World Commodity Prices: The Role of External Debt and Industrial Country Policies

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CONTENTS

FIGURES

TABLES

WORLD COMMODITY PRICES: THE ROLE OF EXTERNAL DEBT AND INDUSTRIAL COUNTRY POLICIES

INTRODUCTION

The domestic support of and protectionist policies toward agriculture in major Organization for Economic Cooperation and Development (OECD) countries has been partly responsible for surplus commodity production and sagging international commodity prices in recent years. Between 1980 and 1987, the International Monetary Fund (IMF) food commodities price index fell by one third in nominal terms and by almost one half in real terms. Although originally undertaken largely for domestic reasons, these policies have led to trade restraints and export subsidies that have reduced prices and aggravated instability in international commodity markets. Attempts to reform policies in OECD countries via General Agreement on Tariffs and Trade (GATT) negotiations or other means have led to only modest changes in world commodity production and trade patterns.

The adverse effects of these microeconomic policies in the OECD has been particularly severe for Less Developed Country (LDC) commodity exporters. In addition, the macroeconomic policies pursued in a number of OECD countries (especially in the United States) have had important ramifications for these LDCs. A restrictive monetary policy, coupled with a deficit-financed fiscal expansion in the United States since 1981, has been transmitted via real interest rates and exchange rates to reduce LDC commodity export prices. The monetary shocks of the early 1980s particularly altered the dynamic path of commodity prices (Rausser *et al.* 1986).

These two sets of policies in OECD countries, one specific to commodity sectors and another more generally macroeconomic, operated in unison to dramatically reduce commodity prices in the 1980s. By contrast, over much of the 1970s these two sets of policies frequently operated in unison to increase commodity prices dramatically.

The commodity-exporting LDCs, especially those with a large external debt position, were particularly hard hit by the combination of commodity sector and macroeconomic policies of OECD countries; and the external debt situation for these LDCs has deteriorated substantially. The United States alone represents nearly 60 percent of the total LDC export market; it is not surprising that it plays a vital role in the economic stability of these LDCs.

Empirical analysis of commodity sector policies, macroeconomic policies, and external debt linkages has, until recently, been conducted in *separate studies*. One stream of the empirical literature focuses on supply and demand conditions underlying individual product prices. Several other studies utilize a complementary approach on aggregate commodity price indices to emphasize the factors that determine investment demand for storable primary goods. Still another group of studies focuses on the effects of macroeconomic variables on aggregate commodity prices, neglecting the fundamental forces of commodity supply and demand. Very few studies have been conducted which isolate the impact of the growing external debt position of LDCs on international commodity prices.

One illustrative empirical analysis of the supply and demand fundamentals in the commodities market is Hwa (1979). He finds that most of the price fluctuation in the 1970s can be explained by factors such as industrial production on the demand side and commodity production and inventory stocks on the supply side. He uses a reduced form of the supply and demand factors for several major product prices to account for structural changes in the pricing relationships in the early 1970s.

Bosworth and Lawrence (1982) use a framework much like Hwa for agricultural commodities and similarly support the traditional pricing analysis. In addition, they utilize the variance/covariance structure of real returns of commodities, bonds, and equity to explain the movements in commodity stocks and prices in the 1970s. They conclude that expanding commodities futures, as well as the large variance in commodity prices over this period, can be explained, in part, by the speculative activity in the primary product markets.

Lawrence and Lawrence (1981) explicitly analyze the speculative causes for movements in relative commodity prices by examining the linkages to global financial markets. They initially estimate a model of relative prices of individual categories on commodities in separate regressions to see how the behavior is related to world industrial production, commodity production, and inventory stocks. In a competing set of equations, the addition of monetary effects via interest rates and inflation rates does not add significantly to the explanation of short-term movement in individual commodity prices for the 1961 to 1979 period.

In 1987, the IMF surveyed the evidence for the more recent episodes in world commodity prices (International Monetary Fund 1987). According to this study, low industrial production growth in the industrialized nations, structural shifts in intensity of commodity use in production, and abundant raw material supplies contributed to the weakness in commodity prices in the 1980s. Moreover, the significant decrease in secular inflation, coupled with the rise in interest rates, have been important macroeconomic influences on the drop in commodity prices.

In another stream of literature [following the earlier work of Sachs (1985) and IMF (1983)]. Dornbusch (1985) derives an empirical model that includes the U. S. real exchange rate, real interest rate, and industrial production as the macroeconomic determinants of the *aggregate* U. S. real commodity prices for the 1970 to 1985 period. Using ordinary least squares methods, he finds elasticity estimates of -1.55 for the real exchange rates; -.24 for the real interest rate; and 2.27 for industrial production. There are a number of potentially serious problems with this analysis. For example, the real exchange coefficient in this estimation is significantly smaller, -1.0. This (absolutely) large parameter estimate implies that the changes in the dollar exchange rate will not only affect the dollar commodity price but also will be magnified in terms of the currencies of other countries as well, i.e., U. S. policies will affect the export prices of LDCs directly, via the exchange rate, and indirectly via the effect on the prices of other countries.

A recent study by Côte (1987) attempts to correct the Dornbusch (1985) analysis by comparing the effects of variables such as world industrial production, interest rates, and the U. S. dollar real exchange rate on three different commodity price indices that represent the real commodity prices in the industrial world. The results are mixed. On one hand, the impact of the dollar appreciation on real commodity prices using the *Economist* dollar index confirms Dornbusch's results of a negative impact; on the other hand, two competing indices (from *International Financial Statistics* and the *Journal of Commerce*) show a positive effect of exchange rate appreciation on movements in commodity prices. Differences in the weighting schemes and the products included in the construction of the various indices are offered as a possible explanation for the divergent results. The selection of particular products and weights in the latter two indices may be an important consideration because certain commodities are produced and traded more heavily by the LDCs than others and, therefore, may represent the impact of the variables on prices more accurately.

Gilbert (1989) suggests that both the strong foreign exchange value of the U. S. dollar and LDC debt service requirements are responsible for the low commodity prices in the 1980s. He criticizes earlier studies for using an inappropriate real exchange rate variable [U. S. trade weighted instead of OECD gross national product (GNP) weighted] and for failure to consider LDC indebtedness. In the category of agricultural foods, Gilbert finds strong evidence of a debt-servicing, induced increase in supply that acts to reduce commodity prices. He also finds a smaller elasticity of dollar appreciation on commodity prices than earlier studies.

To be sure, there are a large number of forces that potentially impinge upon world commodity prices in addition to agricultural subsidization in OECD countries. The dynamic path of commodity prices will also be influenced by the macroeconomic policies in OECD countries, the stock of physical and financial assets of countries throughout the world, and the pattern and spacial distribution of economic growth.

In many of the computable general equilibrium (CGE) examinations of trade liberalization (e.g., Stoeckel and Breckling 1988; Robinson, Kilkinny, and Adelman 1988), a rise in world prices (often 10 percent or so) is assumed when multilateral liberalization is examined. In some commodities this rise is consistent with the empirical results of Tyers and Anderson (1986). However, any rise that might occur will be dependent on the macroeconomic policies and growth of OECD countries. In this paper we will analyze these issues by first examining the mechanisms by which monetary, fiscal, and commodity subsidization policies in the industrialized countries can impact upon developing countries. This descriptive treatment will be followed by a theoretical framework employed to determine the qualitative effects of various forces. The theoretical framework will provide the foundation for an empirical model which is to be estimated and assessed.

INDUSTRIAL COUNTRY POLICY IMPACTS ON LDCS

The three major considerations in the analysis of industrial country-LDC policy links are the particular combinations of monetary and fiscal policies pursued, the impact of distortionary microeconomic policies, and the differences between the developing countries' own internal economic structures. Essentially, policies of industrial countries can affect the LDC commodity exporters via four channels: overall economic growth, real interest rate, real exchange rate, and primary product stocks. The extent of the impact from changes in these variables will vary with the degree of openness in the trade structure of the LDCs and the level of initial indebtedness.

Macroeconomic Policy Linkages

Interest rates play a key role in the performance of developing economies in several ways. If storable commodities are viewed as a portfolio asset, then real interest rates will represent the opportunity cost of holding a commodity and will affect the speculative demand

for the good. Higher real rates cause the demand for primary goods to fall. Consequently, the relative price of commodities will decline until the expected rate of change in the product's value is equated with the real interest rate (plus insurance and storage costs). The foregoing analysis, known as the "overshooting hypothesis" (Frankel 1986; Rausser, *et al.* 1986) explains why the real world commodity prices (i.e., LDC export prices) will remain low as long as the expected future appreciation (due to higher interest rates) remain high.

A second channel through which the LDCs are directly affected by U. S. interest rate disturbances is in changing their debt service obligations. An estimated 80 percent of all major LDC debt is under variable-rate agreements. As real interest rates crept upward in the early 1980s, so did the interest payments portion of their debt service. Additional principal also accumulated with the occurrence of current account deficits due to falling export receipts (assuming these could be financed externally).

Another burden is placed upon the debtor when the value of the debt is fixed in one currency and the export receipts are valued in a different currency. In this case, when the debt currency appreciates relative to the export currency, the value of the LDCs' external liabilities rises—a common situation with the huge dollar appreciation in the 1980s.

Higher real rates can also affect the internal performance via the standard substitution effect of reducing investment in favor of increased saving. Capital flows to countries with higher real rates, and it is not uncommon for real differentials to exist between the developing countries and industrial countries due to regulated financial markets in the LDCs. Although not easily quantifiable, this channel may have important consequences for future LDC debt-serving prospects as the capital goods stock and, therefore, future production possibilities dwindles.

U. S. macroeconomic policies can also operate on the developing economies by altering their terms of trade. In addition to the interest rate overshooting, the terms of trade can be altered by cyclical shifts in U. S. demand for LDC exports and by real exchange-rate movements. In general, business expansions in the industrial nations improve the LDCs'

terms of trade, and therefore the net export position, while recessions are transmitted by a fall off in export demand.

A real-dollar exchange-rate appreciation may also drive down the terms of trade for these primary product exporters. This is because the pass through of exchange rate changes is relatively higher for primary commodities versus manufactured goods because of differences in market structure (primary product markets are competitive while manufactures markets have more market concentration). Moreover, the real currency exchange rate of LDCs moves proportionately more than that of the industrial countries. Finally, LDC supply responsiveness for these products is greater than industrial countries. All of these influences point in the same direction.

From the above discussion, it is apparent that a rise in real interest rates and/or a fall in the terms of trade will reduce the welfare of the developing countries. Consequently, an investigation of the particular policy combinations that will produce either of these results is imperative.

The shift to a more restrictive monetary policy, coupled with an unprecedented fiscal deficit expansion in the early 1980s, put upward pressure on real interest rates both in the United States and abroad. This rise in rates of return directly enlarged the LDC debt service obligations and indirectly drove down commodity prices via overshooting and dollar appreciation. However, expansionary fiscal policy can also increase demand for LDC agricultural exports, thereby producing an offsetting effect on the terms of trade. The net effect on the terms of trade depends upon the relative strength of the three combined effects: exchange rate, interest rate and relative demand shifts on commodity prices.

MICROECONOMIC POLICY LINKAGES

Government policies can also affect the supply and demand for primary goods (and therefore the price) on a specific product basis. The coupled subsidization policies of many

industrial countries has resulted in excess production and growth in commodity stocks. Although these policies combined with supply management have, in some instances, increased industrial country domestic prices in the short run, their long-run effects have been to depress commodity prices especially on external or world markets.

The problems from these programs arise for the LDC commodity exporters when industrial governments dump their stocks onto the world market at prices below the domestic levels or they donate the stocks as aid. In fact, the U. S. Commodity Credit Corporation (CCC), facing enormous commodity stockpiles, began to sell off their inventories after the passage of the 1985 U. S. Farm Bill. This move helped cause many already depressed commodity prices to plummet to lows not seen since the Great Depression.

There have been several studies that have attempted to quantify the impact on LDCs of the protectionist policies of industrialized countries. Valdez and Zietz (1980) use a multiproduct partial equilibrium model with prior estimates of world supply and demand elasticities to analyze the effects of a 50 percent reduction on trade barriers in the OECD countries on LDC export earnings. Their results simulate the effects of reduced protectionism on a large group of LDC commodity exporters by both commodity and geographic region and conclude that there will be a net welfare gain to the LDCs.

Tyers and Anderson (1986) use a multimarket model to arrive at conclusions similar to those of Zietz and Valdez. They also find significant increases in the world price of commodities (as well as increases in world trade) upon the liberalization of major industrialized countries' markets. Large welfare gains for nearly every producing region accompany these changes in prices and volumes. Of course, significant welfare losses are imposed upon most of the commodity importing countries.

In a more recent study, Zietz and Valdez (1986) analyze the potential welfare and foreign exchange gains for developing countries of complete trade liberalization in four major agricultural products: sugar, beef and veal, wheat, and maize. The results of the numerical

analyses are mixed with substantial gains for the LDCs from trade liberalization in sugar and beef and a potential net welfare loss for the LDCs with a reduction of barriers of cereals.

Roningen and Dixit (1989) examine the removal of agricultural subsidies in major countries using an 11-region, 22-commodity net trade, partial equilibrium model. They find that the level of government assistance to the production of a particular commodity is closely related to the world price of that commodity. They estimate, for example, that a full liberalization of agricultural policies by industrial countries would increase world agricultural prices by an average of 22 percent. Liberalization by the European Community (EC), alone, accounts for almost half of the increase. Per capita income gains would be small in the industrial countries, and would be dependent for LDCs on the degree of their net export position.

Loo and Tower (1988) specifically address the impact of a liberalization of agricultural policies on less-developed economies with foreign-debt servicing requirements. Increased foreign aid or a direct reduction of debt is found to be a weak means of improving the real income and debt servicing ability of developing countries. Their analysis suggests that increased agricultural prices stemming from policy liberalization in the industrialized countries would more effectively meet LDC interests. They ignore the impact, however, of higher commodity prices on net-importing debtor LDCs.

LDC Economic Structure

The impact on LDCs of changes in the industrial country policy variables depends critically upon the initial economic structure of the country in question. The two conditions that determine how much industrial country policies are felt within the developing countries are the initial external debt position and the degree of openness in the trade sector. Higher interest rates will increase the debt burden in proportion to the existing liabilities and may increase the net indebtedness. Moreover, the larger the share of exports in total output, the

larger the share of exports that are comprised of primary commodities, and the greater the damage from a deterioration in the terms of trade.

The extent of the spillover of industrial country economic policies onto the LDC commodity exporters will depend upon the initial debt position and the proportion of exports in primary products. Table 1 reports the portion of exports by country. The country share of total world exports by commodity is recorded in Table 2; and a summary of all agricultural exports, as a percentage of total exports, is reported in Table 3. Aggregate LDC borrowers experienced a 5.43 percent increase in their export to GNP ratios and many agricultural LDC exporters saw real declines ranging from 8 to 41 percent of GNP from the years from 1980 to 1984 (Rausser and Rose, 1988).

The change in debt and debt service ratios is even more dramatic. The average increase from 1980 to 1984 in debt and debt service for all borrowers was 38 and 23 percent, respectively. By contrast, the largest LDC rice and cotton exporters, Thailand and Egypt, saw rises in their debt-service export ratios of 146 percent for Thailand and 58 percent for Egypt. There was even more of a marked decline in the export share of GNP for Argentina, an exporter of wheat and corn, where the debt-export ratio nearly doubled.

Further analysis on the distortionary effects of industrial country commodity policies is necessary to separate the macro- vs. microeconomic policy effects on the developing countries. The case of fruits and vegetables offers some further enlightenment (Rausser and Rose, 1988). The Philippines, which has a total market share of approximately 3.5 percent of world fruit exports, had positive growth in the exports share but was well above average in the debt and debt-service growth. The net welfare tradeoff of a higher debt burden that decreases disposable income and higher exports that increase welfare is not apparent.

Finally, in the case of U. S links with LDCs, it is especially important to also recognize the interrelationships between the large current account deficits of the U. S. and the LDC debt service burdens. Ever since 1982, exports of the United States to LDC debtor countries and also of some other large deficit countries has deteriorated greatly. Currency adjustments, the

Table 1

Agricultural Exports as a Percentage of Merchandise Exports, 1980-1985

Country	1980	1981	1982	1983	1984	1985
Thailand	33.2	31.1	32.6	33.2	31.4	28.3
Uruguay	21.5	24.6	27.8	22.7	21.2	21.5
Egypt	19.8	20.0	19.4	20.7	22.5	16.6
Guatemala	57.6	51.3	59.6	51.3	-- [a]	--
Paraguay	56.9	66.2	69.4	68.7	75.5	--

[a]Dashes indicate no data available.

Source: United Nations. *International Trade Statistics Yearbook*, 1986. Vol. 1, New York: United Nations, 1988.

Table 2

Percentage of World Exports by Country, 1981-1986

Commodity/Country	1980	1981	1982	1983	1984	1985	1986
Wheat							
Argentina	2.1	0.5	0.5	0.5	1.1	1.0	0.3
Corn/Maize							
Argentina	0.8	1.6	1.5	8.2	7.4	9.9	9.7
Thailand	3.1	3.5	4.2	3.7	4.2	3.6	6.2
Soybeans							
Argentina	--[a]	- -	3.7	4.8	11.8	10.8	9.5
Brazil	- -	- -	1.8	4.6	11.5	16.6	7.3
India	- -	- -	0	0 .03	0.02	1.0	0
Paraguay	- -	- -	1.5	- -	- -	1.8	1.2
United States	- -	- -	94.4	89.3	75.7	69.6	80.0
Rice							
Burma	3.0	3.2	4.1	4.2	2.1	2.5	1.6
Thailand	22.3	23.7	27.4	25.6	33.1	29.8	29.9
Uruguay	1.5	2.1	2.6	2.1	2.2	3.2	0.4
Cotton							
Egypt	6.5	8.2	7.5	8.1	7.8	8.4	11.0
Guatemala	2.5	1.9	3.0	1.9	1.3	1.2	0.6
Mexico	4.8	5.2	3.3	2.0	3.3	1.5	1.4
Paraguay	1.6	2.2	1.3	1.8	2.4	2.7	1.4

[a]Dashes indicate no data available.

Source: United Nations. *International Trade Statistics Yearbook, 1986* (for 1982-1986 data updates), Vol. II. New York: United Nations, 1988.

Table 3

Agriculture Exports as a Percentage of Total Exports, 1980-1986

Country	1980	1981	1982	1983	1980-1983 Average	1984	1985	1986
Argentina	38.7	45.7	40.1	-- [a]	41.5	49.0	47.0	43.3
Brazil	19.9	13.5	16.1	17.6	17.2	--	--	--
Egypt	19.8	20.0	19.4	20.7	19.7	22.5	16.6	--
Guatamala	57.6	51.3	59.6	51.3	54.4	--	--	--
Paraguay	56.9	66.2	69.4	68.7	61.2	75.5	--	--
Philippines	11.1	10.6	12.0	--	11.3	10.4	11.3	11.8
Thailand	33.2	31.1	32.6	--	33.2	31.4	28.3	--
Mexico	9.3	7.9	--	--	8.6	--	--	--
Uruguay	21.5	24.6	27.8	22.7	24.1	21.2	21.5	--

[a]Dashes indicate no data available.

Source: United Nations. *International Trade Statistics Yearbook, 1986* (for 1982-1986 data updates), Vol. II, New York: United Nations, 1988.

striving for efficiency gains, and other changes are working very slowly to restore balance. However, it must be emphasized that balance will not be achieved on the basis of debt relief alone unless stronger trading relations can be restored between some large industrial countries and their traditional LDC partners. For example, U. S. exports to Mexico and Brazil have not regained their former status that existed as late as 1982.

THEORETICAL FRAMEWORK

In this section we provide an extremely simple general equilibrium model to motivate the empirical analysis. Although many details are not incorporated in the formulation, it does capture the mechanisms that structure the relevant linkages. In essence, the formulation presumes an integrated world market for commodities. These commodities are traded in dollars and are exchanged by countries with various characteristics—exporter and importer, debtor and nondebtor.

Exchange Rates and Commodity Prices

A useful way of initiating the discussion is to consider Dornbusch's (1985) simple model of the world market, consisting of the United States and the rest of the world, for a commodity. An exogenous and fixed supply of commodities is matched by domestic U. S. demand and by foreign demand, both of which depend on the relative price of commodities and on income. Thus,

$$S = D\left(\frac{p}{P}, Y\right) + D^*\left(\frac{p^*}{P^*}, Y^*\right) \qquad (1)$$

where * denotes foreign variables, Y is income, p is commodity prices in home and foreign currency, and P is the national price deflators. Dornbusch assumes that commodity prices are perfectly arbitraged such the $p = ep^*$, where e is the nominal exchange rate (home currency

per unit of foreign currency). The real exchange rate (λ) then depends on P and P* being the home and foreign GDP deflators, i.e.,

$$\lambda = \frac{P}{eP^*} \qquad (2)$$

where, under perfect competition, "exchange rate movements change relative prices one-for-one." Dornbusch then uses (1) and (2) to solve for the real commodity price of the United States as a function of income, the real exchange rate, and exogenous commodity supply:

$$\frac{p}{P} = J(Y, Y^*, \quad :\lambda S). \qquad (3)$$

This equation suggests that a real exchange rate appreciation of the U. S. dollar will "lower real commodity prices in terms of the U. S. deflator while raising them in terms of foreign deflators." With a change in the real exchange rate, commodity prices (relative to national deflators) change but arbitrage ensures that commodity prices themselves are equalized. An increase in the real U. S. exchange rate will decrease real commodity prices by a function of the weighted elasticities of U. S. and foreign demand—as U. S. import prices fall directly and as the relative price of commodities in foreign markets increases.

The Dornbusch (1985) model provides a simple framework in which to evaluate the effects of various shocks to the world commodity market. Here we make several modifications to the framework so as to apply it to the situation of developing countries. First, the supply of commodities will not be assumed as exogenous and fixed but will be determined within the model. Supply can be thought to hinge crucially on the relative domestic price and on government policy toward agriculture in developing countries which, in turn, depends on the size of foreign-currency-denominated foreign debt that must be serviced with export revenues.

A further addition to the model will be the inclusion of stocks of commodities held worldwide. A rise in stocks in net importing industrial countries indicates the effect of their

government transfer programs in closing out the market for imports; a similar rise in stocks in exporting countries also leads to market pressures for a fall in world commodity prices.

Four cases based on the economic position of the developing country in the world commodity market will be considered below: a commodity-exporting country with a foreign debt burden, a commodity-importing country with a debt burden, an exporting country without debt, and an importing country without debt.

Exporting Debtor Country

For this basic case, it is first assumed that a representative developing country produces both an exportable commodity and a composite importable, faces endogenously determined terms of trade, and must service official debts denominated in dollars. Note that each economic agent in the developing country—producer and consumer—takes the terms of trade to be given, while the country as a whole can affect the terms of trade. In this two-goods framework, by Walras law we have the condition that the excess supply of its exportable must equal zero (stars denote foreign variables).

$$S\left(\frac{p}{P},\alpha\right) - D^*(\lambda p, y^*, S^*, \gamma^*) = 0. \qquad (4)$$

The export supply of the developing country, S (•), is a function of the relative (domestic) price of its commodity (p/P) and a summary policy instrument of the government toward the industry (γ). Foreign import demand is a function of the relative price of the commodity, the real dollar exchange rate (λ), foreign activity (y*), the quantity of stocks of commodities held in the industrial world (s*), and foreign tariff and nontariff barriers (τ*). The stock figure indicates the degree of openness in the foreign market, i.e., the extent of its excess demand for commodities and of market conditions for the developing country's exports.

A word should be said about the government measures embodied in the term, α. Government policy toward agriculture usually includes measures that both tax and subsidize

the production of commodities. The net impact of the incentives produced by government policy may be negative (i.e., the producers are, on balance, taxed by the government through export taxes or other measures) or positive (i.e., indicating producers receive revenue from the government either through direct payments, subsidized input prices, or other forms of transfers).

We have a specific notion for the endogenous and equilibrium determination of α. Because the exporting country is a debtor, it must service its debt with, we assume, a constant flow of export proceeds, denoted δ. The foreign currency earned by the debtor country is simply the revenue from its export earnings. It is presumed that the costs of producing the exports are paid in domestic currency. All foreign currency proceeds must be devoted to servicing the flow, δ, which has been exogenously determined by history but whose evolution depends on the prevailing world's real rate of interest. Changes in the domestic supply of the commodity, the price of the commodity, or the real dollar exchange rate all affect the export revenue of the country. Changes in the world's rate of interest affects the flow of resources from the country. We assume government policy, α, is adjusted to ensure that

$$pS(\bullet) = \delta(r).$$

Total differentiation yields:

$$\hat{p} + \hat{S} = \hat{\delta}$$

where hats indicate proportionate changes, i.e., $\hat{p} = dp/p$. $\hat{S}$ can be shown to equal $\epsilon \hat{p} + K\hat{a}$, where ϵ is the price elasticity of supply and K is the elasticity of output with respect to government policy incentives. Rearrangement yields

$$\hat{a} = \frac{\hat{d} - \hat{p}(1+\gamma)}{K}.$$

This is the reaction function for the determination of the change in α. Note that this government reaction function is in accord with the stylized facts of the response of many commodity-exporting countries. Namely, exogenous shocks that affect a country's ability to service its debt requirements, such as a change in λ or in r, result in a changed government policy to increase export proceeds by encouraging the movement of factors and resources into the sector.

For example, Argentina reduced direct export taxes in 1987 on agricultural goods from close to 20 percent to under 5 percent in an effort to increase export supply. Although other increased taxes taxes limited the effectiveness of this direct reduction, the response of the government, and the direction of its action, accord well with the specification we have outlined here.

Totally differentiating the equilibrium condition (1) and, with simple rearrangement of terms, we have:

$$\hat{p} = \frac{n^* \hat{\lambda} + \theta y^* + \mu s - \gamma \alpha - \xi r^*}{\epsilon - n^*}, \tag{5}$$

where hats represent proportionate changes, n^* is the (negative) foreign elasticity of demand with respect to price or exchange rate changes, θ is the (positive) activity elasticity of demand in foreign countries, μ is the (negative) response of current foreign demand to a change in stocks, γ is the (positive) supply response of the exporting country to a change in net government production incentives toward the sector, and ϵ is the (negative) elasticity of demand with respect to tariffs and other barriers. The denominator is positive because $\epsilon > 0$ and $n^* < 0$.

While we are not formally testing this model, it does highlight the salient features we hope to capture in our empirical work that follows. For example, equation (5) indicates (as in Dornbusch's model) that an appreciation of the dollar reduces the world prices of the

commodity, an increase in foreign activity tends to increase commodity prices, an increase in foreign stocks and tariffs tends to decrease commodity prices, and debtor-country encouragement for production tends to decrease commodity prices (through a shift in the supply schedule).

It is important to note that debtor country efforts to increase exports (and thereby preserve debt payment capacity) in the face of, say, an exogenous terms of trade shock actually further deteriorates its terms of trade. Thus, government responds to an increase (decrease) in the price of its own exportable with policies that reinforce the direction of that movement. Governments can, therefore, exacerbate the world price instability of its own exports.

Similar effects are also noted for an increase in the world's interest rate (r). An increase in r leads to governmental efforts to expand export supply and increase foreign currency revenues. At the same time, foreign demand for commodities drops as a result of the movement of stocks from storage to the market. An increase in r then unambiguously leads to a decline in the price of commodities. The stock figure is also dependent on the world's prevailing rate of interest, r, the opportunity cost of holding commodities in stock form. In writing $s^*(r)$, we note that a higher rate of interest will induce holders of stocks to sell their commodities and thus reduce foreign demand for such produce from the developing country.

Importing, Debtor Countries

The second type of countries trading in this world commodity market are the net-importing countries that have a debt burden (Mexico is a prominent example). This is analytically similar to the above situation, but with several differences. The example would have to be recast with the country having an excess demand for the commodity under question, thus,

$$D(p, y, \alpha, \tau) - S^*(p, s^*) = 0 \qquad (6)$$

where D is the developing countries import demand function.

In this case, the role of α and τ would be not to promote imports, but to limit them in response to a price or exchange rate shock. Import restrictions in such a case are the result of an effort to stem the loss of foreign exchange. Both α and τ would distort the developing economy by drawing resources into a sector where the country is a net importer of goods, thereby reducing the total volume of trade. In this instance, a real appreciation of the dollar would reduce debtor country demand for commodities by raising the foreign currency price of the commodities. This rise reduces demand on the world market generating downward pressure on commodity prices.

Exporting, Nondebtor Countries

A third scenario is the case of the exporting developing country with no debt burden to service. Government policy may then be more flexible in its response to external shocks as it does not have a foreign currency debt to service and, indeed, it may have no policy whatsoever. There may be less of a tendency for government policy to expand supply and exacerbate the downward pressure on commodity prices in the face of an external shock. Otherwise, this country is affected by external shocks the same as an exporting, developing country with debt considered earlier.

The United States may also be said to fall into this category. As an exporter of many commodities, however, its government is not a passive participant but adjusts its policy parameter to encourage supply and thereby, at times, increases the stock of commodities.

Importing, Nondebtor Countries

A fourth scenario takes an importing developing country without a debt burden (such as Taiwan). This is also analytically similar to the case in the section, "Importing, Debtor

Countries," except that, there being no debt burden, government policy may not have the protectionist, foreign-exchange-saving objective as would a similarly situated debtor.

Inter-Country Linkages

A final stylized version worth considering is the case where the developing country debtor exports, in competition with the United States, a commodity destined for third-country markets. An appreciation of the dollar in this instance induces a substitution effect in third-country markets between the two suppliers. The appreciation raises foreign prices of the commodity, thus reducing demand. However, the appreciation also increases the price the debtor, developing country can receive through exporting. The net effect on the world price is ambiguous.

Summary

The above cases are summarized in Table 4, where the signs of changes in the exogenous variables and their effect on commodity prices are shown. An implication of the model is that, regardless of the net trade and external debt position of a country, a real exchange rate appreciation of the dollar, an increase in stocks, and an increase in interest rates will decrease commodity prices. Most of the other effects will appear or be muted (zero), depending on the particular case considered (exporter or importer, debtor or nondebtor) and the nature of the shock. Implications about welfare do not necessarily coincide directly with the signs, however, as an increase in the real value of the dollar has an uniform effect on commodity prices with different implications for exporters and importers of commodities.

Any empirical investigation of the world commodity market includes in its sample a number of trading countries whose economic situation is similar to one of the five cases outlined above. In the commodity market, an aggregation of these traders is necessary with implicit weights being the importance of a particular class of countries in world trade. A

Table 4

Summary of Signed Effects

	Effect on World Commodity Prices							
	$\uparrow\lambda$	$\uparrow\alpha$	$\uparrow\tau^*$	$\uparrow y^*$	$\uparrow s^*$	$\uparrow r$	$\uparrow\tau$	$\uparrow y$
Debtor								
Commodity exporter	—	—	—	+	—	—	0	0
Commodity importer	—	—	—	0	0	—	—	+
Nondebtor								
Commodity exporter	—	0	—	+	—	—	0	0
Commodity importer	—	0	0	0	—	—	+	+

Legend:

λ = real exchange rate

α = government policy measure

τ^* = foreign tariffs and nontariff barriers

y^* = foreign activity

s^* = stocks of commodities held in the industrial world

r = interest rate

τ = domestic country tariffs and nontariff barriers

y = domestic activity

glance at Table 4 suggests that there should be little ambiguity over the signs of the aggregate coefficients, although the significance of some may be at issue.

In addition, as Côte (1987) has noted, there may be no clear signed effect for these shocks on the developing countries' terms of trade. For example, the effect of a real appreciation of the exchange rate can effect both developing country import and export prices. To be sure, a real appreciation of the U. S. dollar can lead to either an improvement or a deterioration in LDC terms of trade, depending on the breakdown of LDC trade with industrial trading partners.

EMPIRICAL RESULTS

As noted above, the macroeconomic impact of growth in the industrialized countries and the real foreign exchange value of the dollar on agricultural prices for major developing country exports has been previously examined. These factors (the activity variable through the income effect and the exchange rate through the relative price effect) play a major role in determining the quantity of import demand for agricultural goods.

On balance, developed-country agricultural policies have subsidized their own production, thereby decreasing the excess demand to be filled by foreign suppliers. The summary variable used to characterize these policies is the volume of world agricultural stocks of major commodities. An increase in stocks is a signal that agricultural policies in developed countries have acted to reduce foreign market access. These policies have a depressing effect on world commodity prices (i.e., those for developing country exporters) who must find other, less-lucrative markets for their products.

Yet, under certain conditions the converse can be argued to hold—namely, that a reduction in stocks is indicative of developed-country dumping or subsidizing its stockpile onto world markets and thereby depressing world commodity prices. However, until 1988, world stocks were accumulating, meaning that the direct effect of policies in closing

developed-country markets for imports was more significant than the secondary effort to reduce those stocks through export subsidization.

The foreign indebtedness of the commodity-exporting developing countries can have a significant impact on commodity prices for several reasons. The burden of servicing debt has manifest itself in government efforts to expand exports of goods, especially commodities, to earn foreign exchange. This expansion tended to depress export prices for those commodities that developing countries successfully increased production and reduced, but did not eliminate, the gains from exporting those commodities.

Once again, the converse can be said to hold—that, as commodity prices fell, developing countries borrowed from major private and public lending institutions in an effort to smooth their income and consumption streams. However, this story is not compatible with the stylized facts of the 1970s and 1980s. The accumulation of debt began in the mid-1970s when commodity prices were rising rapidly. The borrowing was to finance further economic expansion at home through investment in a variety of industries. With the recession in the early 1980s, borrowing came to a halt and the problem of servicing the debt became an issue which required renewed attention to export growth. This growth was all the more difficult in the face of slower growth in developed countries and a higher real dollar exchange rate, and the consequent effort to expand exports acted to reduce commodity prices even further.

In summary, three groups of potential causal forces are examined: macroeconomic policies in the industrialized world as reflected by the real exchange rate for the U. S. dollar, U. S. interest rates, and OECD industrial production; microeconomic agricultural sector policies as reflected by commodity production and stocks; and LDC economic structure as reflected by the external debt of Latin American and African countries. The empirical analysis reported in this section is designed to allow for differential responsiveness to each of these causal forces. As in earlier work (Rausser, *et al.* 1986) the analysis will provide evidence on the separate effects of monetary and fiscal policies via interests and exchange rates and of distortionary agricultural policies via commodity production and stocks. The implications of

these policies for LDCs are allowed to be altered by a measure of LDC external debt. Dynamic adjustments are introduced to all specifications via various rational distributed lags.

The estimated equations are based on quarterly data over the period from 1977 through 1987. The first set of equations focuses on explaining world commodity prices and world agricultural prices. In Figures 1 and 3, each of these indices are reported back to 1964 with their corresponding "real" counterparts shown in Figures 2 and 4, respectively. The deflation of each of these series by the U. S. producer price index is almost undistinguishable from the deflated series using the export unit-value index of industrial countries. The real series are used as the dependent variables and are sourced with the *International Financial Statistics* of the International Monetary Fund.

Various measures of the terms of the trade for non-oil developing countries are reported in Figures 5 through 8. In Figure 5, exporting the basket of food commodities onto world markets and importing the average mix of products has been a nightmare since the mid-1970s. For the representative LDC, however, events have not been this unfavorable (Figure 6). In Figure 6, the ratio of export prices to import prices of non-oil LDCs since the mid-1960s is depicted. For those developing countries that export a basket of only commodities, a similar terms-of-trade time series is shown in Figure 7. Finally, for developing countries that export a basket of agricultural raw materials, the relevant terms-of-trade time series is shown in Figure 8. As can be seen from Figures 5 through 8, there are some rather large differences facing various non-oil developing countries. Hence, to differentiate the impact of industrialized country macroeconomic and agricultural sector policies on LDCs, equations are estimated for each of the terms-of-trade time series appearing in Figures 6, 7, and 8. In addition to the above equations, individual world-commodity-price equations are specified for wheat, coarse grains, rice, and cotton. Wheat prices refer to U. S. no. 2 Dark Northern Spring, 14 percent, cif Rotterdam; coarse grains refer to U. S. no. 3 yellow corn, cif Rotterdam; rice is white, fob Thailand; and cotton is "A" index from the *Cotton and wool Situation Report*, cif Northern Europe. For each of these individual

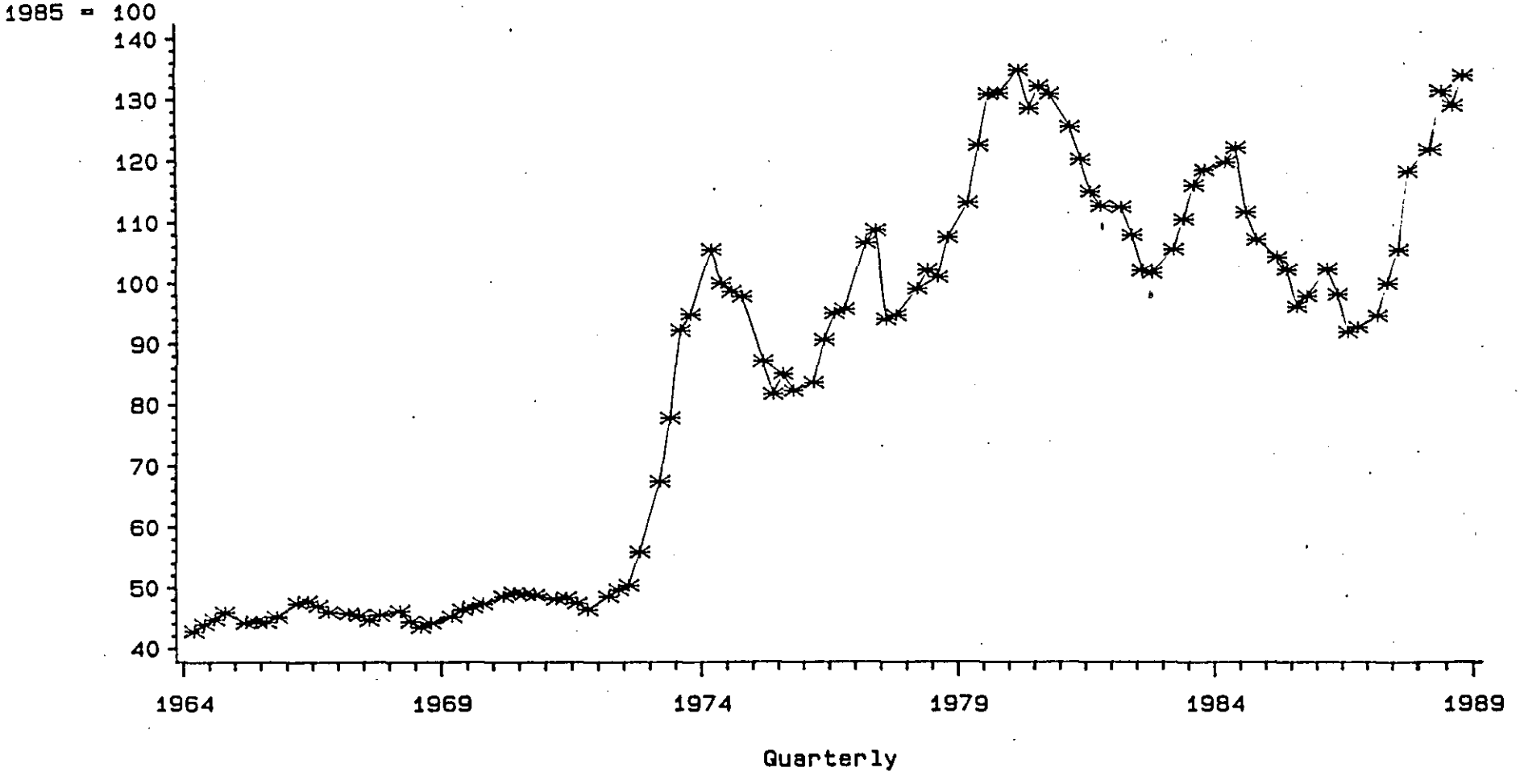

Figure 1. World Commodity Price Index, 1964 to 1989

Source: International Monetary Fund, *International Financial Statistics*, various years.

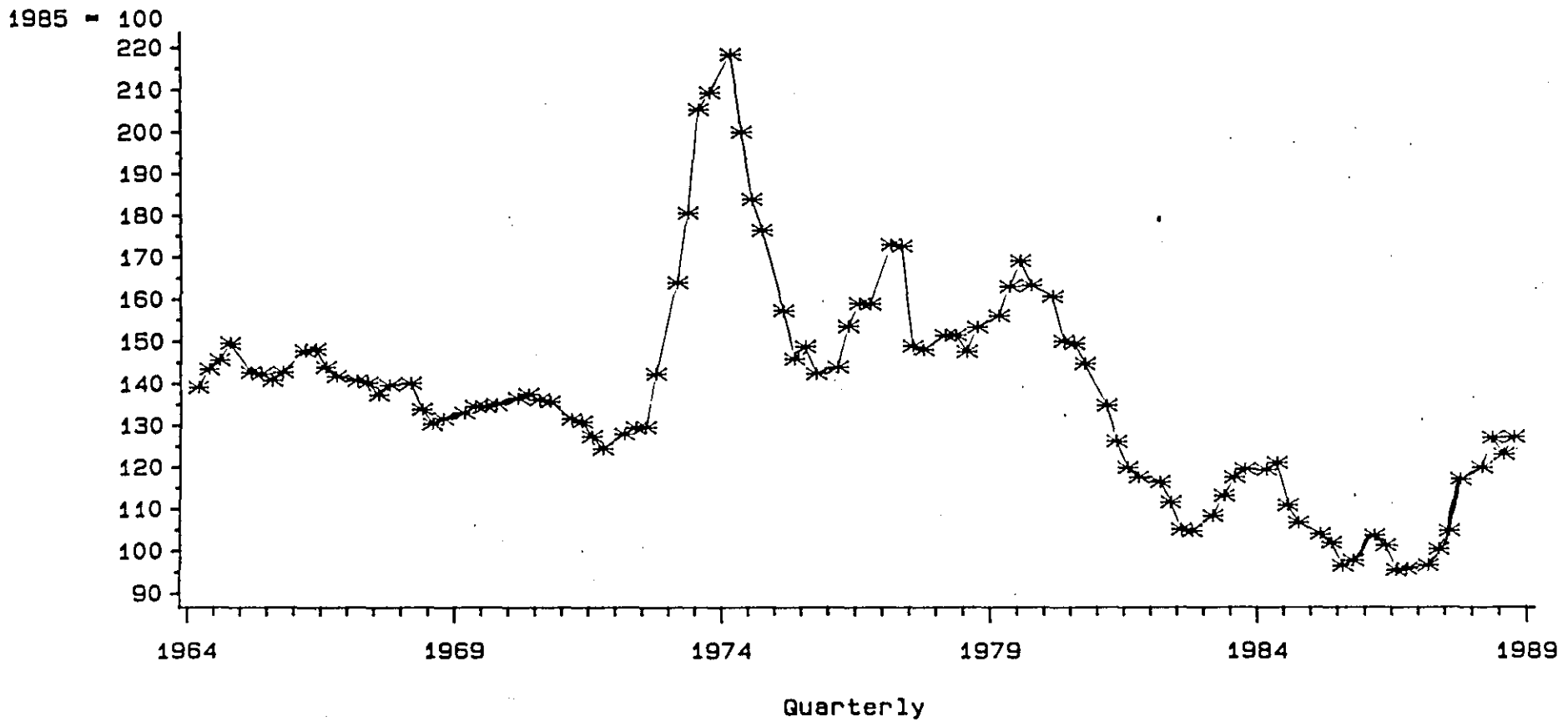

Figure 2. World Commodity Price Index Divided by the U. S. Producer Price Index, 1964 to 1989

Source: International Monetary Fund, *International Financial Statistics*, various years.

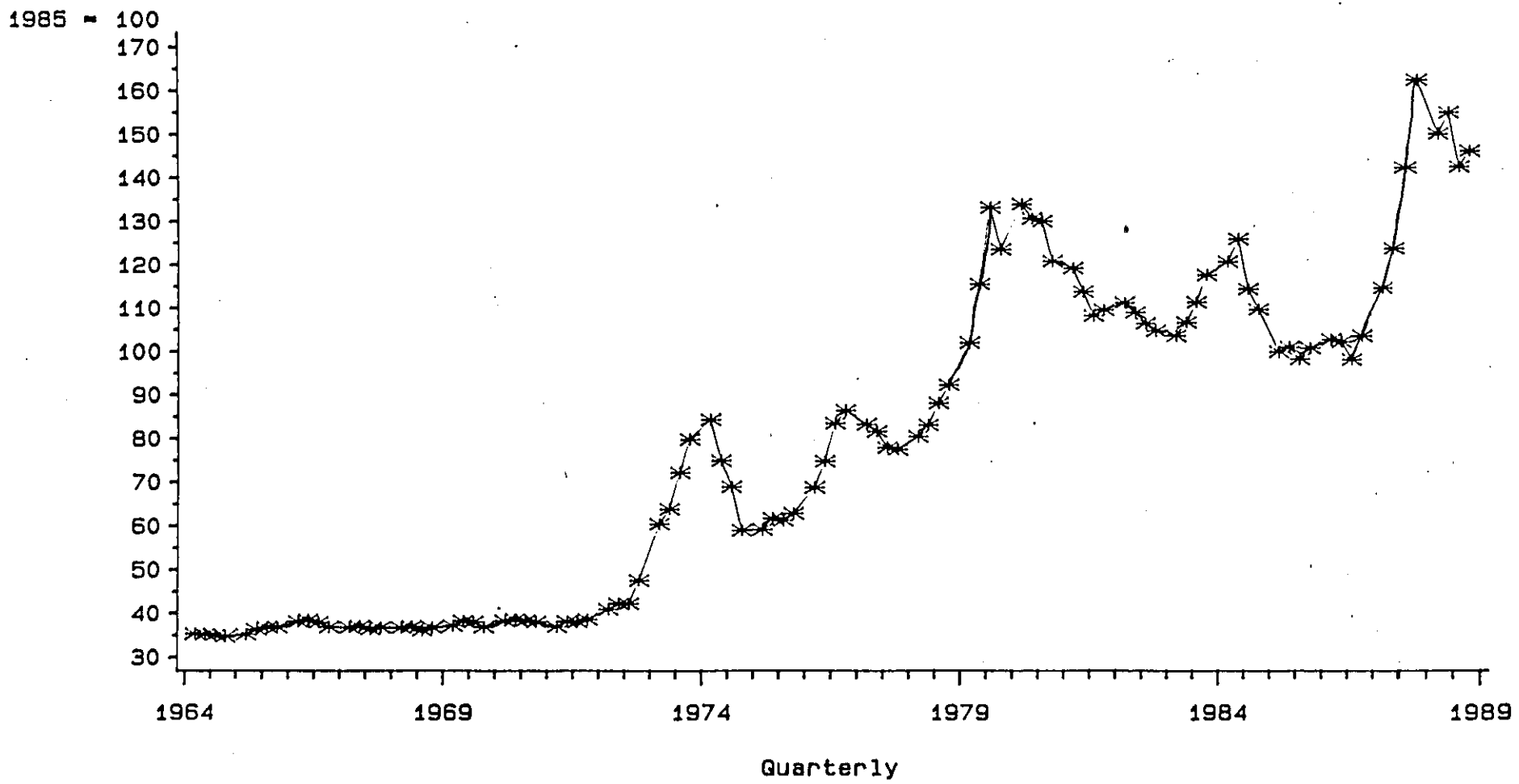

Figure 3. World Agricultural Raw Materials Commodity Price Index, 1964 to 1989

Source: International Monetary Fund, *International Financial Statistics*, various years.

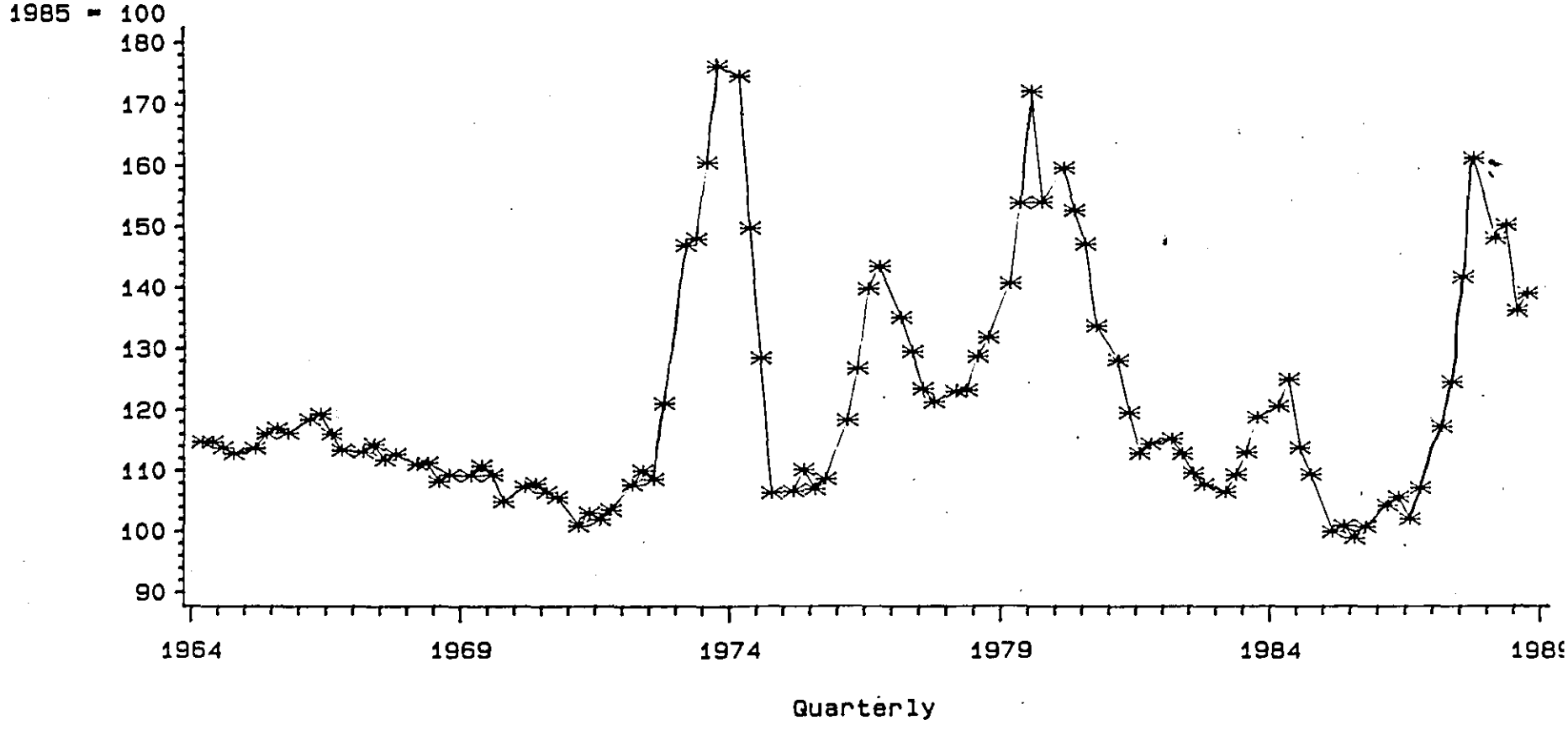

Figure 4. World Agricultural Raw Materials Commodity Price Index, Divided by the U. S. Producer Price Index 1964 to 1989

Source: International Monetary Fund, *International Financial Statistics*, various years.

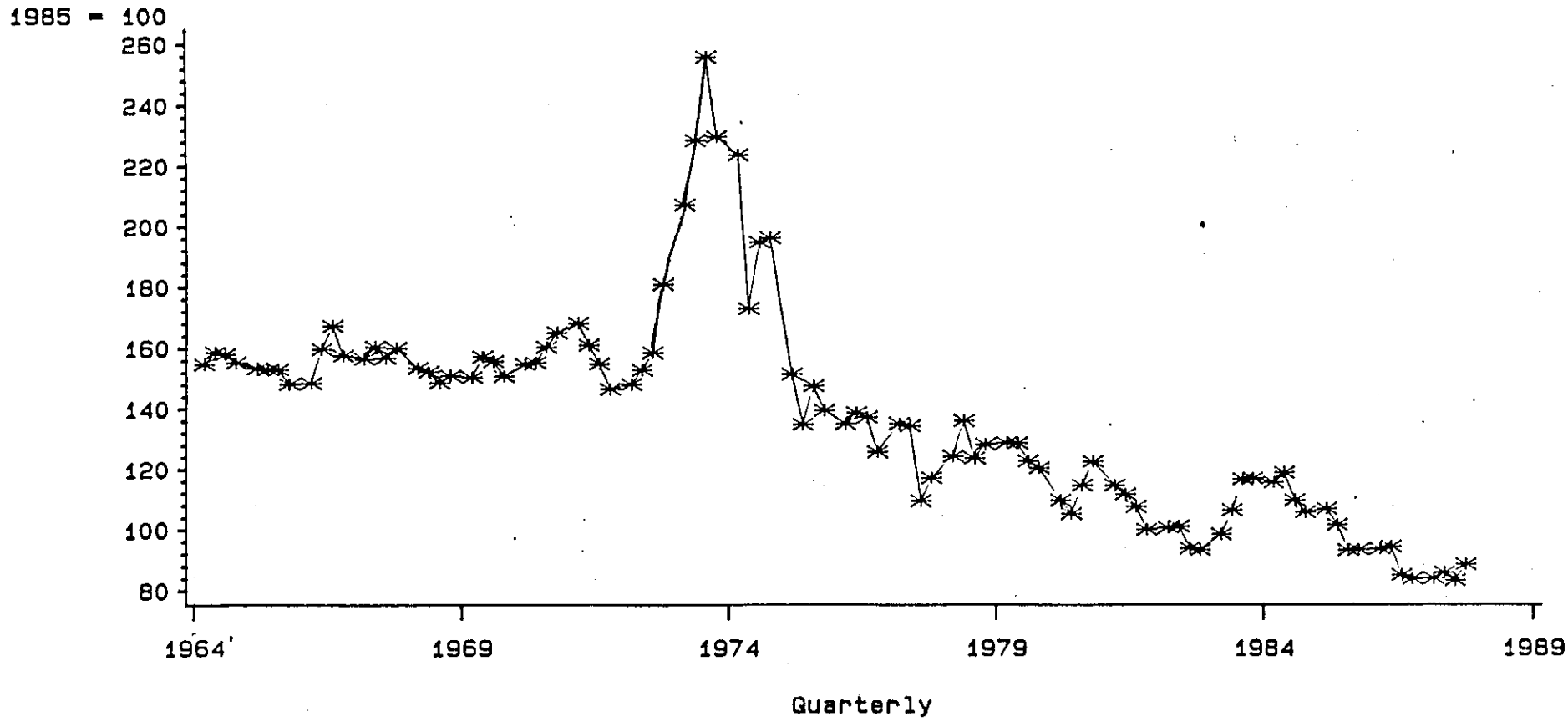

Figure 5. World Commodity Price Index for Food Divided by the Non-Oil LDC Import Unit Value Index, 1964 to 1989

Source: International Monetary Fund, *International Financial Statistics*, various years.

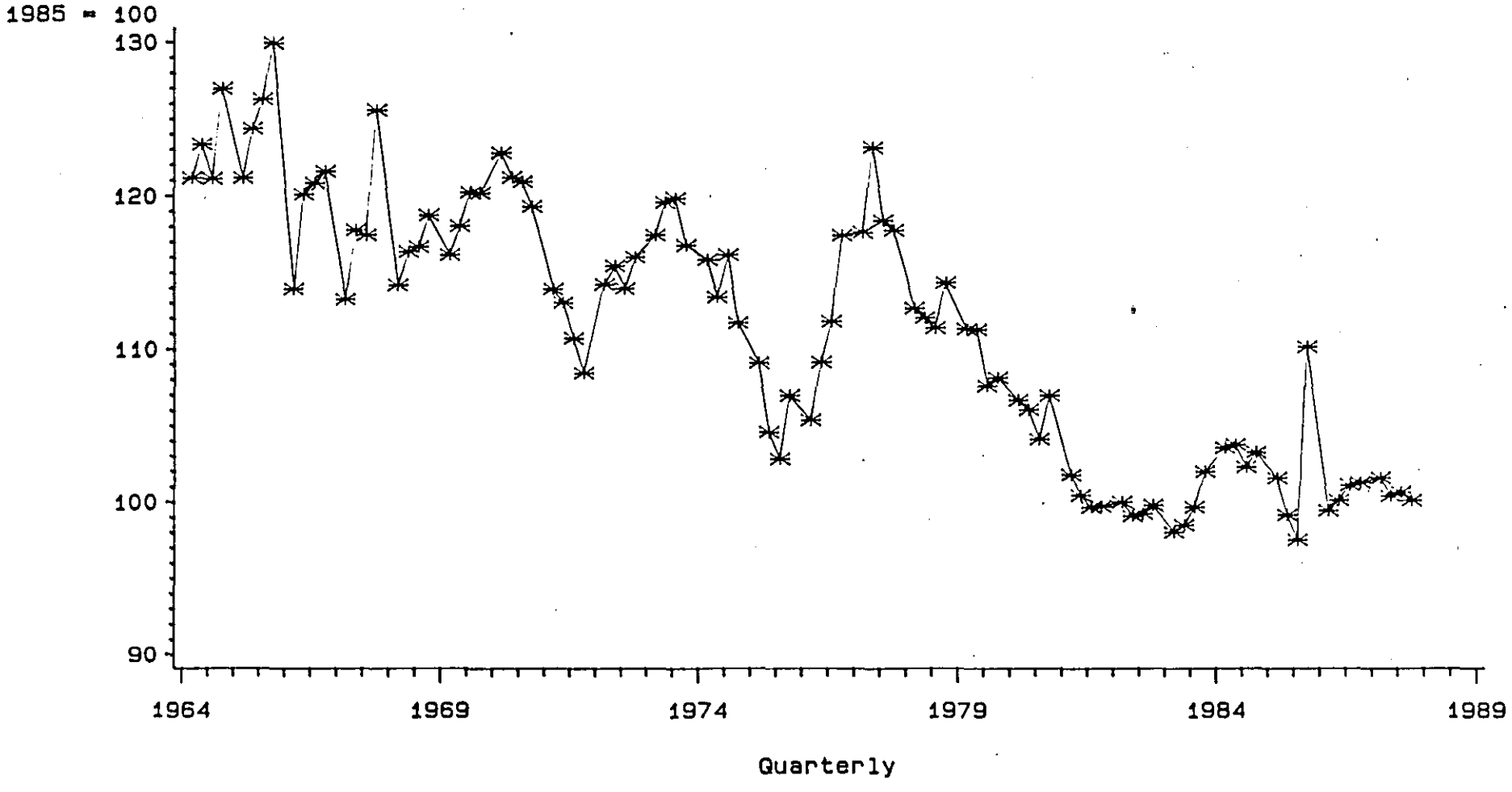

Figure 6. Terms of Trade Index: Non-Oil Developing Countries, 1964 to 1989

Source: International Monetary Fund, *International Financial Statistics*, various years.

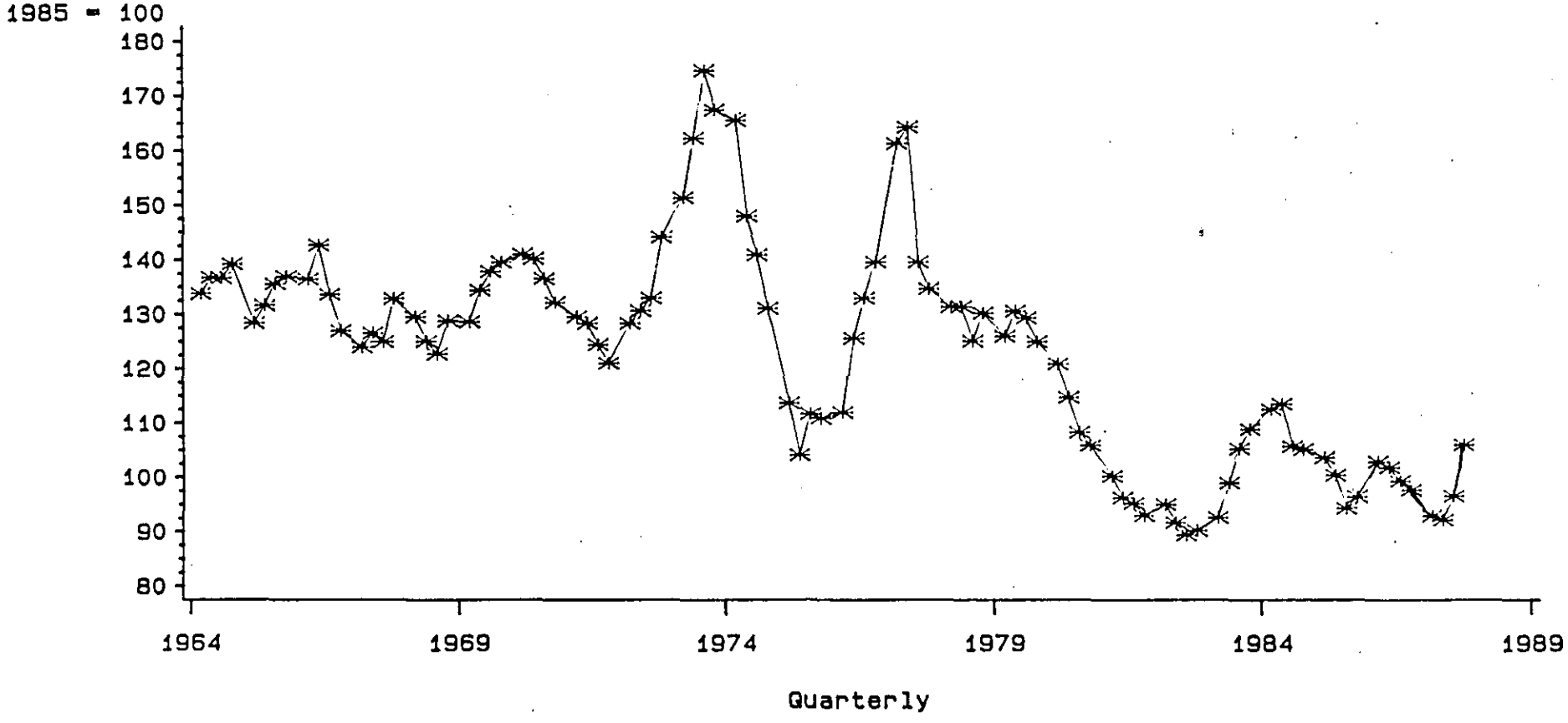

Figure 7. Developing Country Commodity Price Index Divided by the Non-Oil LDC Import Unit Value Index, 1964 to 1989

Source: International Monetary Fund, *International Financial Statistics*, various years.

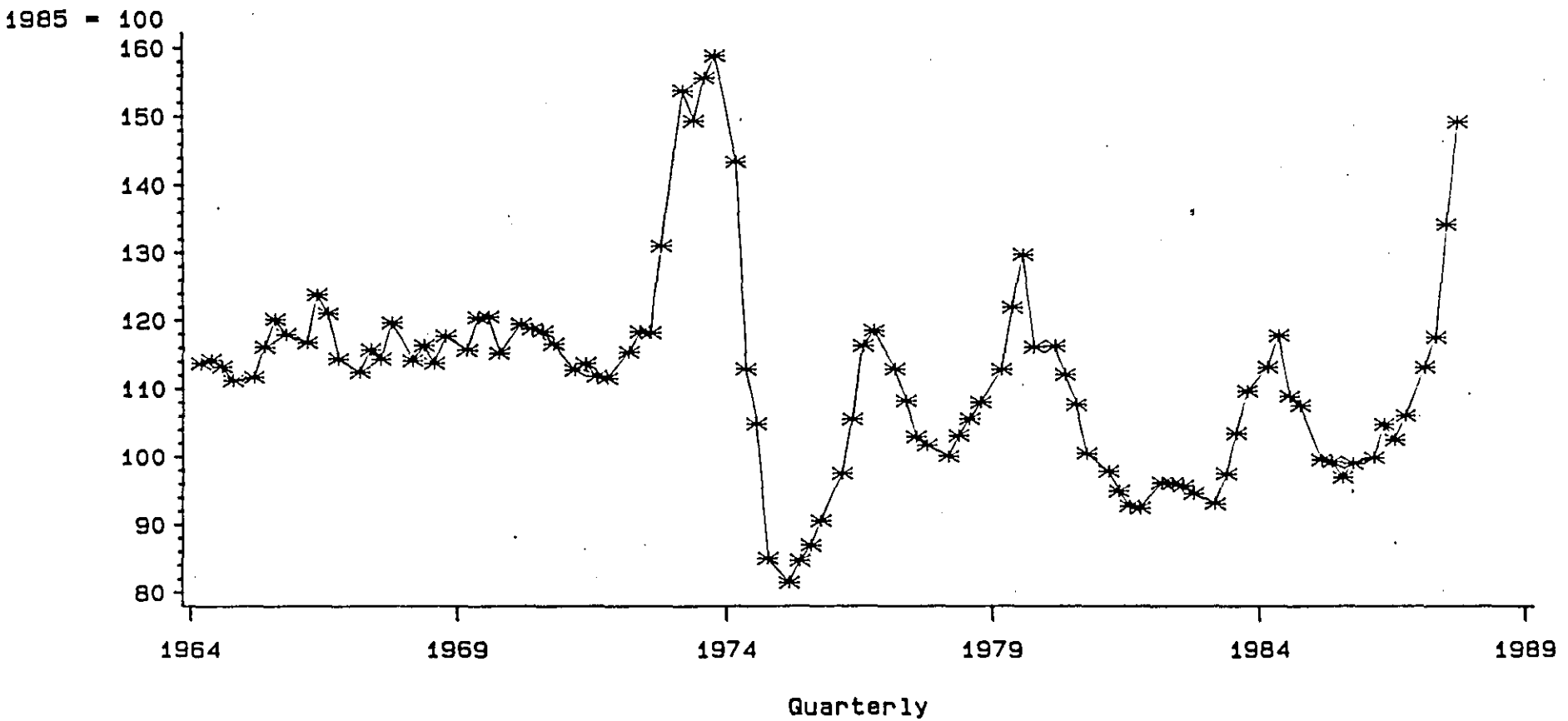

Figure 8. World Agricultural Raw Materials Commodity Price Index Divided by the Non-Oil LDC Import Unit Value Index, 1964 to 1989

Source: International Monetary Fund, *International Financial Statistics*, various years.

commodities, microeconomic policies in the United States play a significant role in determining the path of production, stocks, and worldwide prices.

Explanatory variables for the various estimated equations include a measure of the U. S. real effective exchange rate (based on relative value-added deflators in manufacturing); interest rates, measured by the six-month commercial paper rate in the United States; the OECD industrial-country production index, seasonally adjusted; as a measure for debt, the private sector external liabilities of Latin America and Africa; the total world grain stocks, as a proxy for commodity stocks; and, for the individual commodity equations, their corresponding world production and stock levels. Except for the individual commodity equations, the industrial production index variable was entered as an arithmetic lag over the current and previous two quarters with weights of (.2, .5, and .3). A geometric distributed lag was imposed on all other explanatory variables.

The empirically estimated equations are partially reduced forms in the case of the aggregate commodity price indices or the terms-of-trade measures. For each of these equations, ordinary least squares were employed to generate the relevant statistics. Correlation among the individual equation error terms and the nonequivalence of the regressors dictates the use of seemingly unrelated-regressions methods for the individual commodity equations for wheat, coarse grains, rice, and cotton. To be sure, many of the explanatory variables in a more general structural model would be treated endogenously. Since our purpose is basically exploratory, we will leave for some later application the search for a more complete accounting of macroeconomic variables, microeconomic policies, and developing country debt.

Real Commodity and Agricultural Price Equations

The mathematical specification for all equations was log linear in the variables except the interest rate. Since price indices are the dependent variables, all the estimated coefficients are flexibilities except the coefficient for the rate of interest which is a semi-

flexibility. In reporting the estimated equations, the mean estimated level of the effects (with their associated standard errors) and the standard goodness-of-fit statistics are presented. For each regression equation, we also report the immediate impact, or short-run flexibilities, as well as the long-run stationary state flexibilities.

An interaction effect is allowed between interest rates and the level of commodity stocks in all of the empirical equations. This interaction effect is represented by the product of interest rate and the level of stock. In essence, it admits the possibility that movement in interest rates will have variable effects depending upon the level of commodity stocks. If stocks are nil or nonexistant, the interest rate is expected to have little if any effect on commodity prices. Moreover, if the opportunity costs of carrying stocks as represented by interest rates are very small, the level of stocks is expected to exert less pressure on commodity prices.

As can be seen from Table 5, for both the all-commodity and the agricultural raw materials price equations all qualitative effects correspond to *a priori* notions. Both equations are stable, and the quantitative magnitude of the effects appear reasonable. In both cases, over 90 percent of the variation of commodity and agricultural index prices are explained by the set of explanatory variables.

For both equations, the real exchange rate is highly significant; the industrial production index is insignificant; interest rates are highly significant only for agricultural prices, not for all commodity prices; the level of grain stocks is virtually significant; the interaction affect of stocks and interest rates are highly significant for agricultural prices but not for all commodity prices; and the external debt measure is more significant for all commodities than for agricultural prices.

The effect of real exchange rates no longer has the unbelievable magnitude reported by Dornbusch. In fact, the magnitude of the elasticity of prices with respect to real exchange rates is approximately equivalent to the elasticity with respect to worldwide grain stocks. For all commodities, the impact is largest (absolutely) for the real exchange rate; followed by

Table 5

Impact and Long-Run Flexibilities for Total Commodity and Agricultural Prices

Dependent Variables	Explanatory Variables								R^2	DW
	Constant	U. S. Real Exchange Rate	Nominal U. S. Interest Rate	Industrial Production, Industrial Countries	Stocks of Commodities	External Debt	Interaction Between Interest Rate and Commodity Stocks	Lagged Dependent Variables		
Real Commodity Price										
Impact	4.12	-0.37	-0.08	0.18	0.32	-0.19	0.01	0.42	0.94	1.3
(Standard Error)	(1.13)	(0.11)	(0.08)	(0.28)	(0.16)	(0.12)	(0.01)	(0.08)		
Long Run		-0.63	-0.13	0.31	-0.55	-0.32	0.02			
Real Agricultural Price										
Impact	2.31	-0.33	-0.17	0.33	-0.25	-0.12	0.03	0.78	0.91	1.3
(Standard Error)	(0.98)	(0.11)	(0.08)	(0.26)	(0.15)	(0.11)	(0.01)	(0.08)		
Long Run		-1.50	-0.77	1.50	-1.13	-0.54	0.13			

Calculated.

the level of grain stocks, external debts, industrial production, and interest rates. The ordering for agricultural commodity prices is basically the same except for the interest rate which assumes a much larger importance.

LDCs Terms of Trade Equations

In Table 6 the estimated equations for non-oil LDC terms of trade, commodity-exporting LDC terms of trade, and agriculture-exporting LDC terms of trade are reported. In all three cases, the equations succeed reasonably well in explaining the various terms-of-trade movements over time. Qualitative effects generally correspond to *a priori* notions with a few minor (and insignificant) exceptions.

Real exchange rates and interest rates are significant at the 5 percent level only for the agricultural raw materials terms-of-trade equations. In some cases, the industrial production index is almost significant, but in most instances it proves to be insignificant. The commodity stocks variable has the anticipated effect on all terms-of-trade equations as does the interest rate stock interaction variable. However, only in the case of the agricultural terms of trade are the effects of the latter two variables significant. The external debt variable has the right qualitative effect on all three terms of trade, but it is significant only for the aggregate non-oil LDC terms of trade.

In contrast to the real commodity and agricultural price equations appearing in Table 6, the real exchange rate no longer dominates in the terms-of-trade equations. This is no surprise given that the real exchange rate influences both components of the terms of trade. Note that this observation does not hold for the agricultural raw materials terms of trade. Here, the real exchange-rate effect once again dominates in terms of its absolute level of influence.

Our results for the terms-of-trade equation stand in sharp contrast to those reported by Côte (1987). Her results cover the period, 1963-1983, and show a significant positive link between the U. S. dollar exchange rate and the non-oil LDCs terms of trade. The difference

Table 6

Impact and Long-Run Flexibilities for Non-Oil LDC Terms of Trade

Dependent Variables	Explanatory Variables: Constant	U. S. Real Exchange Rate	Nominal U. S. Interest Rate	Industrial Production, Industrial Countries	Stocks of Commodities	External Debt	Interaction Between Interest Rate and Commodity Stocks	Lagged Dependent Variables	R^2	DW
Total Terms of Trade										
Impact	5.05	-0.20	-0.01	-0.32	-0.11	-0.23	0.01	0.41	0.96	1.3
(Standard Error)	(1.26)	(0.13)	(0.09)	(0.45)	(0.17)	(0.12)	(0.02)	(0.06)		
Long Run		-0.34	-0.02	0.54	-0.18	-0.39	0.02			
Commodity Terms of Trade										
Impact	5.03	-0.24	-0.09	0.06	-0.33	-0.19	0.01	0.05	0.96	1.4
(Standard Error)	(1.60)	(0.16)	(0.12)	(0.40)	(0.23)	(0.19)	(0.02)	(0.02)		
Long Run		-0.25	-0.09	0.06	-0.34	-0.20	0.01			
Agricultural/Raw Materials Terms of Trade										
Impact	4.65	-0.44	-0.21	0.30	-0.41	-0.21	0.03	0.51	0.95	1.2
(Standard Error)	(1.26)	(0.14)	(0.09)	(0.32)	(0.19)	(0.13)	(0.01)	(0.07)		
Long Run		-0.89	-0.42	0.61	0.83	-0.42	-0.06			

Calculated.

between our results can be explained by several factors, including the incorporation of both external debt and worldwide stocks of grains. Even if these variables are excluded, however, the real exchange rate still has a negative effect but is less significant for the total non-oil LDCs terms of trade. In the case of the agricultural raw materials terms of trade, the real exchange rate has a significant negative effect regardless of a set of explanatory variables or, for that matter, the mathematical form of the equation.

Individual Commodity Price Equations

The same basic specifications utilized for Tables 5 and 6 are reported in Table 7 for the real world prices of wheat, coarse grains, rice, and cotton. The estimation method for each of these equations recognizes that the error terms are related; therefore, a generalized least-squares method of estimation is applied. For three of the equations, more than 80 percent of the variation in the real price series is explained by the set of explanatory variables; in one equation (coarse grains), the proportion explained is 78 percent. Each equation is dynamically stable.

For all equations, the real exchange-rate effect is insignificant. This result is not surprising given the importance of the United States as a producer and consumer of these primary commodities. The more important the United States, the less is the U. S. dollar price adjustment to movements in the real dollar exchange rate.

For most of the individual commodity-price equations, stock levels and current production dominate. The effects of interest rates are negative and significant for wheat and coarse grains but are insignificant for cotton and rice. In some cases, the interaction between interest rates and stocks is positive and significant; in other cases, it is insignificantly negative (rice and cotton).

The results for the external debt variable are as expected for all equations except, perhaps, for cotton. The external debt variable has a negative effect on wheat and rice prices, but an insignificant and positive effect on coarse grain prices. The quantitatively large and

Table 7

Impact and Long-Run Flexibilities for World Wheat, Coarse Grain, Rice, and Cotton Prices

Dependent Variables	Explanatory Variables								R^2	DW
	Constant	U. S. Real Exchange Rate	Nominal U. S. Interest Rate	Stocks of Commodities	Output	External Debt	Interaction Between Interest Rate and Commodity Stocks	Lagged Dependent Variables		
Wheat Prices										
Impact	2.57	0.02	-0.39	-0.94	0.44	-0.10	0.09	0.36	0.85	1.8
(Standard Error)	(1.72)	(0.02)	(0.13)	(0.27)	(0.41)	(0.10)	(0.02)	(0.11)		
Long Run		0.03	-0.60	-1.51	0.68	-1.62	0.14			
Coarse Grain Prices										
Impact	6.20	0.01	-0.14	-0.34	-0.78	0.08	0.03	0.57	0.78	2.2
(Standard Error)	(2.69)	(0.02)	(0.08)	(0.18)	(0.48)	(0.10)	(0.02)	(0.16)		
Long Run		0.02	-0.32	-0.79	-1.81	0.18	0.07			
Rice Prices										
Impact	4.65	-0.02	0.15	0.35	-0.33	-0.41	-0.04	0.33	0.87	1.3
(Standard Error)	(1.07)	(0.02)	(0.10)	(0.33)	(0.08)	(0.06)	(0.06	(0.07)		
Long Run		-0.03	0.02	0.53	0.50	-0.62	-0.18			
Cotton Prices										
Impact	2.99	-0.02	0.01	-0.26	-0.99	0.27	0.00	0.41	0.84	1.7
(Standard Error)	(1.40)	(0.02)	(0.10)	(0.24)	(0.34)	(0.09)	(0.03)	(0.14)		
Long Run		-0.03	-0.02	0.44	-1.67	0.46	0.00			

Calculated.

Philippines in world rice markets. The negative effect in the case of wheat, although insignificant, can be explained partially by the role of Argentina in world wheat markets. It is interesting to note that all three of the external debt variables are highly significant in each of the pricing equations for wheat, coarse grains, and rice when nonlinear for trend variables are included in the equations. The outcome for cotton is also not robust under alternative specifications. The incorporation of a time trend will move the effect of the external debt on cotton prices to be insignificantly different from zero, and for some specifications the effect of external debt on cotton prices can also be negative.

CONCLUDING REMARKS

In contrast to a number of previous empirical studies that focus only on industrial-country commodity-sector policies, only on macroeconomic phenomenon, or only on external debt and economic structures of LDCs, in this paper we have examined the joint effects of these forces on commodity prices and alternative measures of LDC terms of trade. Except for the individual commodity price equations, the qualitative effects of all three sets of forces are consistent with *a priori* notions and are statistically significant.

The results reported in this paper stand in sharp contrast to those presented earlier by Dornbusch (1985). He focused only on the macroeconomic linkages with international commodity prices and non-oil LDCs' terms-of-trade. For the former, he obtained the implausible result that the flexibility of world commodity prices to real exchange rates exceeds unity. Our results also contradict the correction of Dornbusch's work offered by Côte (1987). The most dramatic difference between our empirical results and those reported by Côte relates to the estimated effects of the real dollar exchange rate on LDC terms of trade. We obtain a significant negative effect while Côte reports a significant positive effect.

In the final analysis, the reduced-form equations in this paper reflect all three major sets of forces that impinge upon world commodity markets: (1) agriculture and food policy;

(2) conventional supply and demand forces; and (3) macroeconomic linkages of exchange rates, interest rates, and economic growth. The previous work of Dornbusch (1985), Côte (1987), and others focuses on one, or at most two, of these major forces.

The simple theoretical framework advanced in this paper can be extended to a large system of dynamic, econometric equations that evaluate partial or total liberalization of agriculture and food trade regimes in industrialized countries. In contrast to much of the literature on agricultural trade liberalization, however, such an assessment must recognize all three forces mentioned above. In particular, it is crucial to assess the sensitivity of the dynamic adjustment path resulting from any partial liberalization or reduced level of subsidization of OECD countries to shocks arising from the macroeconomic linkages. The simple theoretical framework presented in this paper provides the foundation for empirical studies that can be conducted to capture to implications of such shocks on the liberalization adjustment paths.

Finally, to complete the empirical analysis conducted in this paper, an expanded set of individual commodities should be examined; in particular, sugar, coffee, and cocoa but also other agricultural commodities. It is important to examine the robustness of the individual commodity-price equations recorded here for those commodities in which the United States is not a major player. In future research, alternative specifications will be evaluated and longer time periods will be investigated to determine how stable or robust the flexibility measures reported here are to different regimes that can be identified. The relevant regimes can be defined in accordance with alternative configurations of the three major forces—commodity policy, macroeconomic policy, and the economic structure of LDCs as it relates to external debt.

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