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Primary Commodity Prices, Manufactured Goods Prices, and the Terms of Trade of Developing Countries: What the Long Run Shows

Enzo R. Grilli and Maw Cheng Yang

The authors revisit in this article the empirical foundation of the alleged secular decline in the prices of primary commodities relative to those of manufactures. They use a newly constructed index of commodity prices and two modified indexes of manufactured good prices, and find that from 1900 to 1986 the relative prices of all primary commodities fell on trend by 0.5 percent a year and those of nonfuel primary commodities by 0.6 percent a year. They thus confirm the sign, but not the magnitude, of the trend implicit in the work of Prebisch. But even the more limited secular decline shown by their relative price indexes may be magnified by an incomplete account of quality improvements in manufactures. They then show that the evolution of the terms of trade of nonfuel primary commodities is not the same as that of the net barter terms of trade of non-oil-exporting developing countries. Finally, they find that despite the decline that has probably occurred during the current century in the terms of trade of nonfuel primary commodities, the purchasing power of total exports of these products has increased considerably. Similarly, the fall that may have occurred after World War II in the net barter terms of trade of developing countries seems to have been more than compensated for by the steady improvement in their income terms of trade.

An important focus of the analysis of commodity price movements has been on the distribution of gains from commodity production between producers and consumers. Transposed to the international domain, this type of analysis has focused on the long-term movements in the net barter terms of trade of developing countries, taken as an indicator of the distribution of gains from trade between commodity producers in developing countries and commodity consumers in industrial countries. Alternatively, and sometimes at the cost of some confusion, attention has been placed on the long-term trends in the prices of

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internationally traded primary commodities relative to those of manufactured products.

The contours of the controversy about the alleged long-term deterioration in the (net barter) terms of trade of developing countries, which was generated by the early work of Prebisch and Singer, are too well known to need another review here (see United Nations 1949; Prebisch 1950; Singer 1950; Lewis 1952; Viner 1953; Kindleberger 1956; Ellsworth 1956; Baldwin 1955, 1966; Morgan 1959; Meier 1958, 1963; Maizels 1970; Streeten 1974; Ray 1977; Macbean and Balasubramanyan 1978; and Kravis and Lipsey 1974, 1981). The empirical evidence available so far on the long-term movements in the prices of primary and manufactured products has also been recently revisited (Spraos 1980 and Sapsford 1985).

However, a common problem of the analyses that have focused on the long-run trends in the terms of trade of developing countries, or on the long-run trends in the relative prices of primary commodities, has been the inadequacy of the basic price data. Long-term movements in the terms of trade of developing countries were either inferred from those of certain industrial countries or from the movements in the prices of primary commodities relative to those of manufactured products (the so-called primary commodity terms of trade) without accounting for changes in the volume or composition of exports of the developing countries. Both practices obviously suffer from serious shortcomings. Yet instead of generating caution, the paucity of the available empirical evidence generated a tendency in the opposite direction: strong conclusions were derived from evidence that was weak in both accuracy and economic significance.

In this article we attempt, first of all, to solidify the empirical evidence on the prices of internationally traded goods, with special attention to nonfuel primary commodity prices. We go on to examine the long-run movements in the prices of nonfuel commodities relative to those of manufactures. We then investigate the statistical relationship between the movements in the relative prices of nonfuel primary commodities and those in the net barter terms of trade of developing countries at the aggregate, regional, and country levels. We also look at the evidence on the long-term movements in the purchasing power of total primary commodity exports (and in the income terms of trade of developing countries after World War II) to put in perspective the question of the gains from trade accruing to developing countries that depend on nonfuel primary commodities. We finally examine the various possible effects of growth on the relative prices of primary commodities. In this context, we review the theoretical and empirical validity of the classical economists' argument on the long-run movements in the "real prices" of primary products.

I. Existing and New Evidence on Long-Term Commodity Price Movements

There are several indexes of nonfuel commodity prices, but only the *Economist* Index (EI) and the W. A. Lewis Index (WALI1) cover a sufficient amount of time to be useful in analyzing commodity price movements in the long run (Lewis 1952; and *The Economist* 1974).[1] Both indexes, however, suffer from considerable drawbacks. The commodity coverage of the EI has been revised several times in its long history, and its weights reflect the relative values of commodities in the import trade of industrial countries. The WALI1 stops in 1938 and, instead of international market quotations, is based on export unit values of selected countries. The EI, moreover, does not include fuel prices, whereas the WALI1 does.

The available empirical evidence on long-term movements in the prices of manufactured goods is also limited. There is an index prepared by W. A. Lewis (WALI2) that goes back to 1870, but it has two gaps, which roughly correspond to the two world wars (Lewis 1952). Another index, constructed by Maizels (AMI), covers about the same period as the WALI2, but it is reported only as averages of selected subperiods (Maizels 1970). There is, finally, the possibility of constructing yet another index from U.N. sources (Manufacturing Unit Values, United Nations; MUVUN) covering the period after 1900, but there are two gaps in this index for 1914–20 and 1939–47 (United Nations 1969, 1974). All these indexes are based on unit values of exports for a selected number of industrial countries.

Confronted with the alternative of recomputing the EI on a different weight system and with uniform commodity coverage over time or of computing a new index of nonfuel commodity prices, we chose the second and built a U.S. dollar index of prices of twenty-four internationally traded nonfuel commodities, beginning in 1900 (figure 1). The basic version of this new index (Grilli-Yang Commodity Price Index; GYCPI) is base-weighted, with 1977–79 values of world exports of each commodity used as weights.[2] It therefore reflects the movements over time of the international prices of a given basket of primary commodities. We computed three additional versions of this index. The first two (GYCPI′ and GYCPI″) differ from the basic version in the weighting systems used to construct them, whereas the third (GYCPI′ ′ ′) is also different in commodity coverage, as fuels are included in the sample (Grilli and Yang 1987).

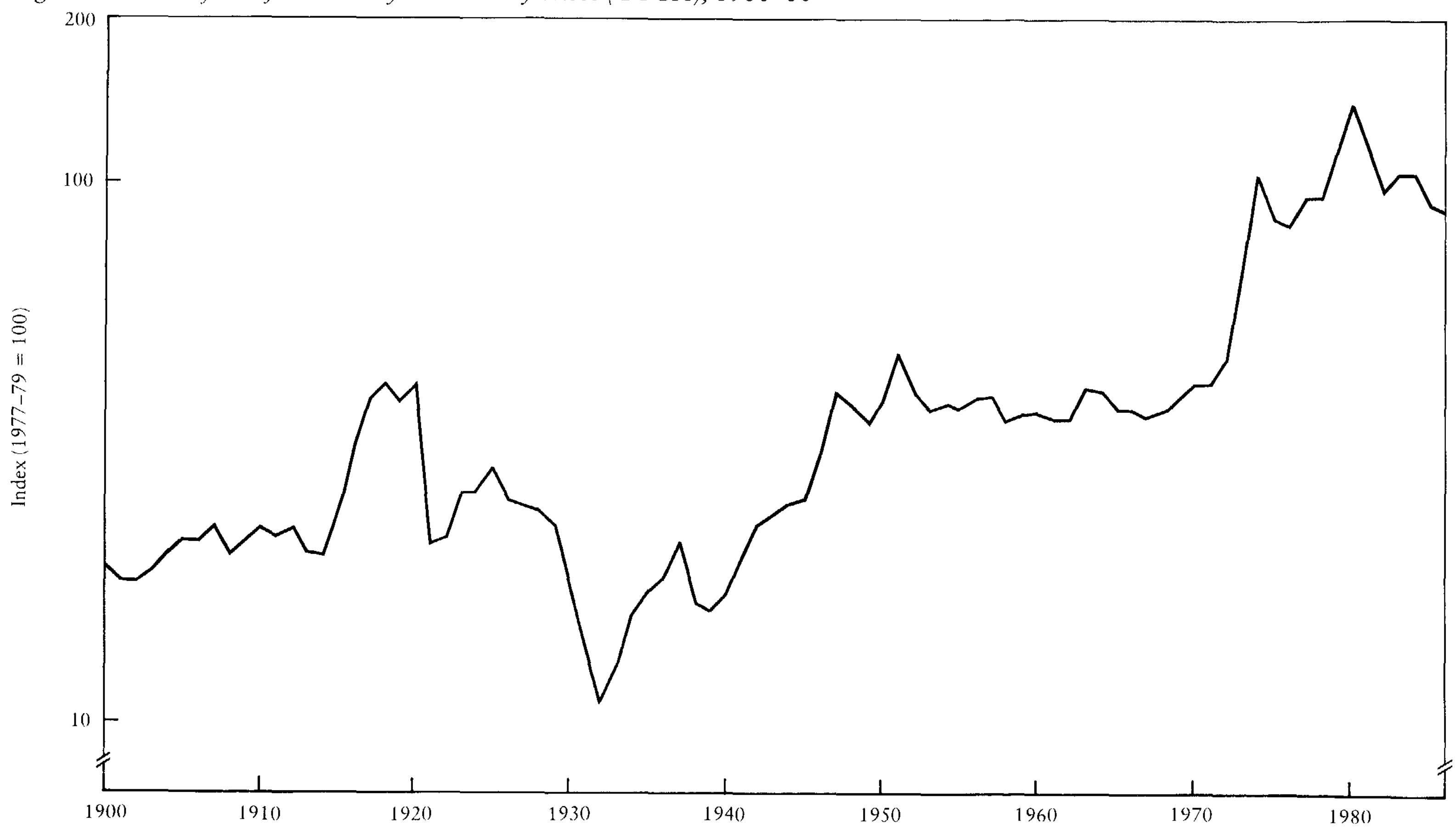
Given the impossibility of computing a new price index of manufactures going back to 1900, we opted for a modified version of the MUVUN, constructed by filling its two gaps by interpolation, using export and import unit values of manufactured goods of the United States and the United Kingdom as indicators.[3] The modified U.N. index (MUV) reflects the unit values of exports of

1. The *Economist* Index begins in 1860 and is regularly updated and reported by the compiler. See, for example, *The Economist,* March 2, 1964, and September 6, 1973. The W. A. Lewis Index of commodity prices starts in 1870 and goes up to 1938. It is largely based on price data reported by Schlote (1938), complemented by data from the League of Nations (1945). A more complete analysis of these indexes is in Grilli and Yang (1987).

2. This new index covers the prices of 54 percent of all nonfuel commodities traded in the world in 1977–79 (49 percent of all food products, 83 percent of all nonfood agricultural products, and 45 percent of all metals). The GYCPI and its components are shown in appendix I.

3. For the years 1915 to 1920, the interpolation was made by first regressing the MUV index (in percentage terms) on the index of export and import unit values of manufactures of the United States and

Figure 1. *Index of Nonfuel Primary Commodity Prices (GYCPI), 1900–86*



Source: Appendix I.

manufactures of a number of industrial countries. It has variable weights that reflect the relative importance of the various types of manufactures in international trade. These were updated every five to seven years until 1938 and changed again in 1959, 1963, 1970, 1975, and 1980 (United Nations 1969, 1972, 1976, 1982, and 1987).

In addition to this index of unit values of manufactures exported by industrial countries, we derived an index of domestic prices of manufactured products in the United States (United States Manufacturing Price Index; USMPI) by netting out energy, timber, and metal prices from the U.S. wholesale price index of industrial commodities (USMPIO) to eliminate overlap with goods in primary commodities indexes and rescaling it (Grilli and Yang 1987). This index is also useful as a reference, for it gives an idea of the relationship between prices and unit values of exports that existed over time and of the reasonableness of the results obtained from the interpolation procedure used to fill the gaps in the MUVUN. These two indexes of manufactured goods "prices" show a very close trend growth from 1900 to 1986 equal to 2.49 percent a year for the MUV and 2.48 percent a year for the USMPI (figure 2).[4] The MUV, however, is slightly more erratic than the USMPI. Its average percentage deviation from trend over the 1900–86 period is 6.2 percent, whereas that of the USMPI is 5.1 percent.

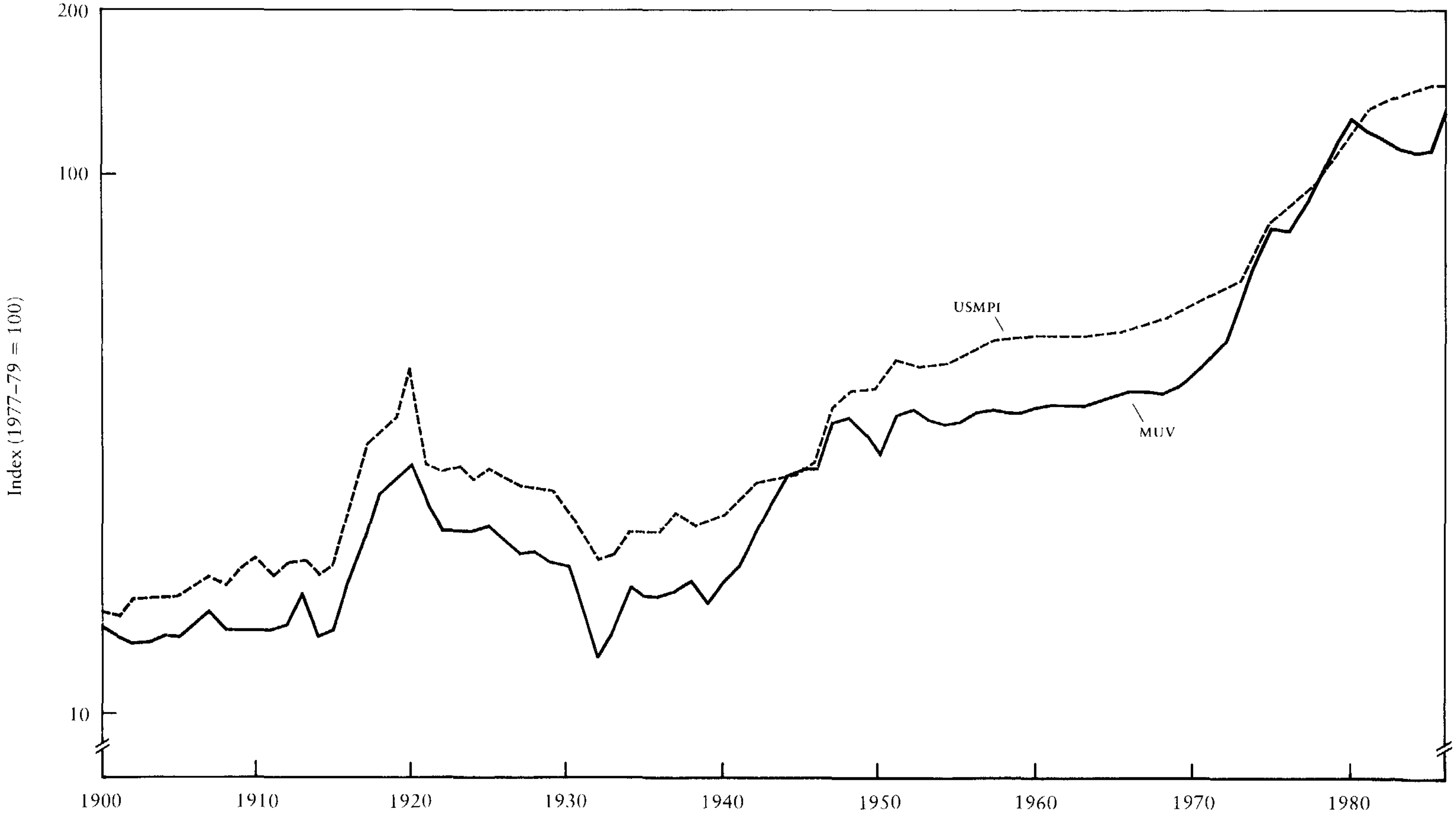
The USMPI and MUV were used to compute two sets of relative prices (or "real" prices) of nonfuel primary products from 1900 to 1986. Measuring, for example, the long-term movements in the relative prices of nonfuel commodities in terms of a wholesale price index or in terms of an index of unit values of trade of manufactures obviously carries different meanings. The first set of relative prices (GYCPI/USMPI) measures the evolution of the purchasing power of nonfuel primary commodities in terms of a basket of tradable goods valued at domestic prices.

In open economies, wholesale price trends should reflect rather closely those of the international prices of the same products. This should be even more so when the time period under consideration is long enough to accommodate possible short-run deviations in the movements of tradable versus nontraded goods prices. Yet, how far one can rely on the law of one price through time is still an open question, given the obstacles to free trade in manufactures that have existed (and still exist) and the possibility that producers of manufactures facing different market conditions domestically and abroad can successfully and persistently employ price discrimination across markets. In our use of the USMPI, the degree of openness of the U.S. economy could also be considered insufficient to

the United Kingdom (in percentage terms) obtained by averaging the subindexes and then by extrapolating the values of the MUV index on the basis of the estimated equation. For the years 1939 to 1947, the interpolation was made using the same procedure, but the MUV was regressed only against the index of import and export unit values of manufactures of the United States.

4. These are semilog trends, corrected for serial correlations using a maximum-likelihood procedure. Both are statistically significant at the 5 percent confidence level or above.

Figure 2. *Indexes of Manufactured Goods Prices (MUV and USMPI), 1900–86*



Source: Appendix I.

warrant the use of U.S. tradable goods prices as proxies for internationally traded goods prices. In making this choice we have "traded off" in favor of an index (USMPI) with a coverage of manufactured goods prices which could be carefully checked and sufficiently narrowed to allow a clear differentiation between the two baskets of goods of which the relative prices were to be measured (nonfuel primary commodities and manufactures). This would not have been possible if we had chosen instead the U.K. wholesale price index because of the greater openness of the U.K. economy.

The second set of relative prices (GYCPI/MUV) measures the evolution of the purchasing power of a basket of nonfuel primary commodities in terms of traded manufactures, valued at "international prices." This type of measurement raises questions about the representativeness of trade unit values as proxies for international prices. In addition, the meaning of the time movements of the ratio of primary commodities and manufactures prices is clouded by the fact that technical progress may have differential effects on the price trends of the two types of goods.

The basic issues are quite familiar. They have to do with the appropriate construction of trade unit values, and how to adequately account for the introduction of new items in the basket of traded manufactures and the "upward bias" carried by manufactured good prices or unit values whenever they incorporate the effects of technical progress that significantly improves their quality (Viner 1953; Baldwin 1955, 1966; Meier 1958, 1963; Morgan 1959; Kravis and Lipsey 1974, 1981). In comparing primary commodities and manufactured goods prices over time, the measurement risks are those implicit in the nonhomogeneity of the two sets of prices and of the two baskets of goods of which the prices are measured. These issues deserve attention, and we will return to them in the last section of this article.

Finally, neither set of relative prices that we have calculated can be taken as an adequate proxy of the net barter terms of trade of developing countries (Px/Pm), because the total price index of exports of developing countries (Px) contains more than primary commodities and the total price index of imports of developing countries (Pm) contains more than manufactures. In addition, the trend shown by any index of the net barter terms of trade should not be taken, in itself, as an adequate indicator of the real income effects of trade over time. A negative trend would not automatically mean that real income has also fallen in time. The sign of the income effect would in fact depend not only on the reasons for the decline in the net barter terms of trade, but also on what happened to the purchasing power of total exports. The latter, moreover, should not be mistaken for the purchasing power of a given basket of exports. To reflect the real income effects of trade, one has to account simultaneously for the movements in the relative prices of exports and for the quantity of exports. The income terms of trade ($Px\ Qx/Pm$) is a measure of this type that reflects the purchasing power of total exports in terms of imports.

II. Long-Term Trends in the Relative Prices of Nonfuel Primary Commodities: The Main Aggregates

Since 1900 nonfuel commodity prices seem to have declined substantially relative to those of manufactured goods sold in the United States, as well as to those of manufactured goods exported by industrial countries. The GYCPI/USMPI series shows a negative exponential trend of 0.57 percent a year over the 1900–86 period. The GYCPI/MUV series shows a trend decline of 0.59 percent a year over the same period (table 1).

Reweighting the GYCPI (still on a 1977–79 basis) to account specifically for the importance of developing countries in world trade of nonfuel primary commodities yields a new index (GYCPI′) that does not differ significantly from the original one. The weights in GYCPI′ are the value share of developing countries' exports of each commodity, instead of the value shares of world exports of each commodity. The purchasing power of the basket of nonfuel primary commodities exported by developing countries measured by the GYCPI′ /MUV appears to have fallen on trend by 0.67 percent a year since 1900. If the GYCPI′ /USMPI is taken as a measure, the trend decline is 0.66 percent a year.

A further check on the tracking stability of our original index was conducted by recomputing it using as weights the value shares of commodities in world

Table 1. *Aggregate Trends in the Relative Prices of Primary Commodities, 1900–86*

Relative price index		*Intercept* ($\hat{\alpha}$)	*Coefficient of time* ($\hat{\beta}$)	*Regression statistics*[a] R^2	*SEE*	*F*	*DW*
ln GYCPI/MUV	=	4.9810*	−0.00589*	0.82	0.11	394.9	1.74
		(67.7)	(−4.11)				
ln GYCPI/USMPI	=	4.7554*	−0.00567*	0.81	0.10	359.1	1.38
		(41.9)	(−2.60)				
ln GYCPI′ /MUV	=	4.9650*	−0.00669*	0.77	0.13	282.2	1.94
		(46.6)	(−3.23)				
ln GYCPI′ /USMPI	=	4.7526*	−0.00665*	0.75	0.12	253.9	1.61
		(31.2)	(−2.29)				
ln GYCPI″/MUV	=	5.1249*	−0.00669*	0.80	0.12	332.3	1.71
		(65.4)	(−4.38)				
ln GYCPI″/USMPI	=	4.8889*	−0.00629*	0.79	0.11	314.7	1.39
		(44.4)	(−2.96)				
ln GYCPI‴/MUV	=	5.0057*	−0.00518*	0.74	0.13	242.6	1.52
		(48.4)	(−2.58)				
ln GYCPI‴/USMPI	=	4.7821	−0.00501*	0.74	0.12	236.6	1.25
		(32.3)	(−1.77)				

t values in parentheses.

* = significant at the 10 percent confidence level or above.

Note: The estimated model is $\ln GYCPI_t = \alpha + \beta t_t + u_t$, where t_t is a time trend. All time series are trend-stationary; ordinary least squares (OLS) estimates are based on annual data. A maximum-likelihood procedure was used to correct for serial correlation.

a. SEE = standard error of the estimate. DW = Durbin-Watson statistic.

trade in 1913, 1929, 1937, 1959, 1963, 1970, 1975, and 1980. These different weights closely reproduce those of MUV. Using this new index (GYPCI″) based on given-year weights, one finds that the purchasing power of nonfuel primary commodities in terms of manufactures declined since 1900 at an annual rate of 0.63 percent to 0.67 percent depending on whether the USMPI or MUV is used as a measure of manufactured goods prices.

Finally, if one includes fuel prices in the index of primary commodities (GYCPI′′′), using the same variable weights as in the GYCPI″ to account for the considerable changes that have intervened over time in the relative importance of fuels in world trade, the rate of decline in the prices of *all* primary commodities relative to those of manufactures (GYCPI′′′/MUV) becomes 0.52 percent a year. The inclusion of coal and oil prices in the basket of primary commodities for which prices are tracked over time does not change the sign of the trend shown by this index relative to that of unit values of manufactures. The relative prices of *all* primary commodities appear to have fallen on trend since 1900 at only a slightly less rapid rate than those of nonfuel commodities.

The trend rate of decline in GYCPI′′′/MUV is closer in absolute value to that of the W. A. Lewis indexes (WALI1/WALI2) for 1871–1938 (0.46 percent a year) than to that implicit in the Prebisch data for 1876–1938 (0.95 percent a year). The original U.N. series, which covers prices of "other goods" (including fuels) in addition to the prices of manufactures, shows in turn a trend rate of decline in the relative prices of these other goods (0.73 percent a year) that falls between that of the GYCPI′′′/MUV and the Prebisch index (W. A. Lewis 1952; Prebisch 1950; and United Nations 1969). Our results therefore strongly support the inference made by Spraos (1980) about Prebisch's original data: the price series he used exaggerated the adversity of the trends in the relative prices of all primary products. Yet our data indicate, from the beginning of the present century to date, a cumulative trend fall of about 40 percent in the market prices of nonfuel primary commodities relative to those of manufactured products and a cumulative trend decline of about 36 percent in the market prices of all primary commodities.[5]

A question that naturally arises is whether the exponential time trends that we computed can be considered acceptable measures of the underlying long-term trends. There is no rigorous answer to this question. Yet at least three sets of issues need to be addressed. The first regards the specification of the time regression model that we used, and the statistical acceptability of the estimates derived from it; the second pertains to the stability over time of the estimated time trend coefficients; the third has to do with the "legitimacy" of the starting point.

As shown by Nelson and Kang (1983), the use of time as an independent variable in regression models is not appropriate when the dependent variable

5. The cumulative decline for the various relative price indexes for 1900–86 are: GYCPI/MUV, 39.8 percent; GYCPI/USMPI, 38.7 percent; GYCPI′/MUV, 43.9 percent; GYCPI′/USMPI, 43.6 percent; GYCPI″/MUV, 43.4 percent; and GYCPI‴/MUV, 35.6 percent.

follows a difference-stationary process (DSP). Conversely, it is appropriate when the dependent series follows a trend-stationary process (TSP). We used a test suggested by Dickey and Fuller (1979) to verify the trend stationarity of our relative price series and found them belonging to a TSP. The (semilog) time regression model that we used thus is correctly specified in all cases and the standard tests can be performed to judge the statistical significance of the estimated time coefficients.

First-order serial correlation, however, was to be consistently present in all the estimated time regressions. It would be expected in the price series under review, insofar as they reflect the influence of random factors (such as the two world wars, several local wars, periods of droughts affecting agricultural prices) spread over several years. We corrected for it using a maximum-likelihood procedure. The time coefficients of the regression models in their corrected version (shown in table 1) maintain statistical significance, whereas the standard error of the estimate (SEE), the *F*, and Durbin-Watson (DW) statistics of the regressions improve substantially with respect to the results obtained from the regressions uncorrected for serial correlation.

The second set of issues that remains to be dealt with pertains to the validity of the assumption of continuous and constant trend growth implicit in the exponential time models that we estimated. The possibility that the negative growth path shown, for example, by the GYCPI/MUV or by GYCPI'''/MUV may not have remained constant over time cannot be ruled out by simply looking at the statistical significance of its ordinary least-squares (OLS) estimates.

Examination of the residuals of the semilog time regressions, as well as a priori knowledge of the exogenous factors that may have caused a structural break in the price series, indicated the possibility of breaks at three points in time: 1921, 1932, and 1945, three of the troughs shown by the series. Various tests were performed to check on the stability of the estimated time coefficients of the GYCPI/MUV and GYCPI'''/MUV regressions.

First we tested for shifts in the slope and the intercept of the estimated time trends using a dummy variable procedure suggested by Gujarati (1970a, 1970b). Then we tested for the possibility of a change in slope, assuming no discontinuity in the time trend, by using the piecewise regression procedure suggested by Suits, Mason and Chan (1978) to estimate the time trend of the GYCPI/MUV and GYCPI'''/MUV. The models used and the results obtained are shown in appendix II. The main conclusion from this analysis is that no clear break seems to have occurred since 1900 in negative trends shown by the indexes of the relative prices of either nonfuel or all primary commodities.

The third set of issues has to do with the "legitimacy" of the starting point (the year 1900) of our estimated long-term trends. The cyclical instability in commodity prices is significantly greater in the first forty years covered by our series than in the subsequent ones. World War I and the great economic depression of the early 1930s seem to have generated such strong cycles in commodity prices that fitting a trend to these prices beginning in 1900 may lead to results that are largely dependent on starting points.

Given the nature of the problem, the usual empirical rule that is applicable is to extend the data sample backward. This option was precluded to us, for the range of price data necessary to do so is not available. A check on the trend of individual price series that go beyond 1900 would seem to indicate that, with very few exceptions, our starting year was quite appropriate. Yet we conducted a further check by comparing the estimated price trends of the GYCPI/MUV and GYCPI′′′/MUV with those of the two available commodity price indexes that go beyond 1900: the EI and WALI1, deflated by a common index of manufactured goods prices—the WALI2 (figure 3).

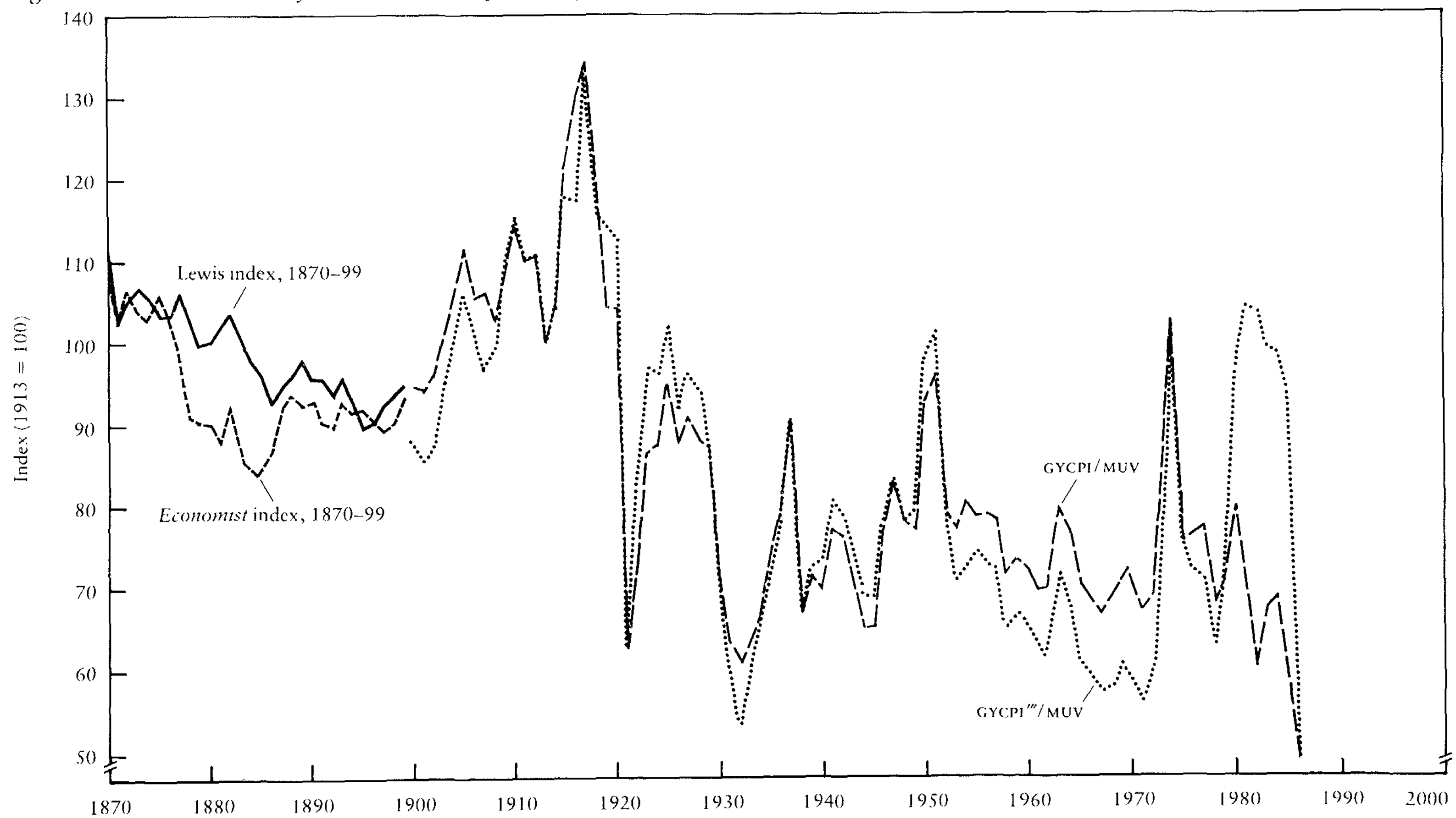
This double comparison is necessary because the GYCPI and EI do not include the prices of fuels, whereas the GYCPI′′′ and WALI1 include them. Over the 1870–1900 period, the annual trend of EI/WALI2 is 0.48 percent, whereas that of WALI1/WALI2 is 0.52 percent. These trends compare quite closely with those respectively shown by GYCPI/MUV (0.59 percent) and GYCPI′′′/MUV (0.51 percent) over the 1900–86 period. Although not conclusive per se, these comparisons of price tendencies before and after 1900 tend to support the notion that the trends in the prices of primary commodities relative to those of manufactured products that we computed after 1900 should not have been much affected by their starting years.

III. Long-Term Trends in the Relative Prices of the Principal Nonfuel Commodity Groups

Taking advantage of the possibility of breaking the GYCPI into its three main components (food prices—GYCPIF, nonfood agricultural raw material prices—GYCPINF, and metal prices—GYCPIM), we computed the trends in the prices of these subcategories of nonfuel commodities relative to those of manufactures. Our results show that over the 1900–86 period the decline in relative prices of nonfuel commodities was not uniform across commodity groups (table 2). Metal and nonfood agricultural product prices (relative to MUV) show a much stronger long-term trend rate of decline than agricultural food prices (0.82 percent and 0.84 percent respectively, versus 0.36 percent a year). Thus, not all producers of nonfuel primary commodities experienced the same falling trend in the purchasing power of a given volume of their products over the past eighty-six years. The export product mix has made some significant difference (figures 4–7).

But there are further significant differences. The negative trend in the GYCPIF/MUV is the composite of a strong positive trend (0.63 percent a year) in the relative price index of tropical beverages (GYCPIBEV/MUV, comprising coffee, cocoa, and tea), and of a negative trend of similar magnitude (0.54 percent a year) in the relative price index of agricultural food products strictly defined (GYCPIOF/MUV) (table 2). The relatively larger weight of other food in the aggregate index (GYCPIF) swamps the effect of secularly rising prices of tropical beverages (especially coffee and cocoa) relative to those of manufactured products. Among all the subcategories of nonfuel commodities, tropical beverages are the only one showing rising relative prices over time. This contrasts rather clearly

Figure 3. *Linked Indexes of Relative Prices of Primary Commodities, 1870–1986*



Sources: Lewis (1952); *Economist* (1974); Grilli and Yang (1987).

Table 2. *Trends in the Relative Prices of the Principal Nonfuel Primary Commodity Subgroups, 1900–86*

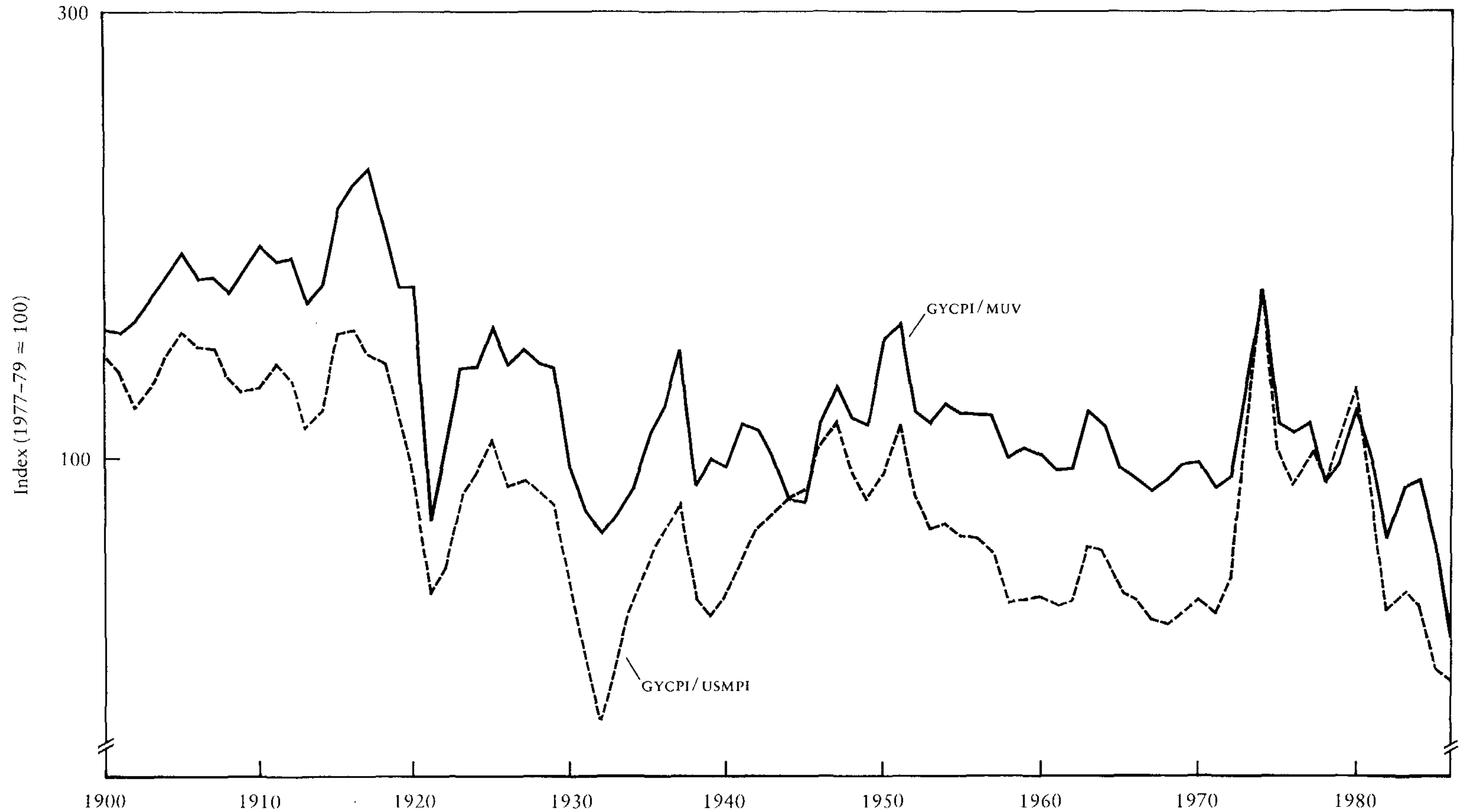
Relative price index	Intercept ($\hat{\alpha}$)	Coefficient of time ($\hat{\beta}$)	Regression statistics			
			R^2	SEE	F	DW
Food:						
ln GYCPIF/MUV	4.8328* (57.5)	−0.00357* (−2.17)	0.72	0.13	215.5	1.73
Nonfood agricultural:						
ln GYCPINF/MUV	5.1259* (55.9)	−0.00817* (−4.57)	0.78	0.12	306.3	1.74
Metals:						
ln GYCPIM/MUV	5.1214* (34.7)	−0.00841* (−2.98)	0.77	0.12	286.2	1.52
Food:						
ln GYCPIF/USMPI	4.5973* (39.7)	−0.00320 (−1.43)	0.72	0.13	214.8	1.46
Nonfood agricultural:						
ln GYCPINF/USMPI	4.8933* (38.2)	−0.00777* (−3.15)	0.77	0.12	276.7	1.56
Metals:						
ln GYCPIM/USMPI	4.9129* (28.4)	−0.00820* (−2.50)	0.76	0.12	264.6	1.49
Tropical beverages:						
ln GYCPIBEV/MUV	3.7192* (26.20)	0.00630* (2.29)	0.50	0.17	84.8	1.75
Nonbeverage Foods:						
ln GYCPIOF/MUV	5.0642* (53.08)	−0.00543* (−2.92)	0.70	0.15	198.2	1.63
Cereals:						
ln GYCPICE/MUV	5.2782* (56.33)	−0.00683* (−3.74)	0.71	0.15	193.8	1.64
Tropical beverages:						
ln GYCPIBEV/USMPI	3.4880* (21.83)	0.00678* (2.20)	0.51	0.17	84.5	1.74
Nonbeverage foods:						
ln GYCPIOF/USMPI	4.8280* (38.58)	−0.00506* (−2.09)	0.70	0.14	194.1	1.38
Cereals:						
ln GYCPICE/USMPI	5.0320* (45.23)	−0.00620* (−2.87)	0.69	0.15	186.5	1.46

t values in parentheses.

* = significant at the 10 percent confidence level or above.

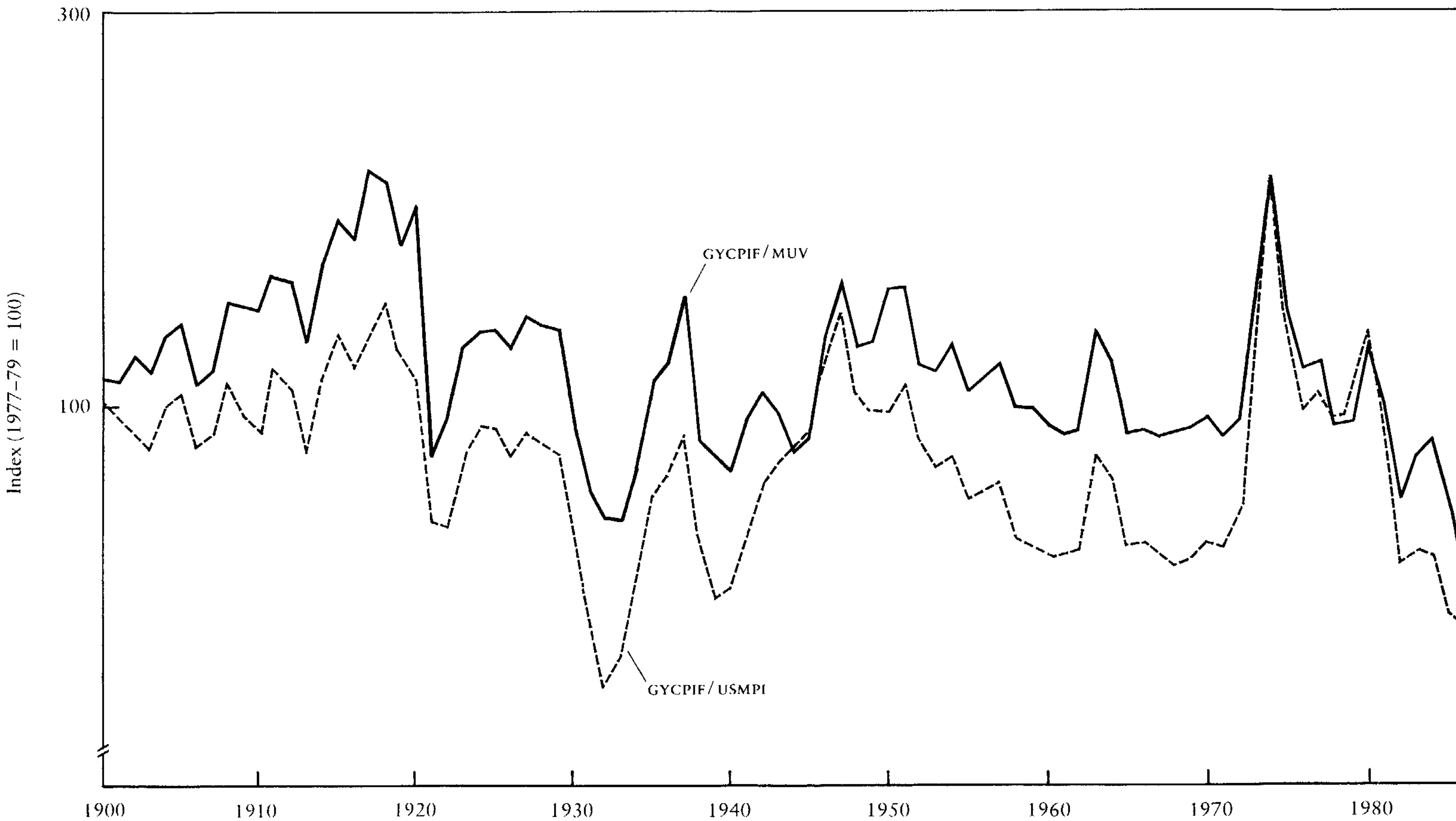
Note: The estimated model is ln $\text{GYCPI}_t = \alpha + \beta t_t + u_i$, where t_t is a time trend. All time series are trend-stationary; OLS estimates are based on annual data. A maximum-likelihood procedure was used to correct for serial correlation.

Figure 4. *Indexes of Relative Prices of Nonfuel Primary Commodities, 1900–86*



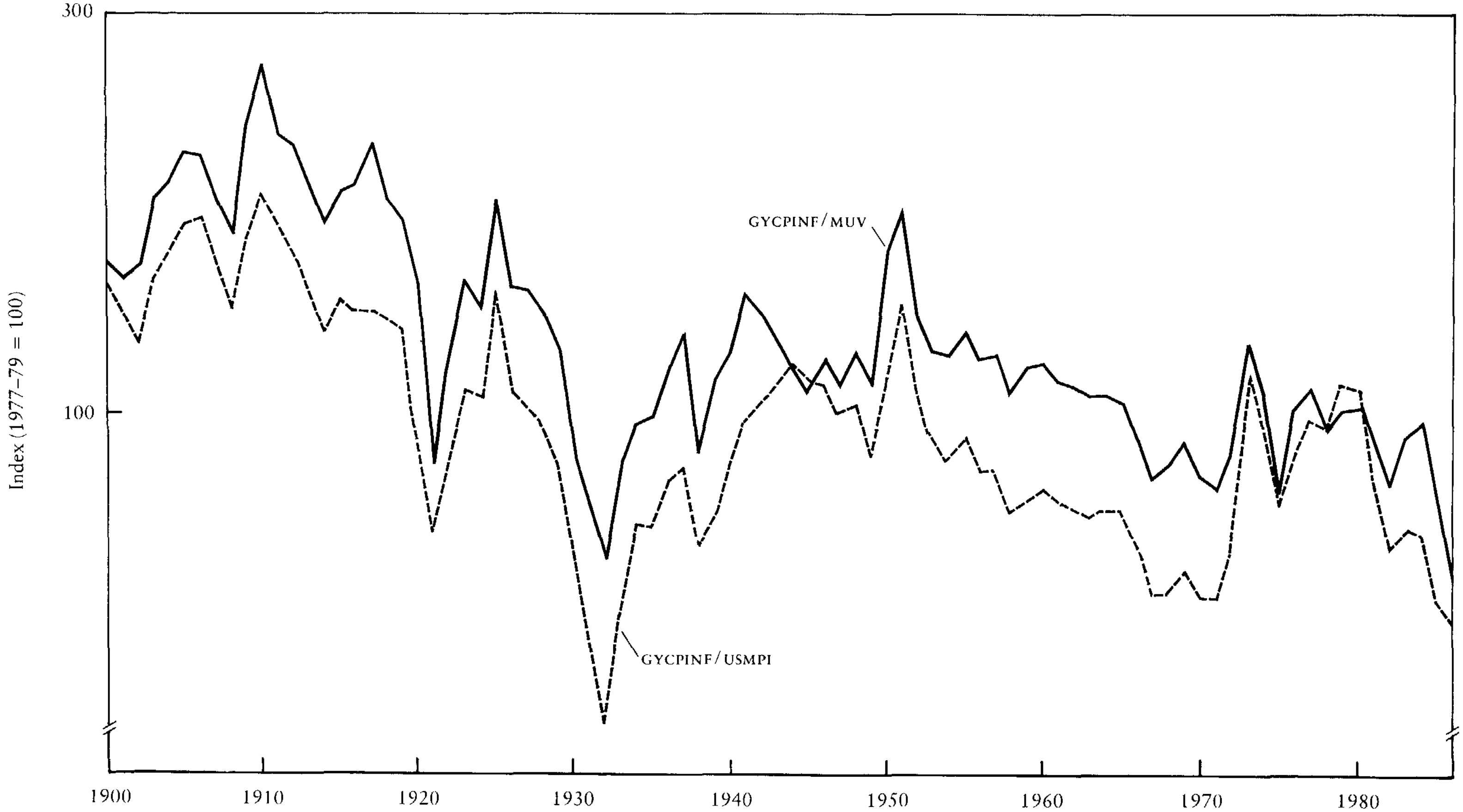
Source: Appendix I.

Figure 5. *Indexes of Relative Prices of Food Commodities, 1900–86*



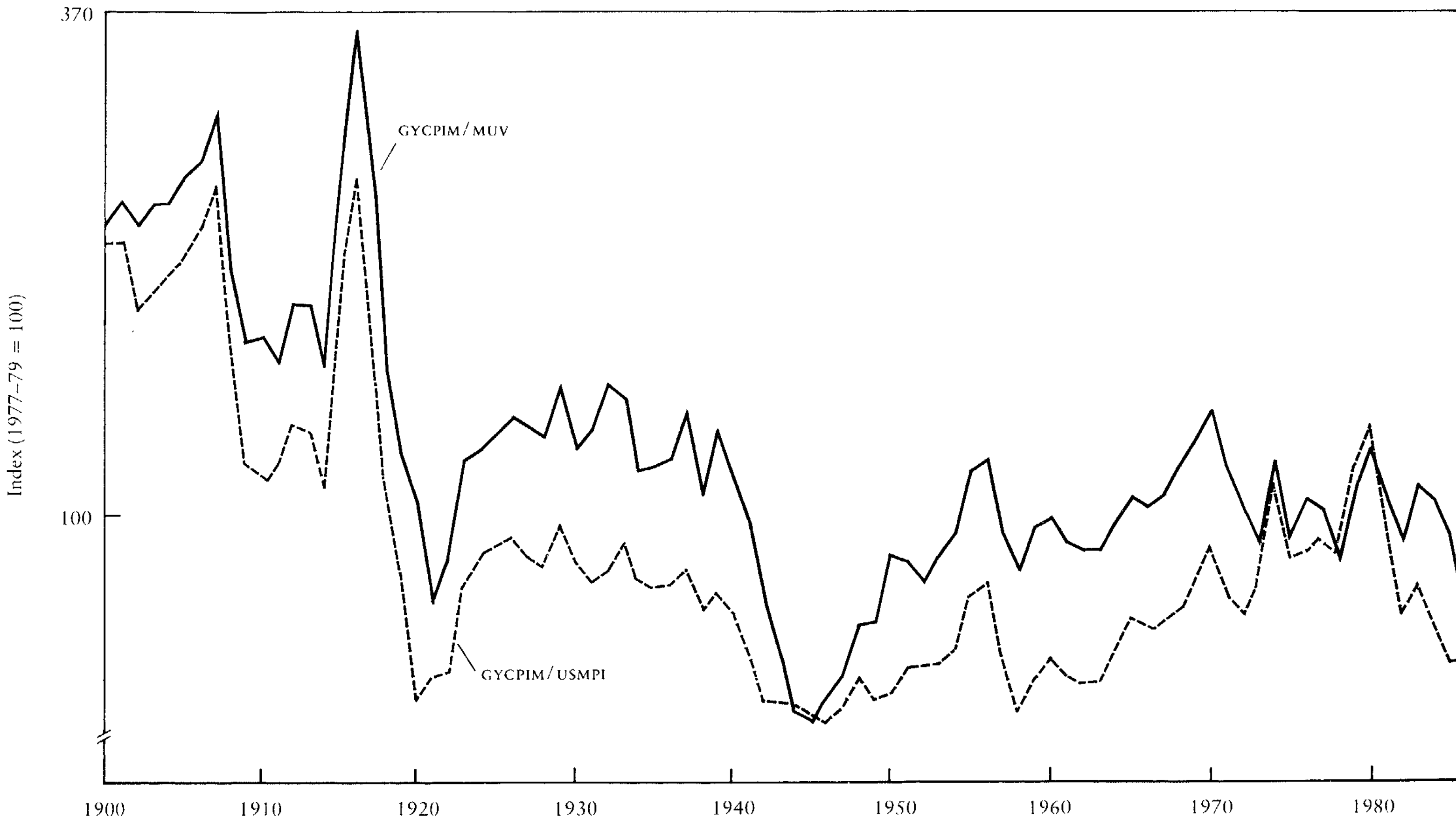
Source: Appendix I.

Figure 6. *Indexes of Relative Prices of Nonfood Agricultural Commodities, 1900–86*



Source: Appendix I.

Figure 7. *Indexes of Relative Prices of Metals, 1900–86*



Source: Appendix I.

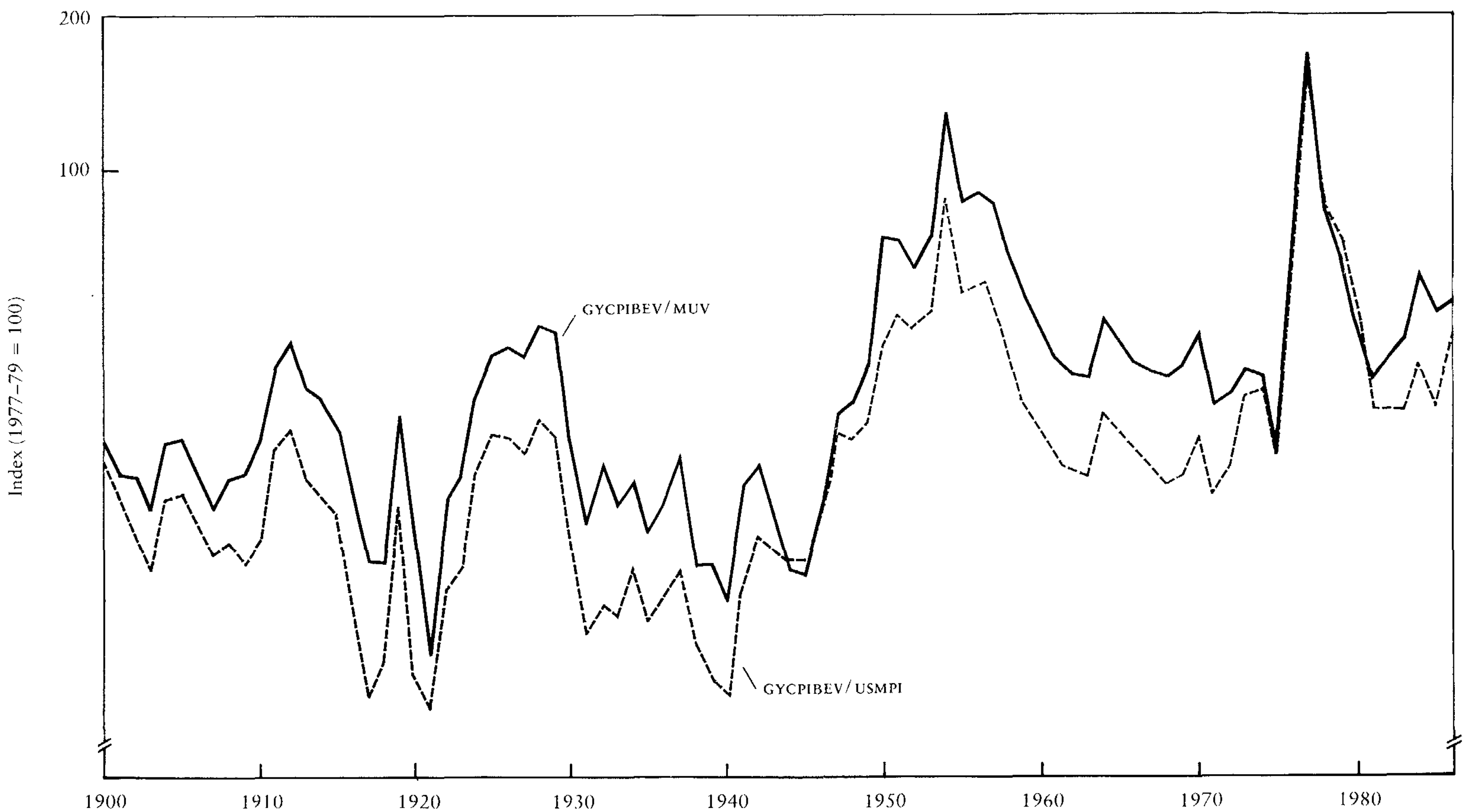
with the behavior of the relative price index of cereals (GYCPICE/MUV, comprising wheat, maize, and rice), which exhibits a long-term falling trend (table 2 and figures 8–10). To gauge the economic significance of these relative price trends, it should be recalled that developing countries are the sole exporters of tropical beverages but are large net importers of most other foods, particularly cereals. Therefore, in drawing inferences between the trends in the purchasing power of commodities and the net barter terms of trade of developing countries, considerable care must be exercised, even when commodity prices are broken down into various subgroups and examined at a fairly high level of disaggregation.

Unlike food prices, whose trends have to be interpreted with great care, nonfood agricultural commodity prices appear to have fallen strongly and steadily relative to internationally traded manufactures. Developing countries are large net exporters of these commodities. Since 1900, the purchasing power of these products in terms of manufactures has fallen on trend by more than 50 percent. The rather devastating effect of synthetic product substitution on the prices of nonfood agricultural raw materials also becomes evident if one looks at the trend over the 1953–86 period (figure 6). It was in the mid-1950s that petroleum-based synthetic products began to exercise strong downward pressure on natural rubber and natural fiber prices (cotton, jute, wool). This pressure continued throughout the 1960s, and contrary to widely held expectations, the two oil shocks of the 1970s do not seem to have significantly modified the falling trend in the prices of nonfood agricultural commodities relative to those of manufactures.

The negative trend present in the relative prices of metals from 1900 to 1986, however, is not uniform over time. A clear break in the price trend occurs in the early 1940s (figure 7). Developing countries are large net exporters of minerals and metals, even though these commodities are also exported in large amounts by resource-rich industrial countries, such as Australia, Canada, and the United States. From 1900 to about 1941, the GYCPIM/MUV shows a strong negative trend (1.7 percent a year). Between 1942 and 1986 the trend turns positive (0.5 percent a year). The rising trend of the GYCPIM/MUV after 1941 was even stronger until the early 1970s. During a period of more than thirty years, metal producers seem to have been able to capture, in terms of realized prices, a good deal of the benefits deriving from the productivity gains that were achieved. And these have been considerable, at both the extraction and refinery stages (Kendrick 1961).

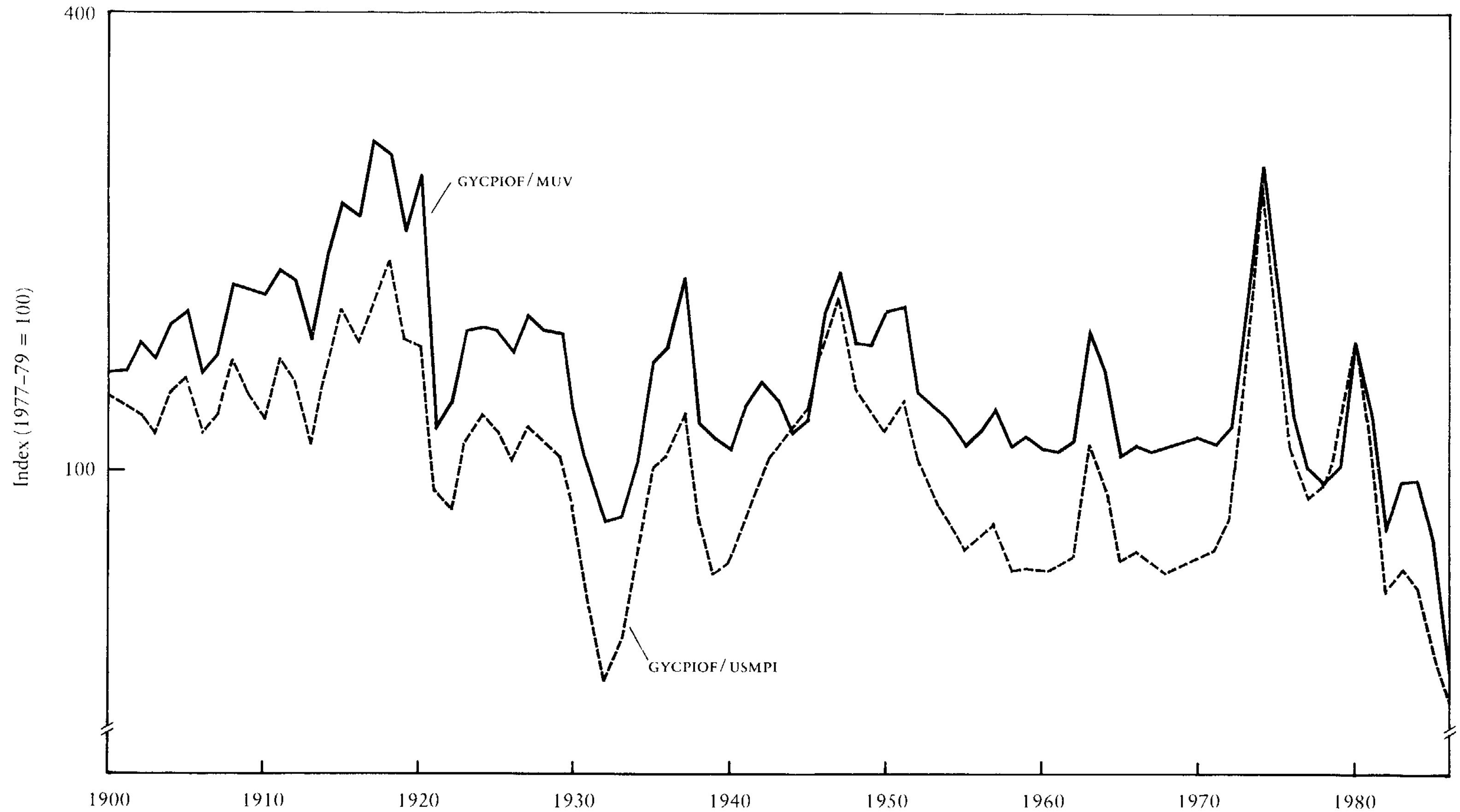
Seen against the rise in productivity realized in the past half-century, this increase in the "real" prices of metals implies rather clearly the existence of effective forms of market control by producers. The market power of the few multinational corporations that long dominated the production, smelting, and primary processing of many metals seems to have been brought to bear quite effectively. However, the weakening in the role played by multinational corporations in the production of metals relative to that of newly formed national companies that has occurred since the late 1960s may have already changed, at least in part, this historical pattern.

Figure 8. *Indexes of Relative Prices of Beverages, 1900–86*



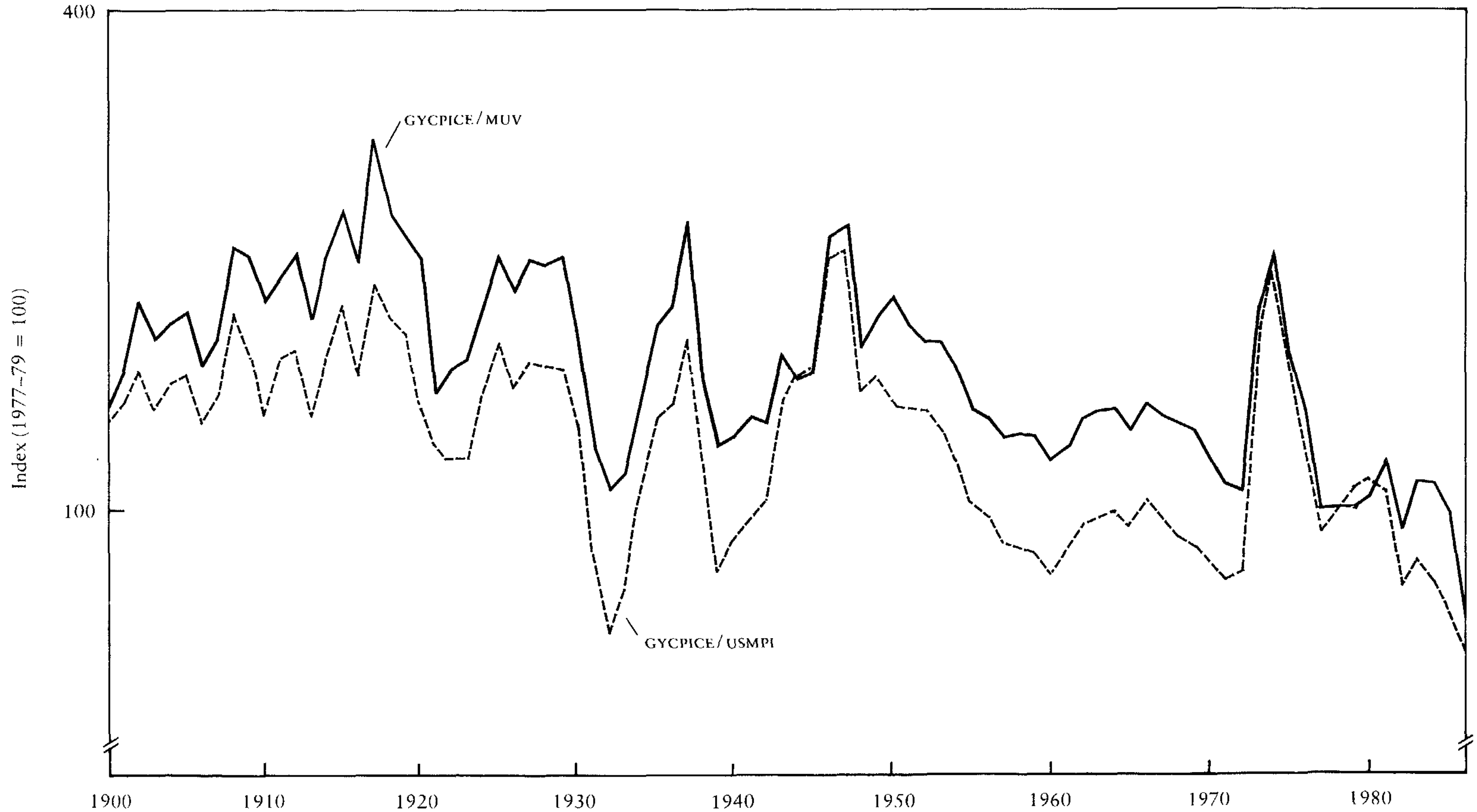
Source: Grilli and Yang (1987).

Figure 9. *Indexes of Relative Prices of Food Products (Excluding Beverages), 1900–86*



Source: Grilli and Yang (1987).

Figure 10. *Indexes of Relative Prices of Cereals, 1900–86*



Source: Grilli and Yang (1987).

The expansion in the number of independent producers (often state-owned companies in developing countries) has in itself complicated the global supply management problem.[6] The divergent productive strategies often pursued at the national level have further increased the difficulties faced by producers in keeping an effective hold on the market. What probably used to be a game quietly and effectively played by a few decisionmakers has now become a semipublic international political affair. The case of copper is highly representative of this trend. The weakening in the real prices of metal that has become evident in the mid and late 1970s is in part the reflection of this reduced ability of metal suppliers to influence the markets.

IV. Commodity Prices and Terms of Trade of Developing Countries

As previously indicated, the trend decline in the relative prices of primary commodities that seems to have occurred from 1900 to 1986 cannot be taken without qualification as a proxy for the evolution of net barter terms of trade of developing countries during the same period. This is the case, quite apart from the possibility that the decline in either the GYCPI/MUV or the GYCPI''' /MUV may be overstated, given that some of the increase in the MUV may be caused by new manufactured products entering international trade or by improvements in the quality of existing ones. Developing countries, aside from exporting primary commodities and importing manufactures, have traditionally also exported manufactures and imported primary commodities. Moreover, the share of manufactures in the exports of developing countries has increased substantially over the years, going from an estimated 3.7 percent in 1899 to 21.1 percent in 1979 (Grilli 1982).

Statistical evidence relative to the post–World War II period shows, for instance, that the net barter terms of trade of non-oil-exporting developing countries are positively related to the ratio of prices of nonfuel commodities and manufactures (GYCPI/MUV) and are negatively related to the ratio of prices of oil and manufactures (OILP/MUV). The net barter terms of trade of non-oil-exporting developing countries improve on average when nonoil commodity prices rise, relative to manufactured good prices, and worsen when oil prices go up relative to those of manufactures, but the partial elasticity of the net barter terms of trade with respect to the GYCPI/MUV is only a fraction of one. The estimated relationships for various periods after 1950 are shown in table 3.

On the basis of the results obtained for the aggregate of developing countries from 1953 to 1983, the only period for which data on developing countries' terms of trade are available, the observed 40 percent decline in the relative prices of their nonfuel primary commodities since the turn of the century would imply,

6. Supply diffusion was helped by the breaking up of vertical integration in the industry after the first oil shock of 1973 and by the "security of supply" policies followed by large industrial countries. Japan, for example, encouraged through government finance the entry of new quasi-independent suppliers of metals in developing countries. We are indebted to Kenji Takeuchi for bringing this point to our attention.

Table 3. *Commodity Prices and Terms of Trade of Non-Oil-Exporting Developing Countries: Regression Results*

Group of countries, continent, or country	Constant term ($\hat{\alpha}$)	Coefficient: GYCPI/MUV ($\hat{\beta}$)	Coefficient: OILP/MUV ($\hat{\gamma}$)	Regression statistics: R^2	SEE	DW	Rho	Years
TOT: all non-oil-exporting	3.6301*	0.2786*	0.0890*	0.82	0.036	1.45	0.73	1953–83
	(10.4)	(3.55)	(−4.05)					
	3.5382*	0.3125*	0.1009*	0.82	0.039	1.60	0.63	1965–83
	(8.63)	(3.37)	(−4.22)					
TOT: Africa	3.0006*	0.4033*	0.0957*	0.88	0.046	1.62	0.91	1955–83
	(7.03)	(3.98)	(−2.41)					
	2.7077*	0.5472*	0.1569*	0.87	0.047	1.42	0.54	1965–83
	(4.46)	(3.98)	(−5.19)					
TOT: Southeast Asia[a]	2.4243*	0.5691*	0.1599*	0.92	0.061	1.84	0.80	1955–83
	(4.11)	(4.27)	(−3.80)					
	3.7206*	0.3409*	0.1400*	0.88	0.035	1.73	0.38	1965–83
	(7.27)	(3.02)	(−6.92)					
TOT: Latin America[b]	3.4199*	0.3681*	0.1764*	0.85	0.056	1.11	0.89	1965–83
	(6.11)	(2.72)	(−2.22)					
TOT: Korea	5.8968*	0.1807*	0.1354*	0.96	0.026	1.90	0.36	1965–83
	(21.3)	(−2.98)	(−12.7)					
TOT: Yugoslavia	5.2472*	0.1224*	0.0243*	0.79	0.015	1.77	—	1965–83
	(34.8)	(−3.49)	(−5.36)					
TOT: India[c]	5.1586*	0.0863	−0.1851*	0.80	0.056	1.49	0.48	1953–80
	(7.76)	(0.56)	(−6.04)					

t values in parentheses.

* = significant at the 10 percent confidence level or above.

— Uncorrected.

Note: The estimated model is $\text{TOT}_i = \alpha + \beta\,(\text{GYCPI}/\text{MUV})_i + \gamma\,(\text{OILP}/\text{MUV})_t + u_t$, where TOT_i = terms of trade of country(ies)/continent; $\text{GYCPI}/\text{MUV}_i$ = prices of nonfuel commodities relative to those of manufactures; and OILP/MUV_t = prices of oil relative to those of manufactures. OLS estimates are based on annual data; Cochrane-Orcutt serial correlation correction is used throughout. Equations are estimated in the levels of logarithms of all the variables. Country definitions and TOT data are from IMF *International Financial Statistics* and *Supplements on Trade and Prices*. "Korea" refers to the Republic of Korea.

a. Southeast Asia includes Malaysia, Philippines, Sri Lanka, and Thailand (recomputation of regional TOT index follows IMF weighting procedures).

b. Latin America includes Central America as well as South America. Data on TOT for Latin America are available only from the early 1960s onward and cover uniformly only a selected number of countries. No regression starting from the 1950s could be estimated as in the case of Africa, Southeast Asia, and all non-oil-exporting developing countries. A dummy variable for the 1976–77 coffee boom years was used in the regression. It has the right sign, and it is statistically significant.

c. India TOT data are available only to 1980. A dummy variable for the 1977 boom in tea prices was used in the regression. It has the right sign, and it is statistically significant.

other things being equal, a cumulative decline in non-oil-exporting developing countries' terms of trade of about 11 percent. Yet although there is no a priori reason to think that the set of statistical relationships bearing on the determination of net barter terms of trade of developing countries may have differed between the pre– and the post–World War II periods, the relative importance of the individual components of these movements has probably changed over time in a manner which suggests that these results may understate the extent of the decline in the terms of trade over the earlier period. The post–World War II period did witness the sharpest increase in the relative importance of manufactured products in the total exports and of oil in the total imports of non-oil-exporting developing countries. In previous years, when dependence on nonfuel primary commodity exports and manufactured product imports was more pronounced, the nexus between net barter terms of trade and nonfuel commodity prices might have been stronger (that is, the value of $\hat{\beta}$ for all non-oil-exporting developing countries in table 3 might have been higher than 0.28). Over the entire 1900–86 period the cumulative decline in non-oil-exporting developing countries net barter terms of trade corresponding to a 40 percent decline in the GYCPI/MUV may therefore have been greater than 11 percent, but in any case a fraction of the measured cumulative trend decline in GYCPI/MUV.

If we restrict our attention to the 1953–83 period, our analysis shows that non-oil-exporting commodity price changes remained an important influence on the net barter terms of trade of African and Southeast Asian countries, but were less important in the case of Latin American countries (table 3). Moreover, although the relative importance of nonoil commodity prices seems to have increased in recent years in the case of Africa, the opposite seems to have occurred for Southeast Asia. For Southeast Asian countries, which succeeded in diversifying their exports into manufactures, changes in nonfuel commodity prices are becoming a less important determinant of their net barter terms of trade movements. For African countries, increasingly dependent on traditional commodity exports, the movement is in the opposite direction.

At the country level, the relationship between nonfuel commodity prices and net barter terms of trade is even more diversified. Not only does the intensity of the (positive) relationship between these two variables differ, but its sign is reversed in some cases. For natural-resource-poor countries that have become principal exporters of manufactures, such as the Republic of Korea and Yugoslavia, a decline in the relative prices of nonfuel primary commodities tends to improve their net barter terms of trade. These countries behave now like industrial countries. India, conversely, constitutes an interesting intermediate situation: changes in nonfuel primary commodity prices relative to those of manufactures do not seem to affect significantly net barter terms of trade in one direction or another. Oil prices, however, are shown to be negatively related to net barter terms of trade changes in a consistent and significant way across the spectrum of non-oil-exporting developing regions and countries.

This analysis of the links between nonfuel commodity prices and net barter terms of trade of non-oil-exporting developing countries in the post–World War II period shows how difficult it is to draw valid conclusions over time and across countries, even from seemingly solid aggregate relationships. The inference remains possible that those developing countries that have continued to export primarily nonfuel commodities and import mostly manufactured products may have faced secularly worsening net barter terms of trade; but this needs to be qualified in both extent and significance.

Although the extent of the terms of trade loss suffered by any developing country or group of countries is largely an empirical question, the economic significance of any such loss is a more complex issue. If there exists an aggregate positive relationship between net barter terms of trade changes and profitability in commodity production, and between profitability in the commodity sector and investments, a secular deterioration in the relative prices of primary products may have had the consequence of holding down the growth potential of these countries via lower investment rates. Such a secular deterioration may also have led to distorted investment patterns, wherever resource mobility was constrained by lack of alternatives or by domestic price policies that did not reflect market forces.

The link between worsening net barter terms of trade and worsening sector profitability depends critically on factor productivity. It is only when reduction in the input of factors per unit of output does not fully compensate for the decline in relative output prices, and the returns to the factors employed in the primary commodity-producing sectors may diminish over time, that overall output growth is limited by lower profitability and underinvestment. The existence of such circumstances, however, is a factual question which is not only time- and country-specific but also probably specific to various export subsectors within the same country.

Even for those developing countries whose commodity and net barter terms of trade may have shown a secularly deteriorating trend, the conclusion that trade has been harming their growth should not be drawn solely on the basis of this type of evidence. Country- and sector-specific information is needed to measure the possible compensating effects of productivity growth in agriculture and mining. Even in the presence of deteriorating commodity terms of trade and net barter terms of trade, single factoral terms of trade may have moved in the opposite direction. At the global level—that is at the level at which our analysis of relative prices has been conducted—no strong evidence exists on secular factor productivity trends in the agriculture and mining sectors of non-oil-exporting developing countries. The growth-constraining effects of deteriorating commodity and net barter terms of trade, via production, for those developing countries that mainly export nonfuel primary products and mainly import manufactures thus remain indeterminate.

The reduction in real income (or purchasing power) evidenced by falling commodity and net barter terms of trade may also have constrained the growth possibilities of non-oil-exporting developing countries, and especially of those that have remained most dependent on nonfuel commodity exports, given that their capacity to import capital goods and other essential inputs was thereby reduced. Here, too, caution must be exercised in drawing conclusions from price evidence alone. The total real income effect of trade, under less than full employment conditions, depends on export quantities as well as on relative export prices. Under these conditions, a fall in purchasing power occurs only if the growth of export volumes is not enough to offset the decline in relative prices.

The evidence on the size of the real income effects of trade on developing countries is much stronger than evidence on the production effects. Both direct and indirect indicators point to a positive real income effect over time. The purchasing power of exports of all primary commodities in terms of manufactures increased at a trend rate of 4.5 percent a year from 1900 to 1913. Between 1921 and 1938 its growth was much smaller (0.4 percent a year), but still positive, notwithstanding the unfavorable trend of relative prices, which declined at 1.2 percent a year. In the period between 1955 and 1983 growth resumed strongly, with a trend rate of 4.2 percent a year. The purchasing power of developing countries' exports of nonfuel primary commodities also rose in the post–World War II period—at 2.8 percent a year between 1955 and 1983—as export volumes grew strongly (3.2 percent a year) in the face of a mild decline in relative prices (−0.4 percent a year). If oil is included in the sample, growth of purchasing power of commodity exports becomes even stronger (United Nations 1969; UNCTAD 1972, 1976, 1983, 1984; IMF 1982, 1985).

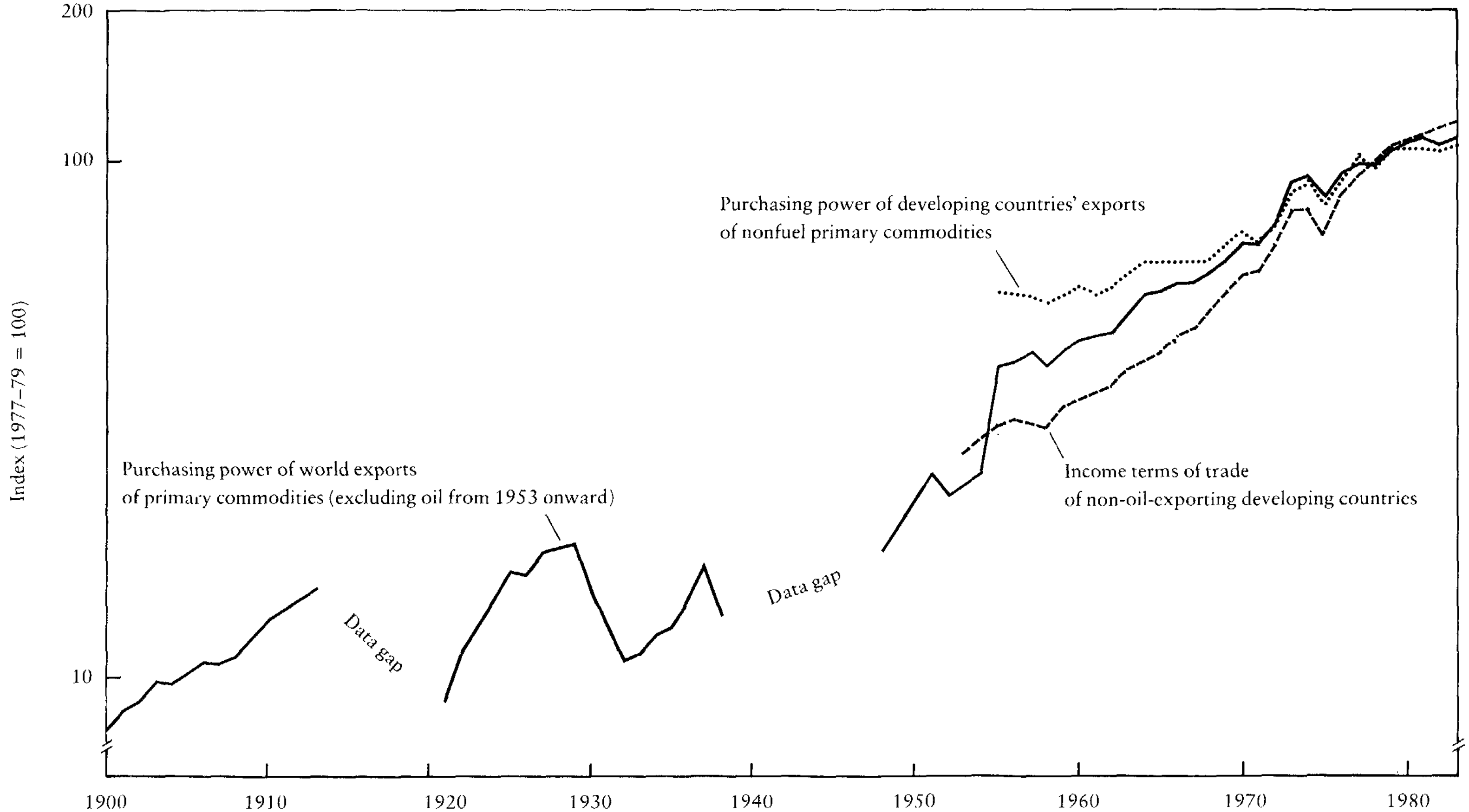
The direct evidence on the behavior of the income terms of trade of non-oil-exporting developing countries is even more persuasive from the early 1950s onward (Wilson, Sinha and Castree 1969). More recent data show that these improved on trend by 5.3 percent a year between 1953 to 1983, a period during which the net barter terms of trade of developing countries declined at about 0.6 percent a year, but overall export quantities rose at almost 6 percent a year. These trends are represented in figure 11, which shows the long-run tendency of the purchasing power of exports of primary products to grow in terms of manufactures.

In the presence of a strong improvement in the purchasing power of commodity exports and in the income terms of trade of non-oil-exporting developing countries, the negative welfare significance of falling relative prices of nonfuel primary commodities should not be overstated. Nor does there appear to be any strong reason to infer from available evidence either that trade per se or trade in nonfuel primary products has in the aggregate been harmful to countries specializing in their production. Obviously, immiserizing growth might have occurred in specific commodities or in specific periods, but its existence cannot be assumed. It must instead be proven and possibly explained in terms of the balance between autonomous factor supply growth (and/or technical progress), market structures, and government price and investment policies affecting output in the export sector. More important, one has to keep in mind that gains from trade are dynamic, far reaching in their effects, and cumulative over time. They go well beyond the direct production and real income effects of terms of trade changes.

V. The Effect of Growth on Relative Primary Commodity Prices: Did Classical Economists Go Wrong?

The observed decline in the prices of nonfuel primary commodities relative to those of manufactures appears to contradict the tightly held belief of classical

Figure 11. *Purchasing Power of Primary Commodity Exports and Income Terms of Trade of Developing Countries, 1900–83*



Source: United Nations (1969 and 1974); UNCTAD (1972, 1976, 1983, and 1984); IMF (1982, 1985).

economists that the expected outcome had to be in the opposite direction. Diminishing returns in primary commodity production and growing population, viewed against the effects of increasing specialization and technological progress in manufacturing, led these economists to expect a falling tendency in the prices of manufactures relative to those of raw materials (Ricardo 1817; Torrens 1821; Mill 1848).

The validity of the position of the classical economists not only remained virtually unquestioned throughout the nineteenth century but was reaffirmed in the current century by modern economists such as Keynes. Constant returns to scale in industry and decreasing returns in agriculture, along with population growth, Keynes argued, would have caused in the long run a decline in the relative prices of manufactured products and thus of the net barter terms of trade of the European countries (Keynes 1912, 1920). This is a conclusion that neoclassical trade theorists would find hard to accept without a precise specification of the shape of the production functions, in a situation where the greater capital intensity of manufacturing production relative to that of agricultural production is normally assumed to exist. It is only by postulating a relatively faster growth of capital (and not labor) in the manufacturing exporting sector, and by assuming away technical progress, that the presumption of deteriorating terms of trade of Europe could have been built on neoclassical grounds.

Yet notwithstanding the apparent theoretical shakiness of the classical economists' case, the Ricardian tradition on terms of trade developments was not seriously challenged until quite recently, with orthodox neoclassical economists not only sitting more or less on the sidelines, but alternating in their judgments on the very importance of the concept of terms of trade.[7] Prebisch and Singer independently—if almost simultaneously and much along the same lines—provided the economic rationale for the counterthesis that terms of trade were bound to deteriorate for developing countries exporting primary commodities and importing manufactured products from industrial countries. Though couched in seemingly unconventional terms, the original Prebisch-Singer counterargument in its essence is based on orthodox economic concepts. If productivity growth systematically shifts the supply curve for primary commodities to the right more than that for manufactured products, and income growth systematically shifts the demand curve for manufactures to the right more than that for primary commodities, the relative price of primary commodities in terms of manufactured goods will tend to decline over time (and to the extent that developing countries export primary products and import manufactures, their net barter terms of trade will tend to fall).

Cast in these terms, the original Prebisch-Singer conclusion on terms of trade between primary commodities and manufactures seems inescapable. Because the

7. Viner (1937) and Kindleberger (1956), among others, have stressed the importance of terms of trade changes, whereas economists such as Graham (1948) have not hesitated to call the terms of trade an irrelevant concept.

point on the higher income elasticity of demand for manufactured products is hardly debatable, what remains to be explained is why productivity growth has a different impact on the supply schedule of primary commodities with respect to that of manufactures. Prebisch and Singer assume competitive market structure in the case of primary commodities and oligopolistic market structure in the case of manufactures (Prebisch 1950; Singer 1950). This assumption is used to explain why the distribution of productivity gains between primary commodity producers and producers of manufactures is uneven (manufacturers would reap the benefits of the gains in terms of rising returns to factors of production, while primary commodity producers would pass it on to consumers in the form of falling prices). However, the device of resorting to the notion of different market structures and referring to the differential effects of productivity under oligopoly, although plausible on the surface, breaks down when one considers that productivity growth can hardly be taken as given and is probably in itself a function of the market form.

If the options for innovation are positively related to the size of the firm, which is much larger under oligopolistic market conditions than under competitive conditions, the rate of technical progress would tend to be greater under oligopolistic (or monopolist) market conditions than under free competition (Sylos-Labini 1956). If this is the case, and there is considerable empirical evidence that shows at least that firm concentration and productivity growth are positively related (Greer and Rhoades 1976; Scherer 1984), then the simple comparative static conclusions regarding prices and output under monopolistic or oligopolistic market conditions, as compared to competitive conditions, are no longer applicable. Output growth would also tend to expand faster under the push of technical progress in noncompetitive markets, a point that had not escaped Schumpeter (Schumpeter 1942).

Pending a more comprehensive analysis of the actual effects of growth on the terms of trade, it is incorrect to suggest that our empirical results on long-term relative price trends of nonfuel primary commodities simply validate the original Prebisch-Singer thesis (with which they appear to be compatible) and invalidate the classical conclusion (with which they appear to be incompatible). Other explanations of the empirical results that we obtained can be found outside both the classical and the original Prebisch-Singer models.

Within the neoclassical model of trade, if growth occurs in the export sector of developing countries and is the consequence of growth in factor endowments (say labor, producing labor-intensive goods), supplies of exports will rise and, other things being equal, developing countries' terms of trade will worsen. The size of the terms of trade effect will depend on elasticity conditions. If growth in exports occurs as a consequence of technical progress in the export sector, the effects will be similar.

Outside the neoclassical framework, one can find models of relations among unequal trading partners that would lead to the conclusions that developing countries' terms of trade are bound to decline (Emmanuel 1969; Amin 1973).

Singer himself has recently come close to this unorthodox tradition of unequal development, which strongly emphasizes the importance of the asymmetry that exists between different types of countries, instead of (or together with) the differences between various types of commodities (Singer 1975).

Methodological, as well as theoretical, explanations can also be put forward to explain the outcome of falling terms of trade. Exponential trends, such as those that we estimated to examine the basic tendencies shown by the relative prices of nonfuel primary commodities, are not always appropriate to depict an underlying reality that is changing significantly over time. An example of this can be found in the trend in the relative prices of metals in the 1900–86 period, which shows a clear primary tendency to fall, but a secondary tendency in the opposite direction. If one computes a parabolic (or log-parabolic) trend for the GYCPIM/MUV, the second term of the fitted parabola is found to be positive and statistically significant, whereas the first term is negative and statistically significant (table 4).[8] The explanatory power of the log-parabolic time model is also superior to that of the exponential model. No other subgroup of nonfuel commodity prices shows significant parabolic or log-parabolic trends over the period.

Such a time profile of the relative prices of nonrenewable resources such as metals can be thought of as the result of two sets of forces affecting their long-run costs of production: on the one hand, technological improvements make it possible to lower directly the unit costs of production of these commodities (for example, new mining and smelting techniques) or to augment the possibilities of producing them (for example, access to new lands and new ore deposits); on the other, limitations are imposed by the finiteness of available physical resources and the effects of decreasing returns (beyond a certain point). The impact of the first set of forces, which has so far been dominant and has tended to push down the real prices of metals, may have been progressively offset by the impact of the second set of forces, the net effect of which is in the opposite direction. Classical economists may have underestimated the extent and possibly the effects of emerging technical progress, and thus misjudged the "length of the long-run," but may still be on the right track in terms of the direction of expected changes in the relative prices of many primary commodities in the longer term.

VI. Statistical Limits of the Present Relative Price Estimates

The question that arises at this point is how reliable are the aggregate price indexes that were used here to measure long-term commodity and manufactured price movements. We have little doubt about the representativeness of the non-

8. Slade (1982) found evidence of a parabolic time pattern of prices at the level of single metals. She showed that this pattern is consistent with a model of long-run price determination where price equals marginal extraction costs and the rate of change of price is equal to that of marginal cost because of changes in technology, plus the discount rate times the rent.

Table 4. *Quadratic Trends in the Relative Prices of the Principal Nonfuel Primary Commodity Subgroups, 1900–86*

Relative price index	*Intercept* ($\hat{\alpha}$)	*Linear coefficient of time* ($\hat{\beta}_1$)	*Quadratic coefficient of time* ($\hat{\beta}_2$)	*Regression statistics* R^2	*SEE*	*F*	*DW*
Tropical beverages:							
GYCPIBEV/MUV	42.859*	0.21190	0.00187	0.08	11.73	3.6	1.80
	(3.59)	(0.34)	(0.27)				
Nonbeverage foods:							
GYCPIOF/MUV	149.67*	−0.11903	−0.00601	0.14	20.67	6.8	1.80
	(8.23)	(−0.12)	(−0.57)				
Nonfood agricultural:							
GYCPINF/MUV	173.71*	−1.4919*	0.00540	0.31	15.73	18.9	1.74
	(10.60)	(−1.74)	(0.57)				
Metals:							
GYCPIM/MUV	208.25*	−3.7843*	0.03035*	0.39	18.96	27.27	1.43
	(12.31)	(−4.26)	(3.11)				
Tropical beverages:							
ln GYCPIBEV/MUV	3.7854*	0.00151	0.00005	0.50	0.17	42.30	1.75
	(19.12)	(0.15)	(0.48)				
Nonbeverage foods:							
ln GYCPIOF/MUV	4.9667*	0.00145	−0.00008	0.70	0.15	99.53	1.65
	(35.90)	(0.20)	(−0.98)				
Nonfood agricultural:							
ln GYCPINF/MUV	5.1384*	−0.00905	0.00001	0.79	0.13	152.21	1.73
	(40.03)	(−1.34)	(0.14)				
Metals:							
ln GYCPIM/MUV	5.3570*	−0.02609*	0.00020*	0.81	0.12	184.07	1.47
	(39.00)	(−3.63)	(2.58)				

t values in parentheses.

* = significant at the 10 percent confidence level or above.

Note: The estimated model is $\ln \text{GYCPI}_t = \alpha_0 + \beta_1 t_i + \beta_2 t_i^2 + u_t$. All time series are trend-stationary, and OLS estimates are based on annual data. A maximum-likelihood procedure was used to correct for serial correlation.

fuel commodities price index that we built. Within the class of index to which it belongs, the tracking behavior of the GYCPI should be more than acceptable, given its coverage, the care taken in choosing representative quotations for each of the twenty-four products included in it, and the results of the various experiments that were conducted to test its sensitivity to different weight schemes. The MUV, on the other hand, is an index of unit values of exports and thus potentially open to more serious questions about its ability to represent market prices.

Although comparison with the USMPI, which represents domestic prices of tradable manufactured products in the United States, seems to confirm the broad representativeness of the MUV as an indicator of long-term trends in manufactured good prices, the appropriateness of the use of the MUV is still open to doubt on account of possible differences between unit values of exports and international market prices. Available empirical evidence on international prices of manufactured goods is still limited. Kravis and Lipsey have built an index of manufactured good prices (KLI) covering the 1953–77 period and the same SITC product categories as are included in the MUV. Compared with the MUV, this new price index shows a much smaller cumulative increase over the period (127 percent as opposed to 153 percent), leading them to conclude that the U.N. unit value index overestimates the growth of prices of internationally traded manufactured goods (Kravis and Lipsey 1981).

The KLI, however, shows a markedly different behavior from that of the MUV only from 1973 onwards. From 1953 to 1972, KLI and MUV movements are remarkably close to one another: their cumulative increase at end points is respectively 41.1 percent and 45.6 percent. It is only in the following five years, characterized by severe monetary and exchange rate turmoil in the world economy and by a major supply shock (1973–74), that the two indexes apparently diverge widely. The KLI shows an increase of 60.7 percent (at end points), whereas the MUV goes up by 73.9 percent.

This strong divergence of the two indexes after 1972 is magnified by several factors. The KLI, apart from its different construction, covers only the prices of manufactures exported by six industrial countries—Canada, the Federal Republic of Germany, Japan, the Netherlands, the United Kingdom, and the United States—whereas the MUV reflects the unit value of exports of five additional countries—Belgium, France, Italy, Sweden, and Switzerland. Of this latter group, the first four are countries that experienced relatively high inflation rates, reflected in part in their faster-than-average growth in the dollar unit values of the manufactures that they exported after 1972.

Moreover, Kravis and Lipsey have complete price information only up to 1975.[9] A strict comparison between the two indexes is thus possible only for the 1973–75 period and should be conducted not on the basis of the overall U.N. MUV index, but of a subindex including the same six countries covered in the KLI. When this is done, one finds that over the 1953 to 1972 period the two indexes show a very similar behavior: the KLI increases by 41.1 percent at end points and the modified MUV by 43.9 percent. Between 1973 and 1975 the KLI increases by 46.1 percent, whereas the modified MUV increases by 59.5 percent. The difference is still large, but we feel that no strong conclusion can be reached on the basis of the behavior of the two indexes over such a short and atypical period of time. The problem of the representativeness of export unit value therefore remains. On the basis of available evidence, it seems that its practical importance may have been exaggerated.

9. Prices for the Netherlands in 1976 and 1977 are missing from KLI, and German prices are not available for 1977 (Kravis and Lipsey 1981, table 2).

The remaining open question regarding our measures of long-term relative price changes has to do with the so-called quality bias, which is potentially worrisome, particularly in the case of manufactured goods. The quality bias has two dimensions. The first has to do with the rate of increase in the number of new manufactured products entering trade, causing changes in the internal composition of the various commodity groups over time. The second has to do with the direct improvement in the quality of the same goods whose prices are measured over time. Even if it were possible to keep unchanged over time the basket of manufactured goods whose prices are to be measured and to deal in this way with the problem of new goods, part of the increase shown by the index would simply represent the effects of improvements in the quality and performance of existing goods.

Some quality improvement of this type should also be reflected in the prices of primary commodities. Our index is based on uniform weights and a single representative market quotation for each product. Quality improvements in commodities such as tea, coffee, rubber, cotton, and vegetable oils did occur over time, even if they are not fully reflected in our index. If quality improvements could be measured by averaging market quotations of various grades and by accounting for the changes in their relative importance, one could presume that such a price index would be positively affected over time by quality improvements. An index of export unit values would also reflect this effect. Yet it can be reasonably assumed that manufactured goods prices reflect more of this upward drift on account of both changes in composition and quality improvement of traded goods. The question that arises is how much more. The empirical evidence on this point is still very scarce.

Kravis and Lipsey have recently constructed an index of U.S. prices of machinery and transport equipment (SITC7) and corrected it for quality improvements, showing that the quality bias accounted for about a quarter of the cumulative price increase over the 1953–76 period (Kravis and Lipsey 1981, table 3). They are inclined to think that a quality bias of such magnitude may be common to the price indexes of SITC7 manufactures exported by the major industrial countries over the same period. We find it hard to accept this assumption, given that for this group of manufactured goods—which includes electrical, electronic, and telecommunication equipment—and for most of the time period covered by this Kravis and Lipsey index, the rate of technological change has probably been faster in the United States than elsewhere.

Whatever may be the merit to this objection to the geographical representativeness of this U.S.-based index, using it to correct for quality improvements across the spectrum of manufactures, as Kravis and Lipsey do, necessitates the acceptance of an even stronger assumption: that the quality improvment factor present in the prices of SITC7 manufactures be considered representative of that of all other categories, from chemical products (SITC5), to manufactured goods classified chiefly by material (SITC6), to miscellaneous manufactures (SITC8). We find that there is no logical or empirical basis for accepting this assumption of equal rate of technological change in such different categories of goods. If anything, one would be prone to assume the opposite, that is, that the quality improvement factor reflected in the prices of SITC7 manufactures may be much larger than that reflected in the prices of SITC5, SITC6, and SITC8 manufactures.

Our conclusion is that the cumulative trend decline shown by the relative price indexes of nonfuel primary commodities that we computed over the 1900–86 period cannot be assumed away simply resorting to either the notion of unit value bias or of quality bias. The available evidence to the contrary is neither totally persuasive nor sufficiently precise to cast overwhelming doubt on it.

VII. Conclusions

Our new series indicate that, relative both to the prices of manufactured goods traded within the United States and to the export unit values of manufactures from industrial countries, nonfuel commodity prices have fallen considerably between 1900 and 1986. A cumulative trend decline of about 40 percent, though possibly magnified by the relatively greater effect of quality improvements on the prices of manufactured products, probably reflects a net fall in the purchasing power of a given basket of nonfuel primary commodities during the past century. No strong evidence of change was found in the negative trend shown over this period by our index of nonfuel commodity prices deflated by the index of unit value of exports of manufactures.

The long-run tendencies in the relative prices of the major subgroups of nonfuel primary commodities, however, are far from uniform. Nonfood agricultural raw materials appear to have sustained the steadiest reduction in purchasing power in terms of manufactured products. Metals, conversely, though showing the strongest overall negative trend in their relative prices over the current century, did experience a precipitous fall until the early 1940s and a strong inversion of that tendency since then. Agricultural food products, considered together, exhibit a substantially smaller trend decline in their relative prices than that of the other two major commodity groups. The trend in the aggregate of food product prices, however, is the result of sharply different within-group tendencies. Beverage prices have increased substantially over time relative to those of manufactures, while those of other food products, including cereals, have declined markedly over the same period.

We also found that the prices of all primary commodities (including fuels) relative to those of traded manufactures declined by about 36 percent over the 1900–86 period, at an average annual rate of 0.5 percent. These results tend to confirm those of Lewis, which were derived using different price information and over a different time period. The results also indicate, however, that the decline in the net barter terms of trade of all primary commodities shown by the data used by Prebisch represents a considerable overstatement of the long-term trend.

The average rate of decline of about 0.6 percent a year in the relative prices of nonfuel commodities that we found over the 1900–86 period does not indicate a similar rate of decline in the net barter terms of trade of non-oil-exporting developing countries. These countries in fact have exported over time increasing amounts of fuel products and manufactures, in addition to nonfuel commodities, and always have imported fuels and nonfuel primary commodities, in addition to manufactures. We found that in the post–World War II period, other things being equal, a decline of 1 percent in the relative prices of nonfuel primary commodities is associated with a 0.28 percent decline in the net barter terms of trade of non-oil-exporting developing countries considered as a whole. It is conceivable that in the earlier part of the century the value of this partial elasticity might have been higher, because of the lower share of manufactures in their exports and of oil in their imports. But to judge even notionally the extent of the effective fall that might have taken place since 1900 one should not forget that: (a) the cumulative trend decline that we observed in our price data may have been somewhat exaggerated by an imperfect account of quality improvements in manufactures, and (b) considerable differences in the relationships between net barter terms of trade and relative prices of nonfuel primary commodities are evident both at the regional and at the country level.

Even greater caution needs to be exercised in drawing conclusions on gains from trade for the developing countries on the basis of export price information alone. Although a deterioration in net barter terms of trade indicates a reduction in real income gains, with respect to a situation of unchanged terms of trade, the actual magnitude of the real income effect over time also depends critically on export quantities. The assumption of constant full employment of resources is not tenable in the analysis of the effects of trade over time. Available evidence indicates that, even if one disregards trade in manufactures and fuels, exports of nonfuel primary commodities by developing countries have grown in terms of volume at appreciably positive rates since 1900. This has given rise to a positive growth in the total purchasing power of nonfuel commodity exports. In the post–World War II period, moreover, available empirical evidence on the income terms of trade of non-oil-exporting developing countries indicates that consistent and substantial gains were obtained by them.

The extent of production effects of falling relative prices of primary commodities is uncertain, given the lack of evidence on long-term factor productivity growth in the agricultural and mining sectors of the developing countries. The presumption, however, is that the negative effects of declining real export prices may have been at least in part mitigated by productivity growth.

There is no comprehensive empirical analysis of the effects of growth on the net barter terms of trade of primary commodities. What can be said about the reasons for this apparent secular deterioration in the relative prices of primary commodities therefore is limited. The simple primary trends that we measured appear to go against the expectations of classical economists regarding the relative price movements of manufactured goods and instead to be consistent with the original Prebisch-Singer counterargument. It is not difficult, however, to show how these empirical findings can be theoretically explained outside both the classical and the original Prebisch-Singer frameworks. Neoclassical analysis of the effects of growth on relative trade prices offers numerous possible alternative explanations, and so does unequal development theory.

Appendix I. Price Indexes of Primary Commodities and Manufactures

Year	*GYCPI*	*GYCPI′*	*GYCPI″*	*GYCPI‴*	*MUV*	*USMPI*	*GYPIF*	*GYPINF*	*GYCPIM*
1900	19.309	20.748	20.391	19.214	14.607	15.382	15.587	21.310	27.778
1901	18.236	18.802	18.765	17.604	13.858	15.169	14.716	19.292	27.522
1902	18.145	17.703	18.772	17.532	13.483	16.180	15.209	19.268	25.518
1903	19.006	19.808	20.543	19.099	13.483	16.340	14.634	22.860	26.668
1904	20.586	21.790	22.220	20.581	13.858	16.393	16.444	24.450	27.526
1905	21.621	23.101	23.765	21.938	13.858	16.499	16.924	26.226	29.150
1906	21.610	23.344	23.877	22.054	14.607	17.032	15.422	27.547	31.726
1907	22.757	23.489	23.793	22.070	15.356	17.883	16.672	25.967	36.699
1908	20.427	20.670	22.570	20.970	14.232	17.245	18.276	22.291	24.245
1909	21.554	23.244	25.506	23.541	14.232	18.575	18.143	28.973	20.822
1910	22.630	26.053	26.618	24.561	14.232	19.373	18.088	32.924	21.026
1911	21.909	24.722	25.328	23.385	14.232	17.830	19.498	28.122	19.923
1912	22.640	24.911	26.023	24.077	14.607	18.948	19.739	28.188	23.176
1913	20.461	21.817	23.443	21.820	14.607	19.161	17.149	25.440	23.134
1914	20.210	20.383	23.579	21.933	13.858	18.130	19.509	22.239	19.291
1915	24.468	23.140	26.851	25.012	14.232	18.594	22.292	24.388	31.321
1916	31.933	29.920	32.753	30.710	17.603	24.105	26.497	30.897	50.327
1917	39.396	33.817	44.339	41.277	20.974	31.419	37.074	40.257	45.271
1918	42.028	36.036	47.002	43.852	25.468	33.943	43.861	42.841	35.121
1919	39.208	34.348	48.802	46.069	26.966	35.334	39.902	43.292	30.853
1920	41.951	40.925	50.275	48.313	28.839	44.141	47.052	39.641	29.684
1921	21.356	18.987	26.111	24.911	24.345	28.689	21.602	21.605	20.219
1922	21.910	20.047	28.973	27.213	21.723	28.020	21.147	24.771	19.919
1923	26.407	26.013	33.632	31.482	21.723	28.638	25.234	29.989	24.587
1924	26.521	24.951	33.292	31.066	21.723	27.350	26.086	28.365	25.066
1925	29.381	28.716	36.139	33.563	22.097	28.123	26.637	36.978	26.315
1926	25.758	24.828	30.987	28.854	20.974	27.402	24.250	28.691	25.962
1927	25.143	23.462	30.585	28.450	19.850	26.355	24.677	26.823	24.028
1928	24.423	21.756	30.216	28.012	19.850	26.327	24.217	25.393	23.585

(*Table continues on the following page.*)

Appendix I. Continued

Year	*GYCPI*	*GYCPI'*	*GYCPI''*	*GYCPI'''*	*MUV*	*USMPI*	*GYPIF*	*GYPINF*	*GYCPIM*
1929	23.266	20.637	26.437	24.516	19.101	25.882	23.098	22.332	25.210
1930	18.277	15.365	19.797	18.570	18.727	23.935	17.838	16.949	21.655
1931	13.610	11.282	13.977	13.240	15.356	21.441	12.675	12.308	18.479
1932	10.797	8.9658	10.685	10.150	12.734	19.156	9.7342	8.9577	16.883
1933	12.591	10.490	13.650	12.893	14.232	19.691	10.833	12.357	18.388
1934	15.763	13.522	17.523	16.513	16.854	21.609	14.522	16.427	18.591
1935	17.294	14.592	18.781	17.631	16.479	21.468	17.465	16.229	18.383
1936	18.418	15.659	20.491	19.213	16.479	21.723	18.369	18.348	18.677
1937	21.361	17.501	24.733	22.798	16.854	23.561	21.988	20.366	20.931
1938	16.552	14.025	18.504	17.389	17.603	22.472	16.105	16.198	18.474
1939	16.019	14.369	18.551	17.324	16.105	22.697	14.267	17.499	19.188
1940	17.237	15.230	20.407	19.100	17.603	23.219	15.063	20.547	18.932
1941	20.093	18.263	23.857	22.337	18.727	24.913	18.288	24.844	18.452
1942	23.073	21.359	27.217	25.403	21.723	27.010	22.419	27.716	18.039
1943	24.283	21.319	29.168	27.193	24.345	27.264	23.905	29.094	18.132
1944	25.243	21.912	30.246	28.222	27.715	27.469	24.816	30.786	18.132
1945	25.832	22.643	31.109	29.021	28.464	27.864	26.186	30.112	18.232
1946	31.232	26.216	36.901	34.182	28.839	30.603	34.314	32.688	19.485
1947	40.389	34.875	45.858	42.408	34.831	37.474	46.952	37.349	24.709
1948	38.722	35.114	44.106	41.895	35.581	40.044	41.107	40.934	27.980
1949	35.845	32.359	41.753	39.009	33.333	39.557	38.930	35.727	26.479
1950	39.263	38.393	47.761	44.316	30.337	40.858	40.130	45.060	27.767
1951	48.093	47.245	58.834	54.094	35.955	45.348	47.929	58.702	32.466
1952	40.508	39.284	46.741	43.925	36.704	44.134	40.623	45.983	31.825
1953	37.897	36.348	42.910	36.998	35.206	44.386	38.289	40.839	32.214
1954	38.565	39.134	43.612	37.620	34.457	44.657	39.738	39.797	33.066
1955	38.233	39.165	44.655	38.450	34.831	45.447	36.107	42.537	38.267
1956	39.895	40.585	45.133	39.075	36.330	47.517	38.747	41.517	40.977
1957	40.108	41.108	45.080	39.227	36.704	49.149	40.525	42.372	35.376

1958	36.231	35.998	40.368	35.226	36.330	49.742	36.235	38.647	32.546
1959	37.113	35.951	42.153	36.144	36.330	50.514	35.926	40.667	35.379
1960	37.327	36.183	42.312	35.965	37.079	50.490	35.305	41.799	36.781
1961	36.466	34.491	40.374	34.605	37.453	50.267	34.917	40.424	35.242
1962	36.486	34.275	40.715	34.888	37.453	50.310	35.377	39.893	34.734
1963	41.419	41.656	46.842	39.787	37.453	50.229	44.723	39.084	34.747
1964	41.046	39.962	45.517	38.659	38.202	50.502	42.774	39.782	37.620
1965	38.119	35.314	40.953	35.063	38.951	50.918	36.429	39.990	40.499
1966	37.935	34.192	40.766	34.879	39.700	51.891	37.325	37.445	40.568
1967	36.846	33.593	39.162	33.585	39.700	52.713	36.830	33.813	41.509
1968	37.431	34.033	39.357	33.605	39.326	53.973	36.718	34.620	43.914
1969	39.761	37.565	42.378	36.046	40.449	55.521	38.322	37.459	47.712
1970	42.201	40.421	43.668	37.161	42.697	57.627	41.381	36.438	53.500
1971	42.324	39.919	43.429	37.397	45.318	59.583	42.051	37.638	50.293
1972	46.625	45.176	50.407	43.318	48.689	61.325	47.037	43.823	49.613
1973	69.472	63.184	76.502	65.043	58.801	63.977	74.123	69.054	55.720
1974	102.41	104.01	111.28	103.46	71.161	74.371	123.33	74.718	79.813
1975	85.156	83.693	91.786	88.288	79.026	83.260	97.598	65.807	76.090
1976	83.110	83.077	85.553	83.775	78.652	87.946	85.707	78.946	81.408
1977	93.125	98.295	92.723	90.871	86.517	92.641	96.064	90.681	87.752
1978	93.627	93.165	93.198	91.662	98.876	99.163	94.159	94.173	91.149
1979	113.25	108.54	114.54	120.82	114.61	108.20	109.78	115.15	121.10
1980	138.83	140.34	155.33	182.10	125.47	119.65	142.99	126.49	144.72
1981	117.94	112.00	128.81	183.92	119.10	130.30	120.38	108.87	124.21
1982	96.784	90.110	100.51	178.32	115.73	135.62	92.364	96.727	110.54
1983	102.78	95.356	107.86	163.00	110.49	138.31	97.566	103.15	118.37
1984	103.54	94.533	104.21	159.30	108.61	142.54	99.686	105.29	112.81
1985	91.268	82.578	92.665	151.62	109.59	144.91	87.022	90.490	105.59
1986	88.358	84.059	90.788	93.759	130.30	144.36	84.013	86.026	105.34

Note: GYCPI, GYCPI′ and GYCPI″ = indexes of prices of nonfuel primary commodities; GYCPI‴ = index of prices of all primary commodities; MUV = index of unit values of exports of manufactures from industrial countries; USMPI = index of wholesale prices of manufactures in the United States; GYCPIF, GYCPINF, GYCPIM = index of prices of food, nonfood agricultural raw materials and metals (sub-indexes of GYCPI).

Source: Grilli and Yang (1987).

Appendix II
Tests on the Stability of the Estimated Time Trend of GYCPI/MUV

Given that both the GYCPI/MUV and the GYCPI'''/MUV price series show three possible common breaks in 1921, 1932, and 1945, we tested first for equality between the estimated coefficients of the regression covering the years before the possible break and those of the regression for the years subsequent to it. To do so we used the dummy variable procedure suggested by Gujarati (1970a, 1970b). This test involves the OLS estimates of the following single regression model:

$$\ln (P_c/P_m)_i = \alpha_0 + \beta_l t_i + \alpha_l D_i + \beta_2 (D_i t_i) + u_i \quad (1)$$

where P_c/P_m is either GYCPI/MUV or GYCPI'''/MUV, t_i is a time trend, and D_i is a dummy variable = 0 up to (but excluding) the year of break, and = 1 in subsequent years.

In this model α_l is the differential intercept coefficient, and β_2 is the differential slope coefficient. The standard statistical significance tests can be performed on their estimated values ($\hat{\alpha}_l$ and $\hat{\beta}_2$) to judge whether the two regressions implicit in this model have a common intercept, a common slope, or both.

The regression results, shown in appendix tables 1 and 3, indicate that there is no strong evidence of parameter shifts, in terms of either slope or intercept, of the estimated trend lines of the GYCPI/MUV and the GYCPI'''/MUV at any of the assumed break points. None of the $\hat{\alpha}_1$ and $\hat{\beta}_2$ parameters is statistically significant at at least the 10 percent level.

After testing for shifts in the slope and intercept of the estimated exponential time trend of the GYCPI/MUV and GYCPI'''/MUV, we tested for the possibility of a change in slope, assuming no discontinuity in the time trends, by using the following piecewise model (Suits, Mason, and Chan 1978):

$$\ln (P_c/P_m) = \alpha_0 + \beta_l t_i + \beta_2 (t_i - t^*) D_i + u_i \quad (2)$$

where t_i is a time trend; D_i is a dummy variable = 1 when $t_i > t^*$, and = 0 when $t_i < t^*$; and t^* is the threshold year.

In this model β_1 gives the slope of the first segment of the regression line, while $(\beta_l + \beta_2)$ gives the slope of the second segment of the regression line. The threshold years are 1921, 1932, and 1945. The hypothesis of no break in the slope of the regression lines at the threshold years can be tested by looking at the statistical significance of $\hat{\beta}_2$.

The results, shown in appendix tables 2 and 4, again indicate that at none of the possible break years is there evidence that a break may have actually occurred in the regression lines.[10] The statistical significance of the $\hat{\beta}_2$ coefficients in either lines 2-1 to 2-3 or lines 4-1 to 4-3 is consistently below 10 percent.

10. We also tested for multiple structural breaks but found no evidence of them.

Appendix table 1. *Dummy Variable Analysis of Trends in the Relative Prices of Nonfuel Primary Commodities, 1900–86*

Relative price index	*Intercept* ($\hat{\alpha}_0$)	*Coefficient of dummy* ($\hat{\alpha}_1$)	*Coefficient of time* ($\hat{\beta}_1$)	*Coefficient of time and dummy* ($\hat{\beta}_2$)	*Regression statistics* R^2	*SEE*	*F*	*DW*
1-1 ln GYCPI/MUV	4.89149*	−0.12237	0.01262*	−0.01521*	0.80	0.09	108.9	1.55
	(51.3)	(−0.90)	(1.83)	(−2.07)				
1-2 ln GYCPI/MUV	5.05227*	−0.24853	−0.00908*	0.00596	0.74	0.11	77.3	1.69
	(51.7)	(−1.37)	(−1.90)	(1.04)				
1-3 ln GYCPI/MUV	5.03845*	−0.08256	−0.00900*	0.00377	0.74	0.11	76.8	1.71
	(63.0)	(−0.34)	(−3.20)	(0.80)				

* = significant at the 10 percent confidence level or above.

Note: t values in parentheses.

The estimated model is $\ln \text{GYCPI/MUV}_t = \alpha_0 + \alpha_1 D_t + \beta_1 t_t + \beta_2 (D_i t_i) + u_i$, where t_i is a time trend, D_i is a dummy variable = 0 up to 1920 in 1-1, 1931 in 1-2, and 1944 in 1-3 and = 1 in subsequent years; OLS estimates on annual data; a maximum-likelihood procedure was used to correct for serial correlation.

Appendix table 2. *Piecewise Regression Analysis of the Trends in the Relative Prices of Nonfuel Primary Commodities, 1900–86*

Relative price index	Intercept ($\hat{\alpha}_0$)	Coefficient of time ($\hat{\beta}_1$)	Coefficient of time and dummy ($\hat{\beta}_2$)	Regression statistics			
				R^2	SEE	F	DW
2-1 ln GYCPI/MUV	5.01402*	−0.00838	0.00313	0.74	0.11	114.9	1.72
	(50.7)	(−1.57)	(0.49)				
2-2 ln GYCPI/MUV	5.04433*	−0.00943*	0.00544	0.74	0.11	116.0	1.71
	(57.3)	(−2.64)	(1.08)				
2-3 ln GYCPI/MUV	5.01496*	−0.00746*	0.00358	0.74	0.11	115.2	1.71
	(59.2)	(−2.78)	(0.70)				

* = significant at the 10 percent confidence level or above.

Note: t values in parentheses.

The estimated model is $\ln \text{GYCPI/MUV}_i = \alpha_0 + \beta_1 t_i + \beta_2 (t_i - t^*) D_i + u_i$, where t is a time trend, D_i is a dummy variable = 0 up to 1920 in 2-1, 1931 in 2-2 and 1945 in 2-3 and = 1 in subsequent years, and t^* = 1921 in 2-1, 1932 in 2-2, and 1945 in 2-3. OLS estimates on annual data; a maximum-likelihood procedure was used to correct for serial correlation.

Appendix table 3. *Dummy Variable Analysis of Trends in the Relative Prices of All Primary Commodities, 1900–86*

Relative price index	*Intercept* ($\hat{\alpha}_0$)	*Coefficient of dummy* ($\hat{\alpha}_1$)	*Coefficient of time* ($\hat{\beta}_1$)	*Coefficient of time and dummy* ($\hat{\beta}_2$)	*Regression statistics* R^2	*SEE*	*F*	*DW*
3-1 ln GYCPI‴/MUV	4.87483*	−0.05912	0.01711*	−0.01937*	0.73	0.12	72.6	1.37
	(33.3)	(−0.28)	(1.68)	(−1.75)				
3-2 ln GYCPI‴/MUV	5.06205*	−0.29885	−0.00667	0.00520	0.68	0.13	58.4	1.50
	(37.7)	(−1.19)	(−1.03)	(0.66)				
3-3 ln GYCPI‴/MUV	5.05007*	−0.21785	−0.00739*	0.00490	0.68	0.13	57.0	1.51
	(42.4)	(−0.61)	(−1.81)	(0.69)				

* = significant at the 10 percent confidence level or above.

Note: t values in parentheses.

The estimated model is $\ln \text{GYCPI}'''/\text{MUV}_i = \alpha_0 + \alpha_1 D_i + \beta_1 t_i + \beta_2 (D_i t_i) + u_i$, where: t_i is a time trend, and D_i is a dummy variable = 0 up to 1920 in 3-1, 1931 in 3-2, and 1944 in 3-3 and = 1 in subsequent years. OLS estimates on annual data; a maximum-likelihood procedure was used to correct for serial correlation.

Appendix table 4. *Piecewise Regression Analysis of the Trends in the Relative Prices of All Primary Commodities, 1900–86*

Relative price index	*Intercept* ($\hat{\alpha}_0$)	*Coefficient of time* ($\hat{\beta}_1$)	*Coefficient of time and dummy* ($\hat{\beta}_2$)	*Regression statistics*			
				R^2	*SEE*	*F*	*DW*
4-1 ln GYCPI'''/MUV	4.99781*	−0.00481	−0.00030	0.68	0.13	86.0	1.52
	(36.9)	(−0.67)	(−0.03)				
4-2 ln GYCPI'''/MUV	5.05294*	−0.00803	0.00455	0.68	0.13	86.5	1.51
	(40.1)	(−1.58)	(0.63)				
4-3 ln GYCPI'''/MUV	5.04872*	−0.00728*	0.00493	0.68	0.13	86.5	1.51
	(43.4)	(−1.98)	(0.70)				

* = significant at the 10 percent confidence level or above.

Note: t values in parentheses.

The estimated model is ln GYCPI'''/MUV$_t$ = $\alpha_0 + \beta_1 t_i + \beta_2 (t_t - t^*) D_t + u_i$, where t is a time trend, D_t is a dummy variable = 0 up to 1920 in 4-1, 1931 in 4-2, and 1945 in 4-3 and = 1 in subsequent years, and t^* = 1921 in 4-1, 1932 in 4-2, and 1945 in 4-3. OLS estimates on annual data; a maximum-likelihood procedure was used to correct for serial correlation.

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