Beverages and Tobacco		Agricultural Raw Materials		Minerals		Energy		All Commodities		All Commodities		Manufactures	
	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980
Africa	30.2	22.2	19.5	11.8	23.4	10.7	26.4	24.5	0.5	30.8	100.0	100.0	62.4	42.0	37.6	58.0
Asia	34.3	32.4	12.4	5.4	37.5	25.9	14.4	13.8	1.4	22.5	100.0	100.0	62.6	35.3	37.4	64.7
Europe	45.2	52.6	18.4	8.2	24.6	24.3	11.6	14.9	0.2	0.0	100.0	100.0	32.4	20.3	67.6	79.7
Middle East (non-oil)	36.5	17.0	0.4	0.0	55.8	17.0	3.4	7.9	3.9	58.1	100.0	100.0	53.7	31.7	46.3	68.3
Western Hemisphere	39.1	40.4	23.7	23.9	15.0	8.3	19.9	20.5	2.3	6.9	100.0	100.0	77.1	62.0	22.9	38.0
Total developing countries	36.2	34.0	18.1	13.0	25.7	16.5	18.4	17.9	1.6	18.6	100.0	100.0	62.3	40.3	37.7	59.7
Industrial countries	50.2	46.5	2.1	1.5	24.1	15.6	18.4	17.6	5.2	18.8	100.0	100.0	22.4	18.5	77.6	81.5
OPEC	6.3	0.5	2.0	0.5	2.1	1.6	2.8	0.8	86.8	96.6	100.0	100.0	78.7	91.2	21.3	8.8
Average world	38.5	26.8	7.3	3.2	21.0	10.5	15.8	11.4	17.4	48.1	100.0	100.0	33.2	30.8	66.8	69.2

3. Trends in commodity exports of developing countries:  
a demand and supply perspective

a. Demand for commodity exports of developing countries

Although activity in the industrial countries is by far the most important determinant of demand for developing country exports, commodity composition, commodity prices, geographical location and industrial country policies also play a significant role.

In the first place, much success or lack of success in exporting for the developing countries can depend upon the types of commodity exported and how world demand for each type moves over time. Exports of fuel and manufactures have increased in importance in world trade over the years. The elasticity of demand tends to be higher for these goods than for non-fuel primary commodities, and manufacturing prices tend to be more stable than prices for food and raw materials. Minerals and metals tend to have an income elasticity of demand greater than that for foodstuffs. In addition the continual shift of mineral processing plants from industrial to developing countries has tended to raise industrial country demand for these developing country exports. Agricultural commodities have fallen as a share of developing country exports despite the accelerating demand for world foodstuffs and beverages that has taken place since 1973; this rise in demand has reflected the rapid increase in demand for food from OPEC, newly industrializing countries, and nonmarket economies that resulted from growth in these countries, rather than high demand elasticities. The rising demand for high-value products such as meat, poultry, dairy produce, fruit and vegetables has been mainly met by industrial countries, with the biggest relative increase coming from the EEC. The performance for developing countries in these growing agricultural export markets has been quite mixed and has varied widely across regions and countries. The successes mainly took place in exports of nontraditional crops, such as soybeans, while in the case of more traditional exports, inelastic demand limited the increase. Therefore the failure of agricultural product exporters to diversify has led to their shrinking share of world trade.

In the second place, the growth of exports can depend in part upon the location of the exporter. For example, most of the markets for Africa's commodity exports are in the EEC because of Africa's location. With European agriculture expanding in the last decade, Africa's exports to this region declined. By comparison, most of the markets for Asian exports have been rapidly growing. Trade in rice between developing countries of South and East Asia has been growing rapidly, as has Japan's imports from the Asian countries.

In the third place, trade and agricultural policies of industrial countries influence the options for exporting that are open to developing countries. Agriculture in some industrial countries is becoming heavily protected and subsidized. The EEC, for example, has become increasingly self-sufficient in a broad range of agricultural commodities, thanks to various protectionist measures. Therefore, in certain products, developing countries have been prevented from expanding into traditional industrial country markets.

b. Supply of commodity exports from developing countries

Weather conditions, resource endowments, relative prices, technology, domestic market growth, and population growth all determine the supply of exports of a developing country. Apart from the weather and resource endowment, all the other determinants of supply are affected by domestic policies.

First, pricing policies have to allow producer prices to reflect market prices if a country is to have an optimal production mix for domestic markets and exports. In some low-income African countries during the period examined, poor incentives to farmers, inefficient marketing systems, high inflation and the maintenance of an overvalued nominal exchange rate led to an appreciation of their real exchange rates, as relatively high rates of domestic inflation were not fully offset by a fall in their nominal exchange rates. Analogously, pricing policies, particularly in agriculture, failed in many countries to display adequate flexibility in the face of domestic inflation: for example, in a number of African countries real producer prices were lower in 1980 than in 1970.

Second, policies that led to higher investment are highly correlated with export growth rates. The spread of new technology in the rural sector tends to raise agricultural capacity and provide increased export earnings, which can be used to import the capital and raw materials necessary to begin expansion in the manufacturing sector. New technology and schooling have also played an important role in the rapid diffusion of high-yielding varieties of crops.

Third, population policy and export growth are related. Many countries have shown that effective measures can be taken to slow population growth; others have failed to take effective measures, with disastrous results in some instances. With the slowing of population growth, more domestic production can be exported, thus providing the means to purchase capital inputs so necessary for technological improvements.

### III. Volume and Price Equations for Commodity Exports of Developing Countries

In the empirical equations developed in this section, five developing country regions and five commodity groups are distinguished. The regions are Africa, Asia, Europe, Middle East and Western Hemisphere, as defined in International Financial Statistics; they are enumerated in Appendix I. They were chosen because of the availability of the data and because of certain similarities that exist among the countries within each region, such as closeness to industrial country markets and transportation costs.

The five commodity groups are (i) food, (ii) beverages and tobacco, (iii) agricultural raw materials, (iv) minerals and (v) energy. This disaggregation is made because an analysis based on aggregate relationships covering all commodities could produce misleading results, owing to differences in the degree of sensitivity to price and income changes among types of commodity exports. In addition, the specification of demand and supply equations may differ among types of commodity. In particular, conditions in the energy market necessitate estimation procedures that are different from those for the other four commodity groups.

#### 1. Demand and supply equations for four commodities

The demand and supply equations for five regions and the first four commodity groupings are based on the equations used by Goldstein and Khan (1978). Adjustment in export demand to changing market conditions occurs within a period of one year; adjustment in export supply allows for the possibility of delayed adjustment beyond one year. In the demand equation commodity k is differentiated by its regional source of supply. 1/

##### a. Export demand

The world demand for exports of commodity k from developing country region R is specified in log-linear form as follows:

$$(1) \ln X_{Rk} = a_0 + a_1 \ln (P_{Xk} / P_{Wk}) + a_2 \ln Y^W$$

where the variables are:

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1/ Commodity exports of different regions are treated as imperfect substitutes in this paper.

- $X_{Rk}^D$  = quantity of exports of commodity k demanded from region R;  
 $P_{Rk}^X$  = export prices of commodity k from region R;  
 $P_{wk}$  = average price of commodity k in international markets;  
 $Y^W$  = real income in importing countries;

All data are expressed in U.S. dollars.

Since equation (1) is specified in logarithms,  $a_1$  is the elasticity of world demand for region R's exports of the kth commodity with respect to the divergence between region R's export price of the kth commodity and the average world price, and  $a_2$  is the real world income elasticity of export demand for commodity k. It is expected that  $a_1$  will be negative and  $a_2$  will be positive.

b. Export supply

The supply of exports of commodity k from region R is specified as a log-linear function of current and lagged ratios of the export price of commodity k to domestic price levels in producing countries in region R, an index of productive capacity in region R, and supply shocks:

$$\begin{aligned}
 (2) \quad \ln X_{Rk}^S &= \beta_0 + \beta_1 \ln (P_{Rk}^X / P_{Rk} E_R) + \beta_2 \ln (P_{Rk}^X / P_{R-1} E_{R-1}) \\
 &+ \beta_3 \ln \bar{Y}_R + \beta_4 \ln SS_R + \beta_5 t
 \end{aligned}$$

where

- $X_{Rk}^S$  = quantity of exports of commodity k supplied from region R;  
 $P_R$  = domestic price level in producing countries in region R, in local currency;  
 $E_R$  = exchange rates of currencies of producing countries, U.S. dollar per unit of local currency;  
 $\bar{Y}_R$  = index of overall productive capacity in region R;  
 $SS_R$  = supply shocks in region R  
 $P_R E_R$  =  $P_R^* E_R$   
 $t$  = trend term that reflects long-run changes that affect the supply of exports of commodity k

All data, except domestic prices, are expressed in U.S. dollars.

Equation (2) embodies the notion that exporters increase their supply of exports as the price of exports rises relative to domestic prices. The lagged price variable allows for the possibility of delayed supply adjustment beyond the period of one year. Exports of commodity k are also expected to increase as productive capacity in region R increases.  $SS_R$  reflects other factors that influence exports from region R.  $\beta_1$  and  $\beta_2$  are region R's price elasticity of export supply, respectively.  $\beta_3$  is the elasticity with respect to productive capacity. It is expected that the sign of elasticities  $\beta_1$ ,  $\beta_2$  and  $\beta_3$  will be positive. Normalizing the equation for the price of exports in region R yields the following equation:

$$(3) \ln PX_R^k = b_0 + b_1 \ln XS_R^k + b_2 \ln P_R^E + b_3 \ln (PX_{R-1}^k / P_{R-1}^E) + b_4 \ln \bar{Y}_R + b_5 \ln SS_R + b_6 t$$

The normalized coefficients are related to the structural parameters in the following way:

$$b_0 = -\frac{\beta_0}{\beta_1}; \quad b_1 = \frac{\beta_1}{\beta_1}; \quad b_2 = \frac{\beta_1}{\beta_1}; \quad b_3 = \frac{\beta_2}{\beta_1};$$

$$b_4 = \frac{\beta_3}{\beta_1}; \quad b_5 = \frac{\beta_4}{\beta_1}; \quad b_6 = \frac{\beta_5}{\beta_1};$$

Since  $\beta_1$ ,  $\beta_2$  and  $\beta_3$  are positive, it is expected that  $b_1 > 0$ ,  $b_2 > 0$ ,  $b_3 < 0$  and  $b_4 < 0$ .

c. Reduced-form equations

Estimates of the structural parameters can be obtained by first solving equations (1) and (3) simultaneously to obtain reduced-form equations (4) and (5), and then estimating (4) and (5) simultaneously.

$$\begin{aligned}
 (4) \quad \ln X_R^k &= \frac{a_0 + a_1 b_0}{D} - \frac{a_1}{D} \ln P W^k + \frac{a_2}{D} \ln Y W + \frac{a_1 b_4}{D} \ln Y_R \\
 &+ \frac{a_1 b_2}{D} \ln P_R^E + \frac{a_1 b_3}{D} \ln (P X_{R-1}^k / P_{R-1}^E) \\
 &+ \frac{a_1 b_5}{D} \ln S S_R + \frac{a_1 b_6}{D} t
 \end{aligned}$$

$$\begin{aligned}
 (5) \quad \ln P X_R^k &= \frac{b_0 + a_0 b_1}{D} - \frac{a_1 b_1}{D} \ln P W^k + \frac{a_2 b_1}{D} \ln Y W + \frac{b_4}{D} \ln \bar{Y}_R \\
 &+ \frac{b_2}{D} \ln P_R^E + \frac{b_3}{D} \ln (P X_{R-1}^k / P_{R-1}^E) + \frac{b_5}{D} \ln S S_R + \frac{b_6}{D} t
 \end{aligned}$$

where  $D = 1 - a_1 b_1$  which is positive.

## 2. Demand and supply equations for energy

The equations for the energy market require a different treatment from the equations for the other four commodities, because the links between energy prices, economic growth and energy demand are complex, and because energy supply is influenced by both economic and noneconomic factors. The equations for energy exports will be specified in a two-stage process. First, the export demand for world energy will be specified with export supply of world energy assumed to be exogenous. Second, export demand for energy will be allocated across developing country exporting regions with reference to a trend term.

### a. Export Demand for World Energy

The world demand for energy is assumed to be determined by the world price of energy relative to the world price level, and to world income, and can be written as:

$$(6) \quad \ln X_W^{\text{den}} = \alpha_0 + \alpha_1 \ln P W^{\text{en}} / P W + \alpha_2 \ln Y W$$

where  $XD_W^{en}$  = quantity of energy exports demanded by the world;

$PW^{en}$  = average world price of energy;

$PW$  = average world price level.

b. Export Supply of World Energy

The world supply of energy ( $XS_W^{en}$ ) is treated as exogenously determined because over the period of estimation (1963 to 1982) many production decisions were made by a partial cartel dominated by OPEC.

$$(7) \quad XS_W^{en} = \overline{XS}_W^{en}$$

c. Export Demand and Supply for Energy from Five Developing Country Regions

World energy demand is allocated across regions with reference to each regions share in world energy demand and a trend variable:

$$(8) \quad XD_R^{en} = w_R XD_W^{en} e^t$$

where  $XD_R^{en}$  = quantity of exports of energy demanded from region R,

$w_R$  = weight of demand for region R's energy exports in world demand for energy exports.

$t$  = time trend

Substituting equation (6) into equation (8), the following estimating equation, specified in log-linear form, was obtained for the demand for energy exports from region R:

$$(9) \quad \ln XD_R^{en} = a_0 + a_1 \ln (PW^{en}/PW) + a_2 YW + a_3 t$$

The supply of energy from each developing country region is also assumed to be exogenously determined. These regions do not include major OPEC members so that production decisions in these countries were not dominated by OPEC. However in many of these countries production decisions were dominated by national governments who provided capital towards initial investments in the oil sector. Thus non-economic criteria also dominated the oil sectors of many of these countries.

$$(10) \quad \overline{X_R^{Sen}} = \overline{X_R^{Sen}}$$

#### IV. Estimation of the Equations

Equations (4) and (5) were estimated using annual data from 1963 to 1982 for the five developing country regions and the first four commodity groups listed in Section III. 1/ Nonlinear least squares estimation procedures were used to obtain the estimates using the MINDIS routine, which performs minimum distance estimation on a multiple equation model. Equation (8) was estimated for the energy commodity group and four developing country regions 2/ using ordinary least squares estimation procedures. All the Fund member countries were taken to represent the world. 3/ Definitions of the data used in the estimation and the sources of these data are given in Appendix II. The estimated coefficients and their respective t-statistics (in parameters), together with the coefficient of determination,  $R^2$ , and the standard error of the estimate, SEE, are presented in Table 6. However, the meaning of these latter two statistics are ambiguous in simultaneous equation models. 4/

In examining the results, it appears that the model performs quite well in terms of yielding parameter estimates that are both of the expected sign and size and that are statistically significant. The estimated price coefficients in the export demand equation (1) carry the expected negative sign for most of the commodity groups and are significantly different from zero at the 5 percent level in 14 out of the 23 equations estimated. In all but one of the equations the estimated price elasticity is less than unity, which implies a fairly limited short-term response of demand for exports to changes in relative prices. The average estimated price elasticities of demand for commodity groups have been computed as follows: food, -0.22; beverages and tobacco, -0.33; agricultural raw materials, -0.62; minerals, -0.51; and energy, -0.21 (Table 7). These estimated price elasticities therefore differ significantly across commodities; the lowest are for food and energy and the highest for agricultural raw materials. There is much less variation in the price elasticities calculated across regions than across commodities (Table 7, Column 6). The range is -0.21 to -0.33 if the high estimated elasticity

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1/ The country classification is given in Appendix I to this paper.

2/ Energy exports from Europe were very small over the estimation period and therefore energy equations were not estimated for this region. For similar reasons, equations were not estimated for beverages and tobacco for the Middle East.

3/ IMF data excludes nonmember centrally planned economies.

4/ The  $R^2$  statistic is not banded (0,1) but  $(-\infty, 1)$  so that the small values are not an indication of a "poor" fit.

Table 6. Five Developing Country Regions: Estimates of Equations for Food, Beverages and Tobacco, Agricultural Raw Materials, Minerals, and Energy Exports, 1963-1982

Commodity	Demand Equation					
	a <sub>0</sub>	a <sub>1</sub>	a <sub>2</sub>	Dum	R <sub>2</sub>	SEE
<u>Africa</u>						
Food	2.96 (3.97)	-0.32 (6.59)	1.01 (6.18)		0.74	0.15
Beverages and tobacco	1.86 (1.41)	-0.31 (4.16)	1.34 (3.37)	-0.09t <sub>1</sub> (4.30)	0.70	0.23
Agricultural raw materials	2.18 (0.77)	-3.28 (2.30)	0.54 (0.91)		0.71	0.16
Minerals	5.26 (2.64)	-0.85 (3.67)	3.85 (5.07)		0.71	0.38
Energy	-17.44 (7.24)	-0.06 (0.54)	5.10 (8.45)	-0.18t <sub>1</sub> (5.57)	0.93	0.13
<u>Asia</u>						
Food	-0.51 (0.46)	-0.33 (2.56)	1.14 (4.62)		0.84	0.19
Beverages and tobacco	4.42 (13.69)	0.08 (2.63)	-0.14 (1.27)	0.01D1 (1.87)	0.34	0.12
Agricultural raw materials	-2.50 (7.77)	-0.34 (2.27)	0.46 (6.59)		0.79	0.06
Minerals	-0.94 (1.23)	-0.40 (1.51)	1.19 (7.06)		0.86	0.12
Energy	-10.21 (14.19)	-0.36 (7.06)	3.56 (17.98)	0.29D1 (3.14)	0.98	0.08
<u>Europe</u>						
Food	-6.26 (1.05)	-0.14 (1.81)	1.12 (8.05)		0.76	0.18
Beverages and tobacco	6.31 (6.03)	-0.26 (1.79)	-0.38 (1.61)		0.17	0.20
Agricultural raw materials	1.39 (2.15)	-0.21 (3.98)	1.15 (5.04)		0.56	0.15
Minerals	-4.37 (4.76)	-0.48 (4.01)	2.91 (7.42)		0.87	0.18
<u>Middle East</u>						
Food	-1.71 (4.00)	-0.46 (10.96)	1.54 (9.63)	0.22D77 (3.41)	0.70	0.17
Agricultural raw materials	-7.56 (17.32)	-0.09 (3.73)	-0.41 (4.03)		0.67	0.16
Minerals	-1.70 (1.34)	0.60 (4.44)	0.26 (0.54)		0.89	0.26
Energy	-5.61 (1.51)	-0.28 (1.17)	2.52 (2.48)		0.61	0.39
<u>Western Hemisphere</u>						
Food	0.35 (0.48)	-0.11 (1.58)	1.32 (4.78)		0.76	0.16
Beverages and tobacco	2.23 (4.43)	-0.33 (3.79)	0.51 (4.46)		0.75	0.07
Agricultural raw materials	5.78 (18.99)	-0.14 (3.53)	0.04 (0.19)		0.37	0.21
Minerals	-0.18 (0.20)	-0.38 (3.38)	1.74 (4.69)		0.54	0.24
Energy	0.75 (0.66)	0.39 (4.14)	0.81 (2.56)	0.60D1-1.69D1 (3.36)(11.46)	0.92	0.16

Table 6 (concluded). Five Developing Country Regions: Estimates of Equations for Food, Beverages and Tobacco, Agricultural Raw Materials, Minerals, and Energy Exports, 1963-1982

Commodity	Supply Equation						R <sup>2</sup>	SEE	
	b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>			
<u>Africa</u>									
Food	3.66 (1.68)	-0.78 (2.50)	0.74 (7.86)	0.25 (2.37)		0.30D1 (3.21)	-0.05t <sub>1</sub> (3.74)	0.96	0.16
Beverages and tobacco	0.30 (0.28)	-0.20 (1.16)	1.29 (12.77)	-0.06 (0.45)		0.48D2 (4.32)		0.95	0.21
Agricultural raw materials	-8.21 (2.29)	1.43 (2.79)	1.41 (7.44)	-0.13 (0.33)		-0.10D1 (2.30)		0.98	0.08
Minerals	-2.36 (2.64)	-0.53 (3.01)	0.04 (0.56)	0.05 (1.12)	1.94 (5.85)		0.02t <sub>1</sub> (5.36)	0.95	0.11
<u>Asia</u>									
Food	-2.61 (5.67)	0.82 (2.15)	1.42 (4.67)	0.20 (1.53)	-0.88 (1.73)	0.53D1 (5.63)		0.99	0.06
Beverages and tobacco	-18.22 (2.50)	4.39 (2.51)	1.40 (1.59)	0.11 (3.46)	-0.39 (1.29)	0.04D1 (1.79)		0.99	0.04
Agricultural raw materials	-25.07 (2.18)	5.89 (1.70)	4.62 (4.40)	-0.12 (0.27)	-4.01 (2.64)	-0.08D1 (0.66)		0.98	0.10
Minerals	-9.34 (2.66)	4.18 (1.95)	3.19 (4.74)	-0.08 (0.26)	-4.19 (2.20)	-0.07D1 (1.02)		0.99	0.05
<u>Europe</u>									
Food	-8.09 (2.26)	5.23 (2.13)	1.05 (3.97)	0.77 (2.78)	-0.42 (1.99)			0.98	0.07
Beverages and tobacco	-4.08 (1.90)	0.81 (1.96)	0.25 (1.81)	-0.09 (0.55)	0.92 (10.86)			0.97	0.06
Agricultural raw materials	6.22 (2.60)	-2.55 (4.21)	0.07 (1.04)	-0.17 (3.11)	2.34 (9.50)	-0.05D1 (1.31)	0.01t <sub>1</sub> (3.42)	0.98	0.09
Minerals	-1.04 (1.31)	0.04 (0.58)	0.71 (5.08)	0.38 (3.11)		0.31D1 (6.10)	0.08t <sub>3</sub> (4.88)	0.98	0.07
<u>Middle East</u>									
Food	0.61 (0.46)	-0.37 (2.49)	1.05 (14.98)	0.20 (1.32)			0.01t <sub>1</sub> (1.02)	0.90	0.19
Agricultural raw materials	20.15 (4.97)	-3.69 (4.64)	0.31 (1.76)	0.39 (4.15)			-0.06t <sub>1</sub> (2.34)	0.99	0.08
Minerals	-2.73 (3.44)	0.14 (0.54)	0.87 (2.40)	0.54 (3.61)		0.43D1 (3.23)	-0.01t <sub>3</sub> (0.86)	0.95	0.15
<u>Western Hemisphere</u>									
Food	1.54 (0.60)	-2.49 (1.97)	0.22 (1.26)	0.18 (1.87)	2.80 (3.13)	0.21D1 (3.98)		0.97	0.10
Beverages and tobacco	-10.50 (2.21)	1.84 (1.62)	1.10 (4.85)	0.36 (1.13)	1.26 (3.90)			0.91	0.25
Agricultural raw materials	18.99 (4.39)	-3.35 (3.68)	1.76 (3.76)	-0.10 (0.26)		0.01D1 (0.46)	0.10D2 (4.31)	0.99	0.07
Minerals	2.61 (2.37)	-1.32 (3.66)	-0.22 (3.24)	0.11 (0.27)	0.89 (7.39)		-0.01t <sub>3</sub> (2.09)	0.97	0.07

Table 7. Estimated Price Elasticities of Demand,  
a<sub>1</sub>, by Commodity and Region

Region	Food	Beverages & Tobacco	Agricultural Raw Materials	Minerals	Energy	Total <u>1/</u>
Africa	-0.32**	-0.31**	-3.28**	-0.85*	-0.06	-0.68
Asia	-0.33**	--	-0.34**	-0.40*	-0.36**	-0.33
Europe	-0.14*	-0.26**	-0.21*	-0.48*	--	-0.22
Middle East	-0.46**	--	-0.09**	--	-0.28	-0.25
Western Hemisphere	-0.11*	-0.33**	-0.14**	-0.38*	--	-0.21
Total <u>2/</u>	-0.22	-0.33	-0.62	-0.51	-0.21	-0.35

\* Significant at the 90 percent level of significance.

\*\* Significant at the 95 percent level of significance.

1/ The weights of each commodity export in 1980 as a percentage of total exports for each region were used to obtain this total elasticity.

2/ The weight of each regions exports in 1980 as a percentage of total exports for each commodity were used to obtain this elasticity.

for Africa is excluded. The price elasticity of demand for all commodities for all developing countries is calculated to be -0.35.

The estimated income elasticities shown in Table 8 have the expected positive signs and are significantly different from zero at the 5 percent level of significance in 17 out of 23 equations. The average income elasticities are as follows: food, 1.20; beverages and tobacco, 0.68; agricultural raw materials, 0.56; minerals, 2.16; and energy, 3.53. These results support the view that exports of agricultural products (food, beverages and tobacco, and agricultural raw materials) are less sensitive to short-term fluctuations in world demand than other exports, such as minerals. Both price and income elasticities will be compared with ones obtained from similar studies in the next section of this paper.

The estimated coefficients in the export supply equation (3) also yield useful information, but in general the performance of the supply equation is poor. The estimate of the elasticity of supply with respect to the price can be derived from the estimated version of equation (3) by calculating  $(b_1)^{-1}$ , and the elasticity of supply with respect to lagged prices, by calculating  $-b_3(b_1)^{-1}$ . These computed elasticities are given in Tables 9 and 10.

The estimated coefficients of exports  $\hat{\beta}_1$  are positive and significantly different from zero at the 10 percent level in 6 out of the 19 equations estimated for the first four commodity groups, implying a positively sloped supply function for exports for these 6 commodities and regions. In terms of the estimates of  $\hat{\beta}_1$  for the geographical regions, the equations for Asia perform the best; these results reflect the policies of Asian countries to allow the producer price to reflect export prices as a way to encourage export production. By contrast, the estimates of  $\hat{\beta}_1$  for Africa for some commodities are implausibly large and have the wrong sign. In Africa producer pricing policies that allowed the real producer price for food crops to fall during the late 1960s and 1970s, despite increases in export prices received by the authorities, led to less food production; indeed, in many African countries during this period producer prices often moved in a different direction from the export price. Under these conditions, the normal relationship between export prices and commodities produced for export was distorted.

In terms of the estimates of  $\hat{\beta}_1$  for the commodity groups, the equations for beverages and tobacco perform the best. The equations for minerals are the poorest. Modeling supply equations for minerals is a complicated process and the supply equations here are probably too highly aggregated. Furthermore, many mineral products are subject to export quotas, and the export price may bear little relationship to the amount exported through quotas.

Table 8. Estimated Income Elasticities of Demand,  
a2, by Commodity and Region

Region	Food	Beverages & Tobacco	Agricultural Raw Materials	Minerals	Energy
Africa	1.01**	1.34**	0.54	3.85**	5.10**
Asia	1.14**	--	0.46**	1.19**	3.56**
Europe	1.12**	--	1.15**	2.91**	--
Middle East	1.54**	--	--	0.26	2.52**
Western Hemisphere	1.32**	0.51**	--	1.74**	0.81**
Total <u>1/</u>	1.20	0.68	0.56	2.16	3.53

\*\* Significant at the 95 percent level of significance.

1/ The weight of each regions exports in 1980 as a percentage of total exports for each commodity were used to obtain this elasticity.

Table 9. Estimated Export Price Elasticities of Supply  $\beta_1$ , by Commodity and Region

Region	Food	Beverages and Tobacco	Agricultural Raw Materials	Minerals
Africa	-1.28**	--	0.70**	-1.89**
Asia	1.21**	0.23**	0.17*	0.24*
Europe	0.19**	1.23**	-0.39**	--
Middle East	-2.70**	--	0.27**	--
Western Hemisphere	-0.40**	0.54**	-0.30**	-0.76*
Total <u>1/</u>	0.70	0.66	0.43	0.24

\* Significant at the 90 percent level of significance.

\*\* Significant at the 95 percent level of significance.

1/ Only those coefficients with the "right sign" were used to obtain the mean total elasticity for each commodity group.

Table 10. Estimated One Year Lagged Export Price Elasticities of Supply,  $\beta_2$ , by Commodity and Region

Region	Food	Beverages and Tobacco	Agricultural Raw Materials	Minerals
Africa	0.32**	--	0.09*	0.09*
Asia	-0.24*	-0.02**	0.02	0.02
Europe	-0.15**	0.11	-0.06**	--
Middle East	0.54*	--	0.10*	--
Western Hemisphere	0.07*	--	0.03	0.08

\* Significant at the 90 percent level of significance.

\*\* Significant at the 95 percent level of significance.

The equations perform poorly with regard to estimated coefficients of  $\hat{\beta}_2$ , the elasticity with respect to lagged export prices. Only six of the 23 equations carry the expected positive sign and are significant at the 10 percent level. The lagged supply price elasticity for the food and agricultural raw materials groups performed the best. For most other groups and regions the data series are not sufficiently long and the lag process is not well specified enough, to capture the long lag structure that exists for certain commodities between prices and export production. There are great differences in the lag structures for different commodities and the estimated equations are unlikely to be disaggregated enough to capture the sophisticated lag structures that exist in commodity markets.

The capacity variable ( $\bar{Y}$ ) was included in the supply equations of the developing countries to capture the effects of domestic capacity on exports. One problem with including this variable is that it is not independent of real world income or of exports in the supplying countries or of the trend term; its inclusion therefore makes it more difficult to interpret the values or significance of the regression coefficients accurately. This problem was particularly severe for most of the African and Middle Eastern equations, and consequently the capacity variable was dropped from these equations. Nevertheless, the capacity variable ( $\bar{Y}$ ) is in accordance with standard theory and has the expected positive sign for 6 out of the 19 equations.

The time trend was removed from most of the equations because it was highly collinear with the income and capacity variables; however, time trends were included for particular periods in regions where important structural changes took place over the estimation period. For example, the negative coefficients on the time trend for food exports from Africa probably reflect the unfavorable incentives for agriculture that had been created. The trends  $t_1$ ,  $t_2$  and  $t_3$  were used to measure these periods of structural change. Dummy variables  $D1$  and  $D2$ , were included in the equations to measure the effects of the two oil crises that took place over the estimation period. On the demand side the oil crisis led to an increase in the demand for some commodities, possibly because some countries faced with higher production costs produced less domestically. On the supply side the oil crisis led to both increases and decreases in exported commodities. For those countries and commodity groups where a fall in exported commodities was experienced the oil crisis probably led to increased production costs which reduced output. For countries and commodity groups where exported commodities rose production costs probably rose less and they were able to expand supply to meet the rise in demand.

## V. Survey of Commodity Demand and Supply Elasticities

This section presents a comprehensive list of demand and supply elasticities of commodities estimated in other studies and compares these with the elasticities estimated in this study. On the demand side, the estimates for the five groups presented in this paper give good information for the purpose of comparison. On the supply side, the estimates for the four groups, excluding energy, are relatively poor, and more reliance may need to be placed on estimates from other studies.

The demand and supply elasticities presented in Table 11 are collected from a number of sources. The demand elasticities are obtained from studies by Behrman (1977) and UNCTAD (1974); these two studies calculate median demand elasticities from estimates gathered from about 200 studies. The supply estimates were obtained from the survey paper by Askari and Cummings (1976); for each individual commodity the mean elasticity is calculated from the hundreds of elasticity estimates presented in their study. In collecting the elasticities, zero elasticities and wrong-sign elasticities were excluded from the individual commodity group prior to its component items being summed. The elasticity estimates of Askari and Cummings were used as the main source for the supply elasticities. Where gaps occurred, these were supplemented by estimates from Behrman.

These estimates need to be treated with caution for several reasons. First, there is wide variation in the quality of the studies from which these estimates were taken, especially on supply responsiveness. Second, there is a wide range of quantitative estimates among the studies for single commodities because of the differences with regard to the price variables, the time periods, and the quality of data used. 1/ Third, some of the equations in the individual studies may be incorrectly specified. For example, a demand or supply equation may be specified separately when both would have been more appropriate. Fourth, lag structures are notoriously difficult to specify; modeling the adjustment process for producers' price expectations may depend on a number of factors, such as changes in the weather, changes in output, and other exogenous economic events that can never be adequately captured by lag structures.

When making comparisons between these estimates it is also important to focus on how the results were obtained. In particular, it is necessary to distinguish between the price elasticity of response for an individual commodity to a change in the relative price for that commodity, and the price elasticity of response for a group of commodities, such as

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1/ By calculating the mean elasticity for individual commodities these differences are smoothed out.

Table 11. Range of Estimates of Commodity Demand and Supply Elasticities

Commodity	Income Elasticity	Price Elasticity of Demand	Price Elasticity of Supply		Author
			Short-run	Long-run	
1. Food:	0.98	-0.58			Goldstein and Khan
	0.50	-0.42	0.43	0.80	Average for food <u>1/</u>
Barley			0.42	0.79	Askari and Cummings
Cereals		-0.35	0.52	0.73	Askari and Cummings UNCTAD
Dairy products			0.18	1.01	Askari and Cummings
Fats and oils		-0.5	0.49	1.06	Askari and Cummings UNCTAD
Fruit			0.31	0.73	Askari and Cummings
Maize		-0.45	0.44	0.57	Askari and Cummings UNCTAD
Meat	0.3	-0.4	0.41	0.80	Askari and Cummings Behrman
Rice	0.3	-0.3	0.27	0.44	Askari and Cummings Behrman
Soybeans			1.14	1.16	Askari and Cummings
Sugar	1.1	-1.1	0.49	0.87	Askari and Cummings Behrman
Vegetables			0.25	0.92	Askari and Cummings
Wheat	0.3	-0.3	0.30	0.56	Askari and Cummings Behrman

1/ This average is calculated as an arithmetic mean of the elasticities for individual commodities shown in this table.

Table 11. (cont'd) Range of Estimates of Commodity Demand and Supply Elasticities

Commodity	Income Elasticity	Price Elasticity of Demand	Price Elasticity of Supply		Author
			Short-run	Long-run	
2. Beverages and Tobacco	0.98	-0.58			Goldstein and Khan
	0.35	-0.45	0.27	0.46	Average of Beverages and Tobacco <u>1/</u>
Cocoa	0.4	-0.4	0.38	0.79	Askari and Cummings Behrman
Coffee	0.5	-0.6	0.37	0.53	Askari and Cummings Behrman
Tea	0.5	-0.3	0.04	0.13	Askari and Cummings Behrman
Tobacco		-0.5	0.29	0.41	Askari and Cummings UNCTAD
3. Agricultural Raw Materials	0.85	-0.67			Goldstein and Khan
	0.8	-0.44	0.33	0.51	Average for Agricultural Raw Products <u>1/</u>
Cotton	0.8	-0.3	0.43	0.89	Askari and Cummings Behrman
Jute		-0.5	0.53	0.74	Askari and Cummings UNCTAD
Rubber		-0.8	0.18	0.31	Askari and Cummings Behrman
Sisal			0.46	0.33	Askari and Cummings
Wood		-0.4	0.3	0.5	UNCTAD
Wool		-0.2	0.1	0.3	Behrman

1/ This average is calculated as an arithmetic mean of the elasticities for individual commodities shown in this table.

Table 11 (concluded) Range of Estimates of Commodity Demand and Supply Elasticities

Commodity	Income Elasticity	Price Elasticity of Demand	Price Elasticity of Supply		Author
			Short-run	Long-run	
4. Minerals		-0.3			UNCTAD
	2.8	-1.1	0.0	0.27	Average for Minerals <u>1/</u>
Aluminum					
Bauxite	2.3	-1.3	0.0	0.4	Behrman
Copper	1.0	-0.2	0.0	0.2	Behrman
Iron ore		-0.7	0.0	0.3	Behrman
Lead		-0.2			UNCTAD
Magnesium		-0.1			UNCTAD
Tin	5.0	-5.0	0.0	0.2	Behrman
Zinc		-0.1			Behrman
5. Energy	1.22	-0.54			Goldstein and Khan

1/ This average is calculated as an arithmetic mean of the elasticities for individual commodities shown in this table.

food, to a change in the group price. The former elasticity is likely to be larger than the latter because the substitution possibilities are much greater for an individual commodity than for a group of commodities. Similarly, the price elasticity for one region is likely to be somewhat larger than the price elasticity for all regions together, because of the greater substitution possibilities between regions. This point should be borne in mind when comparing summed elasticities.

The income and price elasticities contained in Table 12 were summed and averaged across individual commodities to obtain estimates for each of the five commodity groups presented earlier in this paper. These elasticities were then compared with the mean estimates of all regions obtained in Section IV of this paper and with mean demand elasticity estimates <sup>1/</sup> obtained by Goldstein and Khan (1983). These three sets of elasticities are presented in Table 12.

One broad conclusion, gained from examining the estimates shown in Table 12, is that income elasticities of demand for developing country commodity exports fall in the range of 0.3 to 3.5. A further conclusion is that the demand for agricultural products is income-inelastic. For the beverages and tobacco group the results from this study tend to be midway between the other two sets of results. The estimates for food tend to be higher in this study than in others. This could reflect a higher income elasticity for developing country exports than for world exports in general.

A further broad conclusion is that the demand for commodity exports is not very sensitive to short-run price changes. The estimates range from -0.2 to -1.1. Again these elasticities tend to be lower for agricultural products than for minerals and energy, with the lowest for food exports. The estimated price elasticities of demand in this study are lower than the mean price elasticities of demand from other studies, because this study does not include the substitution possibilities that are available in individual studies. The mean estimates from the Goldstein and Khan study are somewhat higher; these estimates include exports from industrial countries as well as developing countries and it is quite likely that this is the reason for the higher price elasticity.

These results also confirm the conclusion that the supply of commodity exports is more sensitive to prices in the long run than in the short run, and that in the short run, price elasticities of supply are generally lower than the corresponding price elasticities of demand. The short-run

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<sup>1/</sup> The mean elasticities are an average of the activity estimates taken from import equations from a variety of studies and presented in Table 4 of Goldstein and Khan. Thus these elasticities are income elasticities of demand for imports rather than exports.

Table 12. Aggregate Estimates of Commodity Demand and Supply Elasticities, All Regions

Commodity Group	Goldstein and Khan	Average of Individual Commodities	This Study
<u>Income Elasticities</u>			
Food	0.98	0.50	1.20
Beverages & Tobacco	0.98	0.35	0.68
Agricultural			
Raw Materials	0.85	0.80	0.56
Minerals		2.80	2.16
Energy	1.22		3.53
<u>Price Elasticity of Demand</u>			
Food	-0.58	-0.42	-0.22
Beverages & Tobacco	-0.58	-0.45	-0.33
Agricultural			
Raw Materials	-0.67	-0.44	-0.62
Minerals		-1.1	-0.51
Energy	-0.54		-0.21
Total			-0.35
<u>Price Elasticity of Supply</u>			
	<u>Average of individual commodities</u>		<u>This Study</u>
	Short-run	Long-run	
Food	0.43	0.80	0.70
Beverages & Tobacco	0.27	0.46	0.66
Agricultural			
Raw Materials	0.33	0.51	0.43
Minerals	--	0.27	0.24

price elasticities of supply in this study are higher than those from other studies, whereas one might expect them to be lower in view of the lack of substitution possibilities. In this case more reliance might be placed on the lower estimates except, perhaps, for the estimates obtained in this study for Asia, where the equations perform quite well.

One of the uses to which this information can be put is to help prepare forecasts, projections and simulations for an individual country. Once the price and income elasticities are determined for those commodities relevant to a country they can be summed over all commodities to determine the effect of changes in domestic prices, foreign prices and foreign income on that country's exports.

## VI. Conclusions

In many ways trade in commodity exports is no longer as important for developing countries as it once was. These countries lost considerable market shares to industrial countries between the years 1965 and 1980, in part because of the growing processing capacity in developing countries and the accelerating growth of these countries' populations over the same period. Developing countries did increase their share in world exports of manufactures over this period; but this was by no means large enough to offset the decline that took place in commodity exports. Developing countries could take a major step toward alleviating their debt problems and improving their long-run growth prospects by recapturing their export shares in world commodity markets. This means that protectionist policies in world commodity markets must be reduced and that developing countries have to maintain a domestic relative price structure that would ensure a sound commodity base, as well as encouraging domestic production in other ways.

The empirical results obtained in this study are very much in line with those obtained from other studies. They demonstrate the inelastic nature of price responses in the demand for exported commodities and the inelastic income responses in the demand for food, beverages and tobacco, and agricultural raw material exports from developing countries. The evidence also shows that price elasticities of supply are generally lower than the corresponding price elasticities of demand in the short run, but that in the longer run the supply of commodity exports from developing countries is more sensitive to prices than the demand.

The results presented in this paper provide further evidence of, and support for, the usefulness of pricing policy. Export supply in developing countries does indeed respond to improved price incentives. This evidence lends support to the use of the exchange rate as a policy tool by a developing country in order to improve the trade balance through both an increase in the demand for and an increase in the supply of commodity exports.

Furthermore, the grouping of developing countries allows more broadly based policy questions to be answered than would be possible for an individual developing country. For example, the empirical evidence suggests that exchange rate or producer pricing policies conducted simultaneously by each member of a group of countries can give rise to an increase in exports of commodities from each of these countries; this result, however, abstracts from the global price effects of a worldwide increase of these commodities. At the same time, the results show that supply responses to such policies will differ between regions. However, on the demand side there is generally much less difference between regions than between commodities. In general, price elasticities of demand tend to be larger for Africa and Asia than for the other regions; they also tend to be slightly larger for agricultural raw materials and minerals than for other commodities.

There remains a considerable amount of work to be done in this area; in particular, more work needs to be done in deriving a set of estimates for the supply equation that are completely satisfactory and that allow us to give stronger support to the preliminary results obtained in the present study. Further work on the demand for and supply of exports of manufactures from developing countries would also prove fruitful and add to our knowledge of how countries can use policies to change the mix of their exports and thereby improve their balance of payments position; such a study is currently under preparation by the author.

Classification of Countries

The classification of countries adapted in this paper is the same as the one adapted by the Fund in International Financial Statistics:

African countries

Angola	Ghana	Rwanda
Benin	Guinea	St. Helena
Botswana	Guinea-Bissau	Saó Tome and Principe
Burkina Faso	Ivory Coast	Senegal
Burundi	Kenya	Seychelles
Cameroon	Lesotho	Sierra Leone
Cape Verde	Liberia	Somalia
C. African Rep.	Madagascar	Sudan
Chad	Malawi	Swaziland
Comoros	Mali	Tanzania
Congo	Mauritania	Togo
Djibouti	Mauritius	Tunisia
Equatorial Guinea	Morocco	Uganda
Ethiopia	Mozambique	Zaire
Gabon	Niger	Zambia
Gambia, The	Reunion	Zimbabwe

Asian countries

Afghanistan	India	New Caledonia
American Samoa	Kampuchea, Dem.	Pakistan
Bangladesh	Kiribati	Papua New Guinea
Bhutan	Korea	Philippines
Brunei	Lao P.D. Rep.	Singapore
Burma	Macao	Sri Lanka
China, People's Rep.	Malaysia	Thailand
Fiji	Maldives	Tongo
French Polynesia	Nauru	Vanuatu
Guam	Nepal	Viet Nam
Hong Kong		Western Samoa

European countries

Cyprus	Hungary	Romania
Faeroe Islands	Malta	Turkey
Gibraltar	Portugal	Yugoslavia
Greece		

Middle Eastern countries

Bahrain  
Egypt  
Israel

Jordan  
Lebanon  
Syrian Arab Rep.

Yemen Arab Rep.  
Yemen, P.D. Rep.

Western Hemisphere countries

Antigua & Barbuda  
Argentina  
Bahamas  
Barbados  
Belize  
Bermuda  
Bolivia  
Brazil  
Cayman Is.  
Chile  
Colombia  
Costa Rica  
Dominica  
Dominican Rep.  
Ecuador

El Salvador  
Falkland Islands  
Greenland  
Grenada  
Guadeloupe  
Guatemala  
Guiana, French  
Guyana  
Haiti  
Honduras  
Jamaica  
Martinique  
Mexico  
Montserrat

Netherlands Ant.  
Nicaragua  
Panama  
Paraguay  
Peru  
St. Christopher &  
Nevis  
St. Lucia  
St. Pierre & Miquelon  
St. Vincent  
Suriname  
Trinidad & Tobago  
Uruguay  
U.S. Virgin Islands

1. Definitions of the Variables in the Model

All data are annual.

$P_{R E}^1$  = index of the consumer price index in producing countries in region R, in U.S. dollars, 1980 = 100;

$P_{R k}^X$  = index of the export price of commodity k, from region R, in U.S. dollars, 1980 = 100;

$P_{Wen}$  = index of the average world price of energy, in U.S. dollars, 1980 = 100.

$P_{Wk}$  = index of price of commodity k, in international markets, in U.S. dollars, 1980 = 100;

$P_W$  = index of consumer price index for the world, in U.S. dollars, 1980 = 100;

$X_{R k}$  = index of the volume of exports of commodity k from region R, in billions of U.S. dollars and in 1980 prices;

$X_{WR}$  = index of the volume of energy exports from region R, in billions of U.S. dollars and 1980 prices;

$\bar{Y}_R$  = trend of real output in region R in index form;

$Y_W$  = index of real world income, in U.S. dollars, 1980 = 100.

2. Data Sources

World Bank Trade System, International Financial Statistics, IMF - Commodities Division, Current Studies Division.

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1/ This series was calculated in the following way:

$$P_{R E}^1 = \sum_j \alpha_j P_j E_j$$

$$\sum_j \alpha_j = 1$$

where  $\alpha_j$  is the weight of country j's GDP in region R in U.S. dollars.

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