FOR AGENDA

SM/87/291

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December 11, 1987

To: Members of the Executive Board

From: The Secretary

Subject: Commodity Price Baskets as Possible Indicators of Future Price Developments

Attached for consideration by the Executive Directors is a paper on commodity price baskets as possible indicators of future price developments, which has been tentatively scheduled for discussion on Friday, January 8, 1988.

Mr. Boughton (ext. 7477) is available to answer technical or factual questions relating to this paper prior to the Board discussion.

Att: (1)

Other Distribution:
Department Heads

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INTERNATIONAL MONETARY FUND

Commodity Price Baskets as Possible Indicators of Future Price Developments

Prepared by the Research Department

Approved by Jacob A. Frenkel

December 10, 1987

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I. Introduction

The Interim Committee, at its meeting on September 27-28, 1987, "welcomed the more extended use of indicators in the context of surveillance and the recent world economic outlook exercise. Committee members ... encouraged the Executive Board to pursue its work in this area ... and to continue to explore the development of criteria that would be helpful in judging the sustainability and desirability of the evolution of a limited set of key economic variables." 1/ In this vein but more specifically, the Governors for the United Kingdom and the United States, in their addresses at the 1987 Annual Meetings, suggested that the indicator process might be enhanced by the addition of an indicator of commodity price movements.

The address by the Governor for the United Kingdom noted that "we must also ensure that there is no persistent inflationary (or for that matter deflationary) bias for the group [of major industrial countries] as a whole. This can be helped by ... the development of indicators for the group as a whole; these will be mainly financial but special attention should also be given to the trend of world commodity prices." The Governor for the United States stated that "the United States is prepared to consider utilizing, as an additional indicator in the coordination process, the relationship among our currencies and a basket of commodities, including gold. This could be helpful as an early-warning signal of potential price trends." This paper reports the findings of some initial work by the Fund staff in response to the requests by the Interim Committee and by individual Governors.

The task of this paper is to provide some basic evidence on the question of how effectively commodity prices could be used as an inflation predictor for the large industrial countries that have a major influence on global economic and financial developments. A more ambitious application of commodity price indexes would be for them to serve as a supplementary indicator for the implementation of monetary policy. In the context of efforts to coordinate policies among the large industrial countries, such indexes might be considered as helping to provide an aggregate nominal "anchor" for monetary policy, either in place of or in addition to other variables such as aggregate growth rates for monetary aggregates or nominal income. This more systemic type of application is not considered in this paper. As noted in the work program, the question of anchors for the international monetary system forms part of the research agenda of the staff, and a paper on that subject will be produced in due course. 2/ In a similar vein, it is worth noting that

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1/ Press communique of the Interim Committee, September 28, 1987, paragraph 4.

2/ See "Statement by the Managing Director on the Work Program until the April 1988 Meetings of the Interim and Development Committees - Executive Board Meeting October 28, 1987," (buff 87/207, October 20, 1987).

this paper does not address the issues of whether and how commodity prices themselves should be stabilized.

The organization of this paper is as follows. Section II provides a general discussion of the role of commodity prices in the world economy and of the use of commodity prices in the Fund. Section III examines the behavior of commodity prices in recent years. Then Section IV turns to the more specific question of the relationship between commodity price indexes and inflation in the industrial countries. Conclusions of the exercise are set out in Section V.

II. The Interpretation of Commodity Prices

1. The use of commodity price indexes in the Fund

Almost since its inception, the Fund has monitored commodity prices for the purpose of providing a basis for estimation and projection of export earnings of its member countries. Commodity prices are a key input into the projection of trade balances in Article IV consultations and in discussions with members that undertake stand-by or other arrangements with the Fund. In addition, the processing of requests by member countries for drawings under the compensatory financing facility, which was introduced in 1963, involves a careful assessment of both actual and projected export earnings of individual commodities for the countries concerned.

Since 1973, in addition to work on individual commodity prices and price projections, the Fund has developed and used aggregate commodity price indexes. The development of the first IMF aggregate commodities price index coincided with the onset of the sudden and marked rise in the prices of a number of commodities that culminated in the first round of oil price increases toward the end of 1973. The "overall" index was computed using 37 price series for 30 different primary commodities, weighted in accordance with earnings shares in the exports of developing countries over the period 1968-70. The index did not include petroleum, in part because petroleum prices had for many years been stable; it was felt that petroleum prices could be studied more effectively separately from the overall index. If included, petroleum would at that time have had a weight in the index of about one quarter.

In 1986 the original index was replaced by three indexes using 1979-81 export weights: a world index, an index of commodity prices of exports of developing countries, and an index of commodity prices of exports of industrial countries. The development of an industrial country index was considered desirable because the composition of industrial country exports of primary commodities differs from that of the developing countries, and because the value of these exports has for a number of years exceeded the value of exports of primary commodities by

developing countries by a considerable margin. The new indexes cover 39 price series for 34 primary commodities. 1/ Again, petroleum has been excluded from this index in order to avoid the dominance by a single commodity: if included, petroleum would have a weight of over one half in the world index and over 70 percent in the index for developing countries.

In the rapidly changing world economic environment of the 1970s and 1980s, the Fund's commodity price indexes have been found most useful in assessing developments relating to export earnings of groups of developing countries, their terms of trade, and inflationary trends. Reports on the movements in the indexes and implications of these movements have been published periodically in the IMF Survey (beginning May 28, 1973), and regularly in the Annual Report of the Fund (since 1974) and in the World Economic Outlook (from its first publication in 1980). Beginning in 1986, a detailed discussion of movements in commodity price indexes has been provided in the annual publication Primary Commodities: Market Developments and Outlook. 2/ Since August 1977, the indexes have been published and updated each month in International Financial Statistics.

2. Commodity prices and the indicators process

The Fund staff has been investigating the use of indicators for policy analysis since 1985 in response to requests from the Interim Committee and the Executive Board. 3/ This task has had three dimensions: the development of a limited set of variables to characterize the main features of macroeconomic developments affecting the large industrial countries; enhancements to the theoretical framework employed by the staff for analyzing policy interactions among these countries; and a more detailed specification of the medium-term effects of policy actions in the World Economic Outlook. In addition, the Fund has cooperated with the countries concerned in their efforts to use indicators as an aid to policy coordination.

The indicators that have come to play a central role in this process are the rates of growth of output and demand, unemployment, inflation rates, current account and trade balances, fiscal policy indicators,

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1/ There are two prices for cotton (medium and long); two for wool (fine and coarse); two for coffee ("other milds" and robusta); and three for sugar (a free market price and prices maintained in the United States and the European Community). For a description of the prices and the commodity coverage, see Primary Commodities: Market Developments and Outlook (World Economic and Financial Surveys, May 1986).

2/ World Economic and Financial Surveys, May 1986 and May 1987.

3/ For a review of this process, see "The Use of Indicators in Surveillance - Analytical Issues" (EBS/87/135, June 24, 1987).

monetary growth rates, exchange rates, and interest rates. 1/ The current and projected values of these variables are examined for each of the large industrial countries and for the group as a whole as part of the World Economic Outlook exercise and as background for policy discussions with the countries concerned.

While this list of indicators is fairly comprehensive, it is not intended to provide a complete picture of the economy. It has always been recognized that macroeconomic analysis must be based on all available information; for example, the appropriateness of the stance of fiscal policy depends on the level and composition of spending and tax revenues as well as the size of the fiscal deficit. In addition, the list has been chosen more for the central importance of the variables than for the ability of the indicators to foretell future developments in other variables.

In examining whether an index of commodity prices might be a helpful addition to the list of principal indicators, there are at least three pertinent questions. First, are commodity prices of central importance to economic performance or to policy transmission in the large industrial countries? Second, do they provide information at an early stage about changes in inflationary pressures? Third, might they provide a better general indication of global inflationary forces than is provided by the indicators for individual countries that have been emphasized so far?

The possibility that commodity prices may be especially useful as an indicator of global inflation arises because many primary commodities are widely traded at fairly uniform prices throughout the world. Although the ideal composition of a commodity index no doubt varies among countries, the effects of these differences would be expected to be minor in the sense that the individual country indexes would all give similar signals if expressed in the same currency or basket. In contrast, when global inflationary prospects are indicated by aggregating country-specific leading indicators, there are greater problems of comparability. Notably, it is difficult to interpret movements in an aggregate money stock because of differences in money demand relationships among countries and over time.

While commodity prices expressed in a single currency or basket can be interpreted as a single indicator of global inflationary conditions, they may also provide helpful indications of the appropriateness of conditions in individual countries when expressed in different currencies. The clearest circumstance would be one in which financial policies were directed at promoting stability both of exchange rates and of consumer

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1/ See "The Chairman's Summing Up at the Conclusion of the Discussion on the Use of Indicators in Surveillance," Executive Board Meeting 87/107, July 23, 1987 (SUR/87/68, July 27, 1987).

prices. Assuming a stable relationship between commodity and other prices, economic performance could then be enhanced if it were possible to use monetary policy to help stabilize the commodity price index in terms of the currency of each country concerned.

To illustrate how commodity prices might help in this way, suppose that, over some time period, the U.S. dollar were tending to appreciate against the deutsche mark. If the authorities wished to attempt to resist this tendency through adjustments to monetary policy, they could do so either through an easing in the United States or a tightening in Germany. However, suppose in addition that commodity prices were declining in terms of U.S. dollars while they were stable in terms of deutsche marks. This movement could then be interpreted as one indication that financial conditions may be too restrictive in the United States. Obviously, one would need to examine economic conditions much more carefully before concluding whether any adjustments to policies were warranted. The advantage of having such an aggregate indicator would be simply to provide a basis for beginning to determine whether a given shift in exchange rates should call forth an easing by one country or a tightening by the other.

3. Commodity prices as an inflation indicator

The relationship between changes in commodity prices and in the overall inflation rate is complex. A rise in commodity prices need not be followed by a generalized rise in the level of prices, although there will be occasions when the link between commodity and overall prices will be close. The basis for believing that a commodity price index may be a good predictor of general inflationary trends is, first, that commodities enter the production process at an early stage; and, second, that commodity prices tend to respond fairly quickly to changes in underlying supply and demand conditions or in expectations of future inflation. One would expect the prices of manufactured goods to respond more gradually to a general inflationary impulse. Since the consumer price index (CPI) includes, in addition to primary commodities that are consumed directly, manufactured goods and services with relatively sticky prices, it also may respond more slowly in response to changing conditions.

It is also necessary to recognize that commodity prices may simply indicate changes in relative prices. For example, a rise in coffee prices may reflect nothing more than a shift in specific conditions affecting the supply of coffee and need not signal a general upward pressure on other prices. In general, supply-induced changes in commodity prices may be more likely to signal changes in the prices of primary commodities relative to other goods and services, while demand-induced price changes may be considered to be more likely to spread to other products.

A rudimentary way to summarize these two interpretations of commodity price movements is to consider the relationships among consumer prices, unit labor costs in manufacturing, and commodity prices. 1/ The movements in these three series are illustrated in Chart 1. 2/ A striking feature of this chart is the similarity of the movements in the CPI and in unit labor costs. The inflation rate is higher for the CPI than for labor costs, but the two series otherwise move fairly closely. In contrast, commodity prices--weighted by their importance in world exports--show much more variability and frequently move in ways that seem to be unrelated to inflationary conditions.

The divergent paths of commodity prices, on the one hand, and consumer prices and unit labor costs, on the other, would seem to favor the hypothesis that commodity price movements have largely reflected shifts in relative rather than absolute prices. Nonetheless, there have been a number of recent periods when large swings in commodity prices have been observed in advance of shifts in the same direction (although of smaller magnitude) in the aggregate CPI: notably, the upturn from mid-1978 to 1980 and the downturn beginning in 1984. There is thus a prima facie case that commodity prices may give early indications of major changes in inflationary (or deflationary) conditions. This case would appear even stronger if the commodity price index were adjusted to compensate for differences in trend and for its greater volatility; these types of adjustment are discussed below, especially in Section IV.4.

A theoretical framework for analysis of the relation between commodity prices and industrial prices is presented in Appendix I. In this framework, commodities can be either final goods for consumption or inputs into the production of industrial products. As inputs, commodities are combined with labor and capital to produce industrial output. Prices of industrial goods then embody past commodity prices and unit

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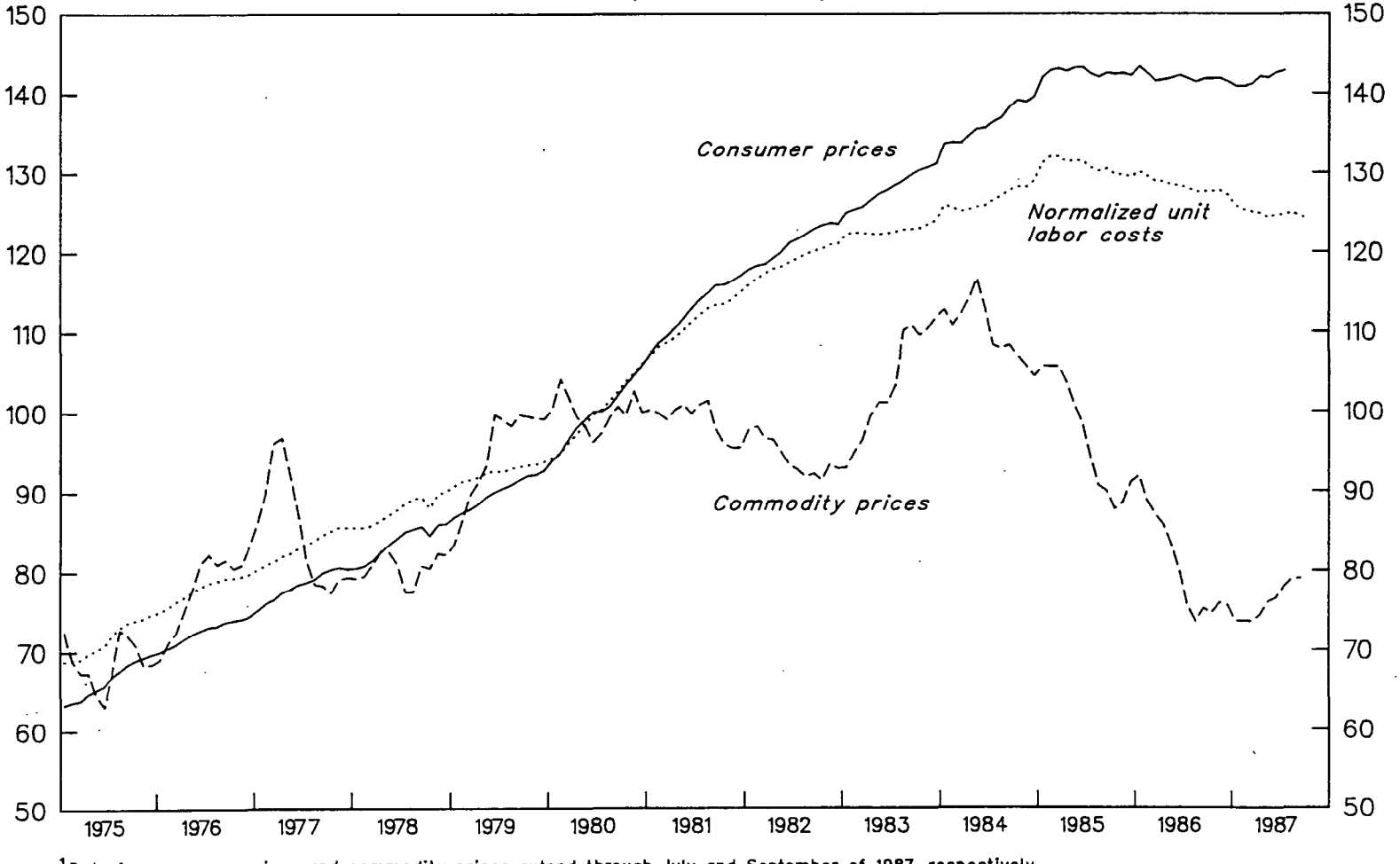
1/ There are a number of other influences on consumer prices that may have been important in recent years, including changes in profit margins, unit capital costs, or taxes, and compositional shifts such as changes in the portion of costs attributable to imports. These factors are not analyzed here.

2/ The CPI and normalized unit labor cost series are aggregated from the data for the seven countries, with all data expressed in SDRs. Although this approach has the advantage of denominating the data in terms of a representative basket, it does leave some anomalies, which are discussed later, in Section IV.3. Other choices of denomination would probably raise their own difficulties of interpretation; in any event, the choice does not affect the relationships being discussed here. The chart begins in 1975 because some of the unit labor cost data are unavailable prior to that year.

CHART 1

CONSUMER PRICES AND UNIT LABOR COSTS IN THE LARGE INDUSTRIAL COUNTRIES, AND COMMODITY PRICES, JANUARY 1975–OCTOBER 1987 [1]

(In SDRs, 1980=100)



[1] Data for consumer prices and commodity prices extend through July and September of 1987, respectively.

labor costs. 1/ As final goods, commodities may be substitutes for industrial goods. In either case, commodities generally are traded in auction markets, while industrial goods are traded in markets with price-setters who adjust their prices gradually in response to excess demand. This feature of the framework permits commodity prices to be leading indicators of more general price inflation. Since commodity prices adjust instantaneously to changes in market participants' perceptions of inflationary conditions, they can embody expectations of future general inflation.

The discussion in the Appendix treats separately the two cases in which commodities are final goods or inputs. The essential results are the same and may be summarized as follows. In response to an unanticipated monetary expansion, commodity prices are likely to rise rapidly and overshoot their final equilibrium level, while industrial prices adjust gradually. Commodity prices will, in these circumstances, lead industrial prices and will thereby be reasonable candidates as leading indicators. The relationship will be improved by focusing on distributed lags on commodity prices in order to smooth out the tendency to overshoot but still capture the ability of commodity prices to lead consumer prices.

In response to supply shocks that raise commodity prices, industrial prices may fall in the absence of monetary accommodation. More generally, the response of the general price level to a supply-induced change in an individual commodity price may be diminished by technological shifts in production processes and by conservation and substitution effects in consumption patterns. This dependence of the relationship between movements of commodity and industrial prices on the source of the disturbance points to the utility of a commodity price index that takes into account the interrelationships among commodity prices, in order to minimize the effect of individual supply shocks on the index.

4. Empirical literature on commodity prices and inflation

This subsection discusses selected characteristic results from the recent literature that bear on the question of whether one would expect commodity prices to be a good leading indicator of inflation. The first part concentrates on the literature on the determinants of commodity price movements in order to examine the extent to which these movements have resulted from monetary impulses rather than from supply shocks. This literature is generally in agreement on the effects of demand shocks

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1/ Movements in the cost of capital and taxes would also enter the prices of industrial goods. Since the purpose here is not to model the prices of industrial goods, but only to show how commodity prices could be a useful indicator of their future movements, we do not include these additional factors in the analysis here.

on commodity prices, but not on the effects of exchange rate changes. The second part concentrates on the effects of changes in commodity prices on general inflation, both in a causal sense and in a predictive sense.

a. Determinants of commodity prices

The literature on this topic is in substantial agreement regarding the impact of financial variables on commodity prices, but less on the role of supply disturbances. Studies by Dornbusch (1985) and Sapsford (1987), and by Holtham and Durand (1987) using the OECD Interlink model, generally estimate the elasticity of real commodity prices (relative to industrial countries' prices) with respect to real activity in industrial countries to be about 2. Chu and Morrison (1984) and Morrison and Wattleworth (1987) estimate the elasticity of nominal commodity prices with respect to activity to be about 2, so the elasticity of real commodity prices would be somewhat less. This finding implies that monetary impulses will in general have sizable effects on commodity as well as industrial prices.

The studies are in less agreement on the effects of changes in exchange rates on commodity prices. Most find that changes in the U.S. dollar's nominal effective exchange rate would have approximately the same effect on commodity and industrial prices and thus would have little impact on real commodity prices. 1/ But Dornbusch (1985) finds that a real appreciation of the dollar would lead to a significant decline in real commodity prices.

A view of commodity price determinants that emphasizes expectations is presented by Frankel and Hardouvelis (1985). They use a model similar to the one presented in Appendix I to analyze the reaction of commodity prices to Friday announcements of money stock data by the U.S. Federal Reserve. Their hypothesis is that if the money supply announcement on Friday is unexpectedly high, the markets will anticipate a tightening the following week. This, in turn, will lead to a fall in commodity prices at the Monday opening of the markets. The hypothesis is supported in a test on weekly data from the period July 1980 to November 1982 for nine commodities. This provides a direct empirical confirmation of the model of commodity prices as an inflation hedge.

b. Commodity prices and inflation

The causal link from commodity prices to general inflation is analyzed extensively in Bosworth and Lawrence (1982, Chapter 3). They treat commodity prices as an exogenous force driving inflation, along with

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1/ The argument for this finding is set out in the World Economic Outlook (April 1985), page 138.

aggregate demand. They conclude that commodity prices contributed significantly to inflation in the 1970s in the United States, Germany, and Japan. The major contributors were food and energy prices; other raw materials were relatively insignificant. Beckerman (1985) also attributes considerable significance to commodity prices as influencing general price trends in the period of declining inflation in the early 1980s. He notes the correlation between the "swing" in commodity prices from 1978-80 to 1981-83 and the slowdown in CPI inflation over the same period.

A more formal test of the value of commodity prices as an inflation predictor is provided by Horrigan (1986). Using monthly data since January 1959, Horrigan provides several tests of the relative significance of various commodity price indexes, M1, and the monetary base in the United States for predicting the U.S. CPI. In formal causality tests, the monetary base outperforms M1 as an inflation predictor, and the commodity price indexes are also significant, along with money. 1/ However, the quantitative effect of commodity prices is small. Horrigan concludes that while commodity prices are statistically significant in predicting inflation, their volatility gives them a quantitatively unimportant effect.

This brief summary of recent empirical work on the relationships between commodity prices and general inflation suggests that linkages do exist in both directions and are potentially quantifiable. The results appear to be encouraging enough to warrant the development of new empirical work on the value of commodity prices as predictors of inflation, as reported below in Section IV.

III. Behavior of Commodity Prices

Before turning to the question of how best to construct an index of commodity prices as an indicator of inflationary pressures, this section examines in more detail the behavior of commodity prices during the past thirty years and their relationship to general price movements. As was suggested by the analysis of Chart 1 above, there appears to have been some correspondence between overall commodity price movements and those in consumer prices (based on world export weights), even though there are important differences in the behavior of the two types of data.

1/ For this type of test, known as the Granger-Sims causality test, the question is whether lagged values of the independent variable are significant explanators of current values of the dependent variable, while future values are not. Similar causality tests are reported below, in Sections III and IV.

Chart 2 shows the evolution of prices for 11 important commodities or groups of commodities since 1958, indexed in terms of the SDR. A number of striking facts emerge from these data. First, for almost all of the price series there is a clear break in the pattern beginning in 1972 or 1973. Up to that time, most prices had been quite stable in nominal terms, with little variance. After that date, the variability of commodity prices generally increases substantially. The exceptions are rubber, sugar, and the "other metals" index, each of which showed about the same variability before 1972 as later.

A second feature is that most of these prices show no trend either before or after 1972, but the level of prices is much higher in the more recent period. The exceptions here are meat prices, which had a distinct upward trend through 1972 but no trend since the late 1970s, and gold prices, which had a strong upward trend from 1972 to 1980.

Third, all of these price indexes have undergone at least brief periods of very rapid increase that have later been substantially reversed. In this sense, commodity prices may be said to have a tendency to overshoot substantially and for extended periods in response to changing circumstances.

Fourth, although there have been some notable periods when most commodity prices have moved together--the commodity booms of 1972-73 and 1978-80 and the major decline in 1984-85--there have also been large nonsynchronized movements in most of these series. These latter movements, some of which have been large enough to generate shifts in the overall indexes, represent shifts in supply or demand for individual commodities; in many cases, these movements have run counter to general inflationary trends.

Chart 3 shows the price indexes for these same commodities in real terms, as viewed from the perspective of the large industrial countries. That is, each price index has been deflated by an index of the aggregate level of consumer prices in these countries. In most cases, there has been a secular decline in real commodity prices, the exceptions being gold, petroleum, and timber. Real prices of cereals, vegetables, beverages, sugar, metals, and rubber have all declined by more than 50 percent during the past thirty years. On balance, therefore, non-oil commodity prices have made a negative contribution to inflationary pressures in the industrial countries over the longer run.

Another interesting implication of these movements in real prices is that commodity prices and CPIs do not in general share common trends over long periods of time. That is, there does not appear to be a mechanism that tends to stabilize relative prices around a fixed level, as there normally would be in the absence of trends in supply or demand

CHART 2

SELECTED COMMODITY PRICE INDEXES, JANUARY 1958–SEPTEMBER 1987

(In SDRs, 1980=100)

FOODS

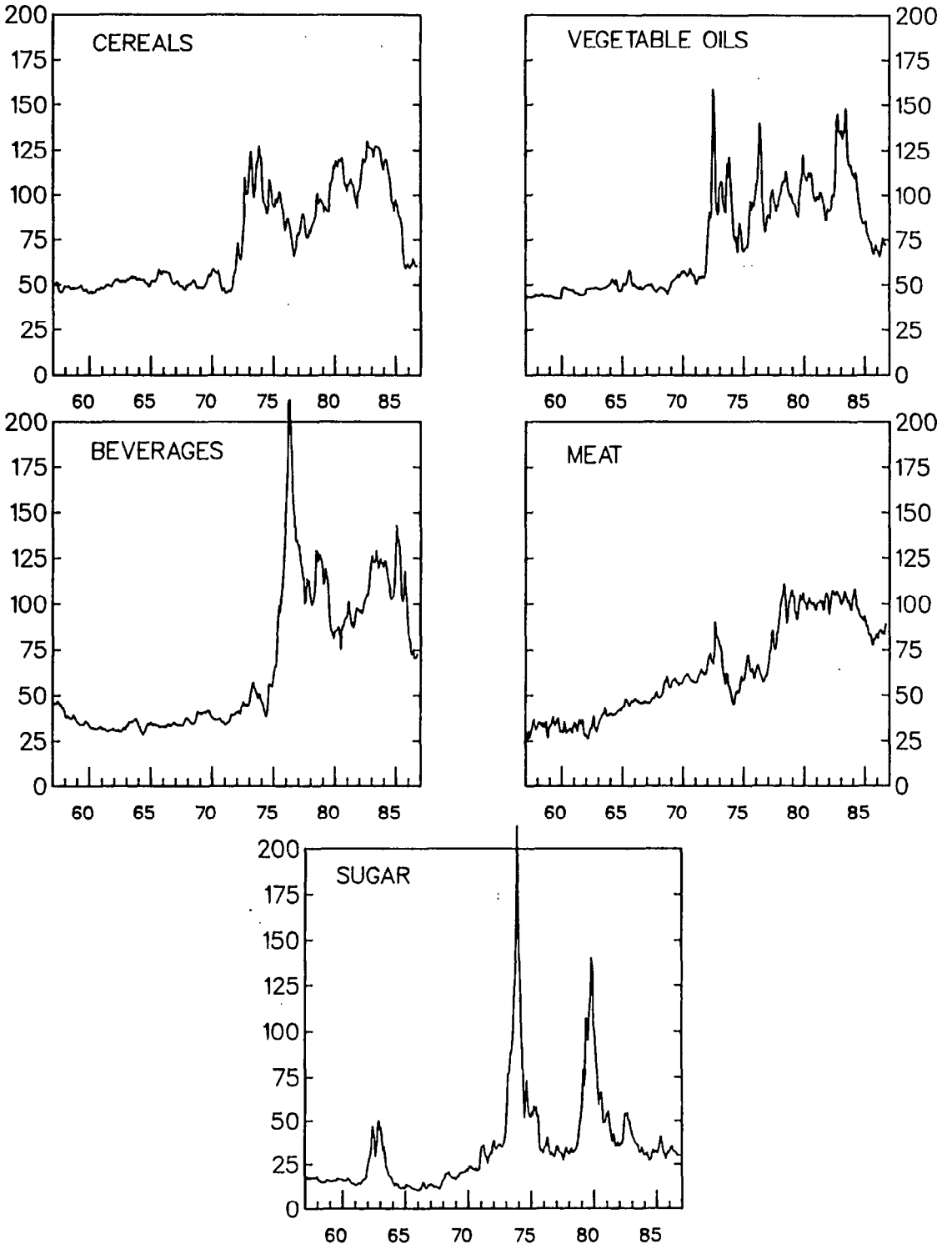


CHART 2 (concluded)

SELECTED COMMODITY PRICE INDEXES, JANUARY 1958–SEPTEMBER 1987

(In SDRs, 1980=100)

NON–FOOD COMMODITIES

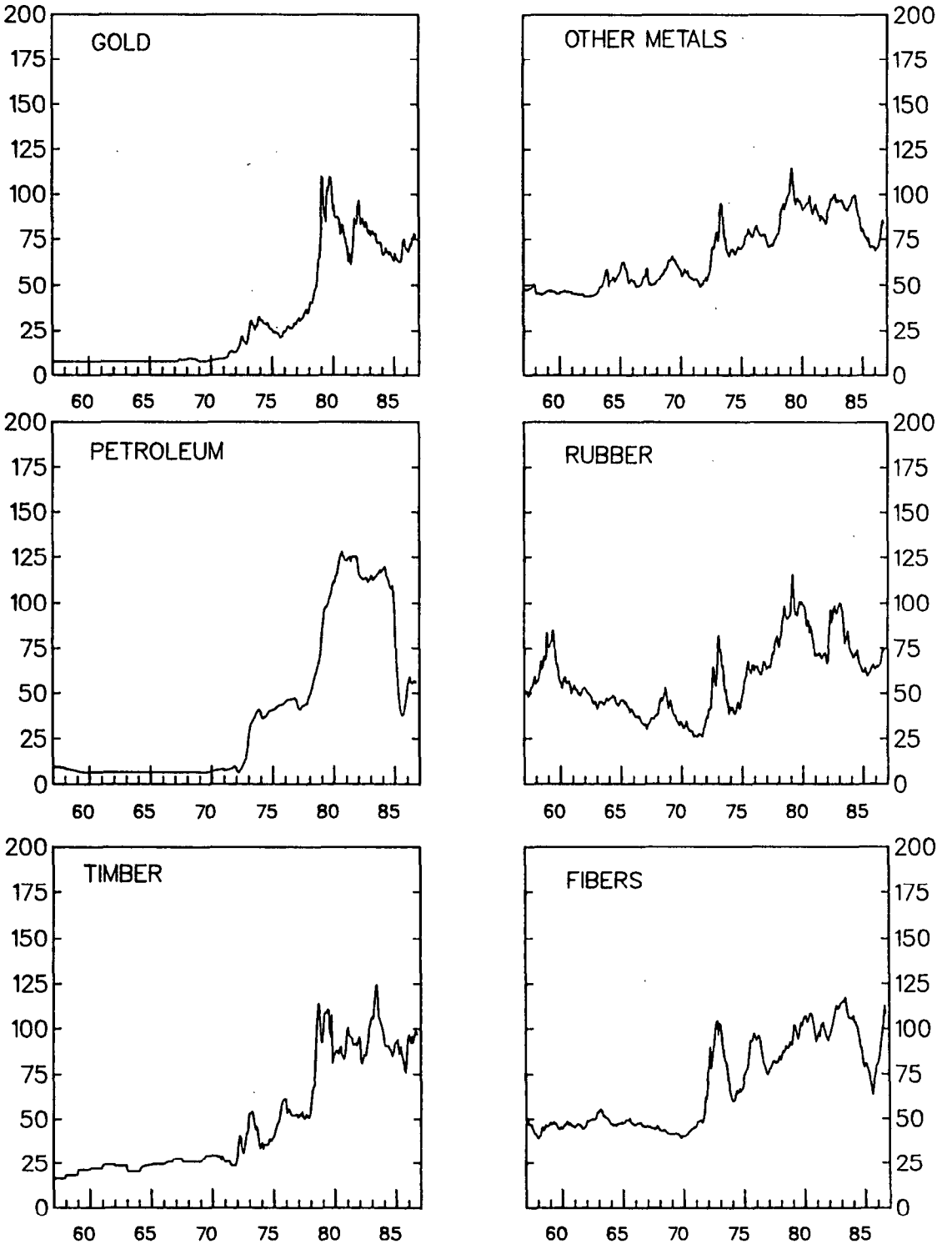


CHART 3

SELECTED COMMODITY PRICES RELATIVE TO INDUSTRIAL COUNTRIES' CONSUMER PRICES, JANUARY 1958–JULY 1987

(In SDRs, 1980=100)

FOODS

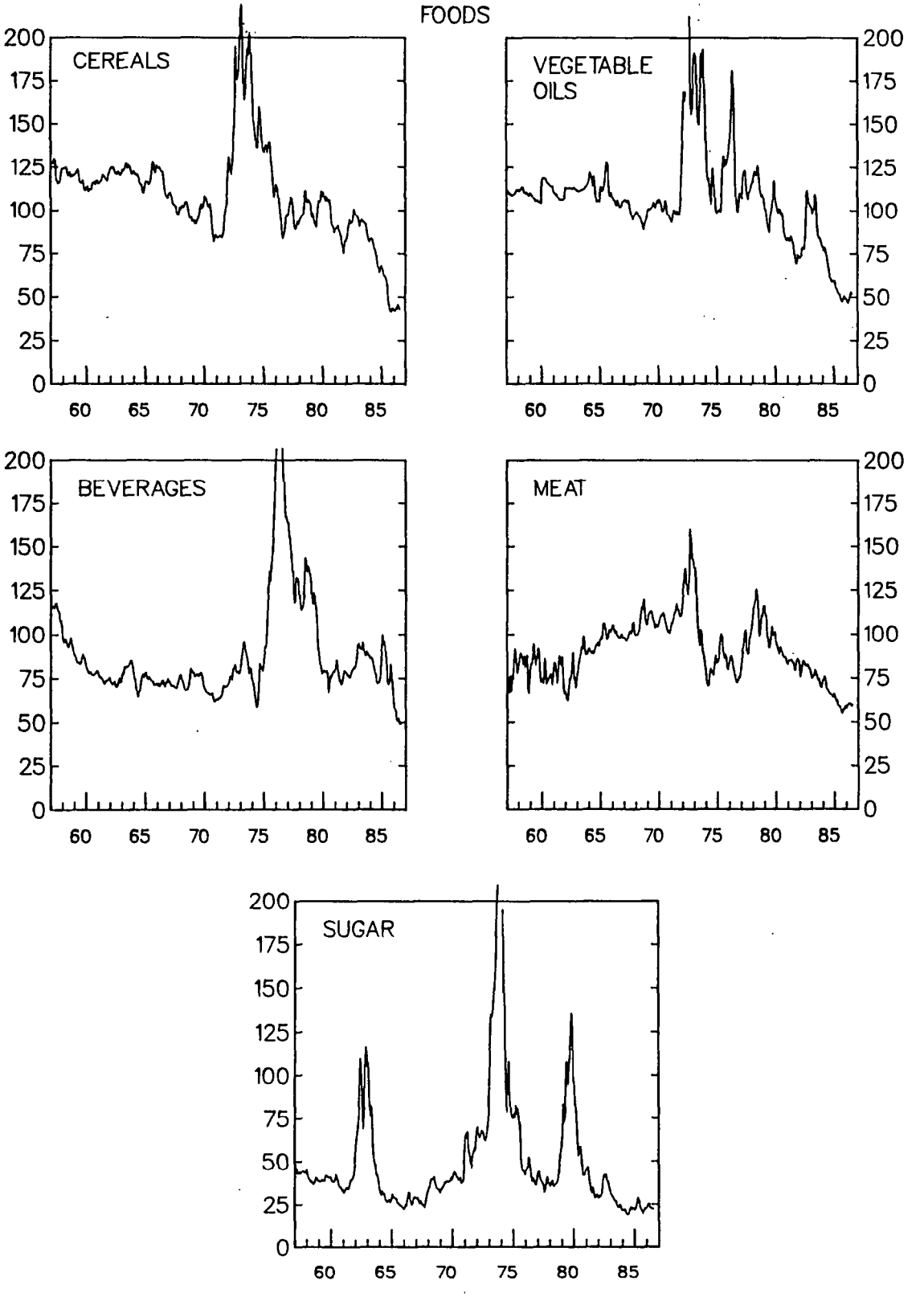
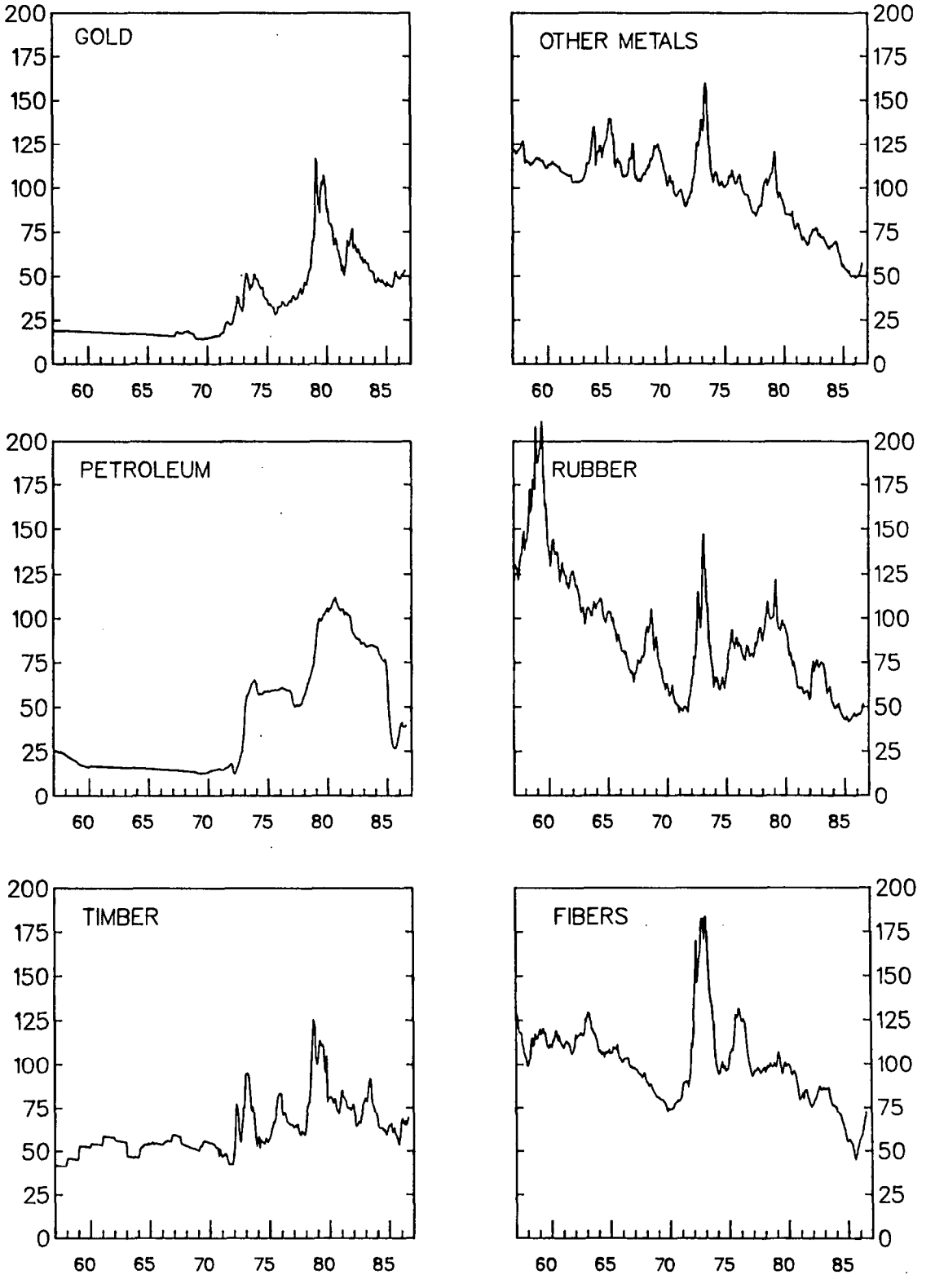


CHART 3(concluded)

SELECTED COMMODITY PRICES RELATIVE TO INDUSTRIAL COUNTRIES' CONSUMER PRICES, JANUARY 1958–JULY 1987

(In SDRs, 1980=100)

NON–FOOD COMMODITIES



conditions. 1/ For example, the prices of many foods are no higher now in nominal terms than they were during the 1960s, in spite of the near-tripling of consumer prices that has occurred in the interim. The absence of a stable long-run relationship of this type makes it more difficult to interpret the general inflationary consequences of even sizable movements in commodity prices.

The overall movement in commodity prices relative to the aggregate CPI, using the conventional export-based IMF index, is illustrated in Chart 4. Here it may be seen that, with the exception of the commodity price boom in 1972-74, there has been a secular overall downward trend in commodity prices relative to consumer prices in industrial countries. From 1958 to 1971, the decline amounted to 20 percent. The real commodity price, by this measure, rose by 64 percent from 1971 to 1974 and then again declined by 62 percent to 1987. The total decline in the real price from 1958 through August 1987 amounted to nearly 50 percent.

Chart 4 also suggests that the real price of primary commodities is unusually depressed at present, having recovered only slightly from the 1984-86 decline. Whether one measures against the average rate of decline over the full thirty-year period shown in the chart or just since the mid-1970s (after the sharp 1973-74 cycle), the real price is substantially below its historical trend. 2/ If a commodity price index were to be used as an indicator of inflationary conditions, one would have to be careful to distinguish general inflationary pressures from a rise in commodity prices that might simply be shifting relative prices back toward more normal levels. The inflation forecasting exercise, if it is to be useful, must proceed from an appropriate base period for the level of commodity prices.

Another question that may be examined at this stage concerns the extent to which commodity prices have moved in advance of consumer price indexes. If there is such a tendency, then commodity prices might well be a useful additional indicator even if their contemporaneous correlation with inflation is no better than that of existing indicators. As discussed above, there are a number of reasons to expect commodity prices to provide an early warning of impending inflationary pressures.

1/ In technical terms, the implication is that commodity prices and consumer prices are not strictly cointegrated; the ratio of one to the other is not a stationary series over time. It is possible, however, that if commodity prices were modeled to take account of shifts in supply or demand conditions, then the resulting residuals would be stationary. This weaker form of cointegration has not been tested here.

2/ Based on a constant log-linear trend since January 1958, the real price as of October 1987 was 36 percent below trend. Starting from January 1975, the gap is 10 percent.

One way to approach this question is to estimate the significance of lagged values of one index in "predicting" the other. If commodity prices are useful leading indicators of inflation, then one would expect the past values of commodity prices to be significant explanatory variables over and beyond the extent to which they were correlated with the lagged values of inflation. In other words, the interesting question is whether commodity prices add significantly to the information that is already present in the history of inflation itself.

This type of test is summarized for the prices of 11 important commodities or groups of commodities in Table 1. Some, but not all, commodities do have a significant predictive ability. However, it may also be noted that there is significant feedback from consumer prices to commodity prices in several cases. This finding is consistent with the conclusion noted in Section II.4a that shifts in aggregate demand have a strong effect on commodity prices; it does not weaken the potential usefulness of commodity prices as leading indicators.

IV. Development of a Commodity Price Index as an Inflation Indicator

1. Introduction

In addition to the Fund indexes discussed in Section II, some of the more widely cited indexes of commodity prices are those of UNCTAD, The Economist, the Hamburg Institut für Wirtschaftsforschung, and the World Bank. 1/ All of these indexes, like those used by the Fund, are aggregated using weights based on the pattern of international trade. They differ in a number of details, such as the choice of commodities, whether the weights are for imports or exports, and whether the data apply to total world trade, industrial countries only, or developing countries. In general, their movements over time appear to be quite similar, as is illustrated for selected indexes in Chart 5. 2/ The major exception is that the Economist and World Bank indexes show relatively larger upward spikes in 1977; this difference is attributable essentially to the large weight of beverages in those two indexes (approximately 22 percent) compared with the IMF index (12 percent).

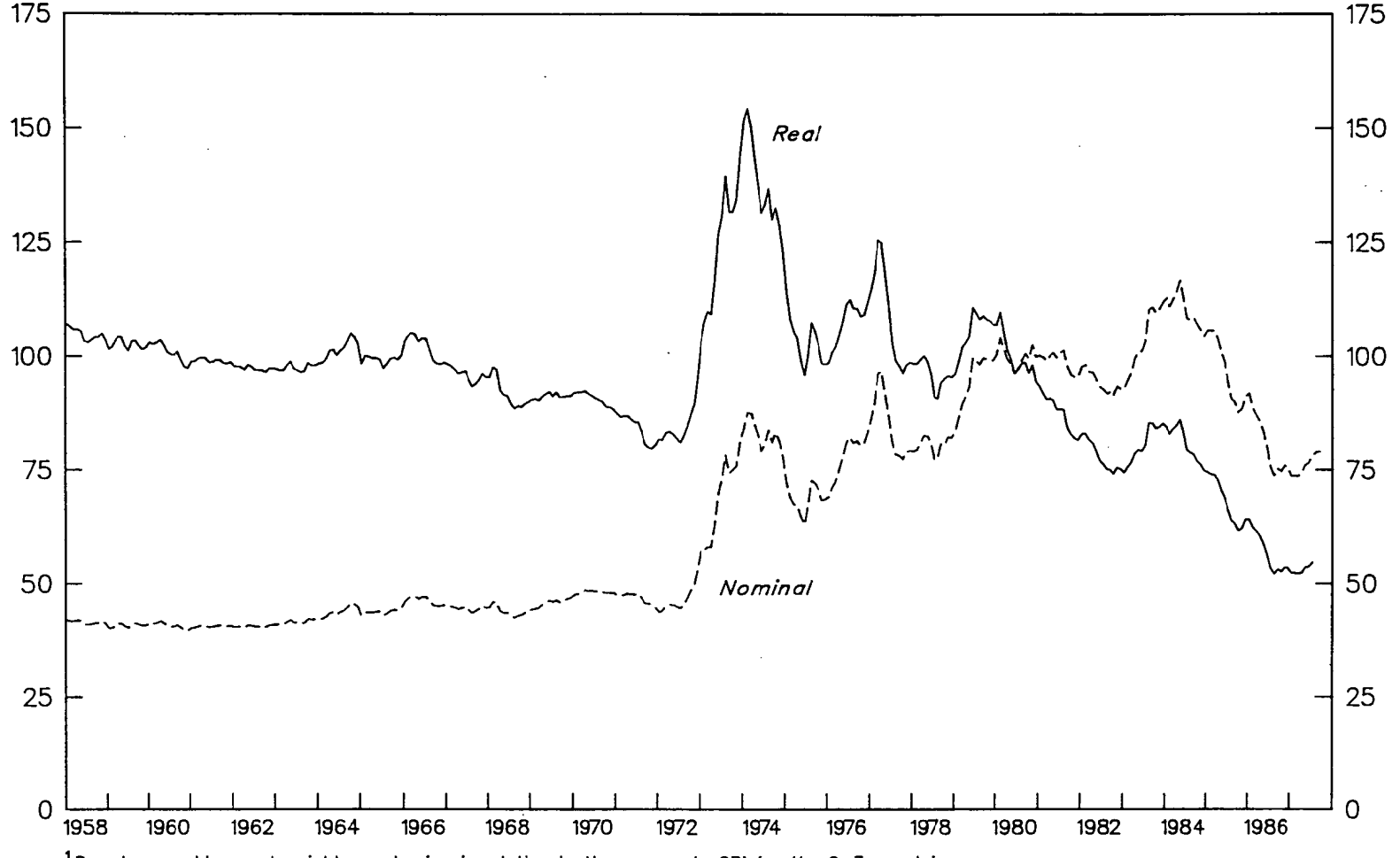
1/ The methodology and history of the development of commodity price indexes, and the construction and behavior of nine of them, are reviewed in Siddique (1984).

2/ The Economist index plotted in Chart 5 has been constructed by the staff by applying the published weights for that index to the IMF price data; it thus differs somewhat from the data published in the magazine. For the current weights and a presentation of the index, see The Economist, March 28, 1987, page 80.

CHART 4

COMMODITY PRICES IN NOMINAL AND REAL TERMS, JANUARY 1958–SEPTEMBER 1987 [1,2]

(In SDRs, 1980=100)



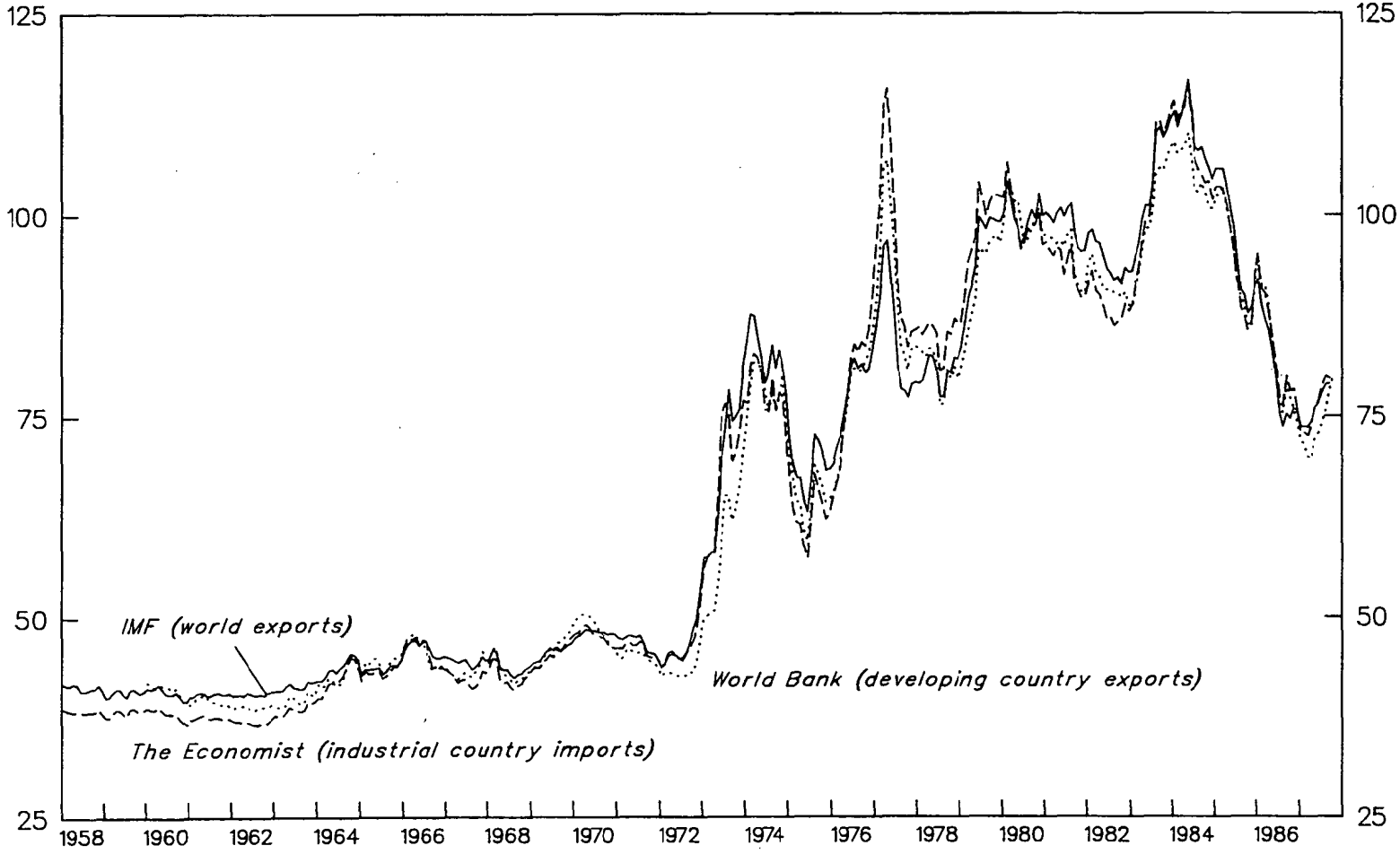
[1] Based on world export weights; real price is relative to the aggregate CPI for the G–7 countries.

[2] Data for real commodity prices extend through July 1987.

CHART 5

COMMODITY PRICE INDEXES USING ALTERNATIVE WEIGHTS, JANUARY 1958–OCTOBER 1987 [1]

(In SDRs, 1980=100)



[1] Data for IMF index and Economist index extend through September 1987.

Table 1. Test of Whether Commodity Prices Lead and/or Lag Consumer Prices, January 1962-July 1987 1/

Commodity	Effect of Commodity Prices on Consumer Prices 2/	Effect of Consumer Prices on Commodity Prices 3/
Cereals	**	**
Vegetable oils		**
Meat		
Sugar		
Beverages		
Timber	**	
Fibers	*	**
Rubber		**
Gold	*	**
Other metals		*
Petroleum	**	

Source: Staff estimates.

1/ * = The null hypothesis that the aggregate effect of the lagged values of the indicated variable is zero may be rejected with 95 percent confidence.

** = The null hypothesis may be rejected with 99 percent confidence.

2/ For this test, the consumer price index has been regressed on 18 lagged monthly values of the commodity price index plus 18 lagged values of itself. The basic data are indexes of prices expressed in SDRs; the consumer price index is an aggregate for the Group of Seven countries (the United States, Japan, the Federal Republic of Germany, France, the United Kingdom, Italy, and Canada), weighted according to relative GDP. All data have been made stationary by taking monthly changes in 12-month inflation rates.

3/ This test is identical in form to the first, except that the current value of the commodity price has been regressed on the current, lagged values of itself and the consumer price index.

For the present exercise, what is desired is an index that bears a close relationship to the pattern of general price movements in the large industrial countries. One approach to this problem would be to weight commodities by their importance in industrial country consumption. Another approach would be to determine weights econometrically, on the grounds that a commodity price might be a sensitive indicator of inflationary expectations even though the commodity itself might be relatively unimportant in consumption and trade. Gold would be the most obvious candidate for this approach. It would also be possible to look at various weights and to combine them so as to arrive at a simple set of averaged weights. It is important when conducting this type of research to ensure that the resulting index is sensible from an economic perspective as well as having the desired statistical properties. 1/

This section will discuss both consumption patterns and predictive ability as bases for developing commodity price indexes. In each case, the indexes will be presented and discussed in terms of the SDR. It should be noted that the choice of denomination is arbitrary; for clarity of presentation it has been decided to use a representative currency basket, but any other basket or single currency could equally well have been chosen.

2. Indexes based on the pattern of consumption

Table 2 presents weights for several commodities and commodity groups, using the traditional basis of international trade along with weights based on the pattern of consumption in industrial countries. The first three columns are comparable in terms of commodity coverage and differ only in the allocations of weights. 2/ The last two columns

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1/ Hall (1982) argued in favor of a commodity standard based on the historical association between the chosen index and the general inflation rate; his index included only 4 commodities: ammonium nitrate, copper, aluminum, and plywood. This proposal was discussed critically by Cooper (1982), and Hall (1987) later noted that the index had diverged quite widely from the CPI in subsequent years. In view of the widespread and very sharp decline in commodity prices, this divergence would have occurred with almost any commodity price index during the past few years. Nonetheless, the breakdown of sample-period relationships in out-of-sample simulations is a serious potential problem that may be partially alleviated by ensuring that the index not be too narrowly based or too divergent from observed patterns of consumption or trade.

2/ The consumption weights have been derived from different data bases and relate to a more recent base period (1983-85, compared with 1979-81 for the trade-weighted indexes). There are some discrepancies in coverage that have not yet been resolved; for example, consumption of rubber is estimated to be improbably small, in view of its weight in industrial country imports. The treatment of ferrous metals is not

Table 2. Consumption and Trade Weights for Primary Commodities 1/

Commodity	World Exports	Industrial Country Imports	Industrial Country Consumption	G-7 Consumption	G-7 Consumption with oil
Cereals	20.8	8.9	16.8	17.1	8.4
wheat	10.0	3.4	6.2	5.7	2.8
maize	7.6	4.9	8.3	8.9	4.4
rice	3.2	0.6	2.3	2.5	1.2
Vegetable oils	11.2	9.2	8.2	8.0	4.0
soybeans 2/	8.9	7.9	7.7	7.5	3.8
other 3/	2.3	1.8	0.5	0.5	0.2
Meat	6.4	6.2	17.1	15.8	7.8
beef	5.5	5.3	15.9	15.1	7.5
lamb	0.9	0.9	1.2	0.7	0.3
Sugar	3.2	3.3	10.2	11.2	5.5
Bananas	0.9	1.6	0.6	0.6	0.3
Beverages	11.8	13.7	4.2	3.7	1.8
coffee	7.4	9.4	2.6	2.3	1.1
cocoa	3.1	3.5	1.3	1.1	0.5
tea	1.3	0.8	0.3	0.3	0.2
Agricultural raw materials	23.7	25.9	30.9	28.6	14.0
timber	10.6	14.9	24.6	23.2	11.4
cotton	4.1	2.6	1.4	1.5	0.7
wool	2.5	2.2	1.5	0.8	0.4
rubber	2.6	2.4	0.1	0.1	--
tobacco	2.5	2.6	1.7	1.5	0.8
other 4/	1.4	1.2	1.6	1.5	0.7
Metals	22.0	30.8	12.0	15.1	7.4
gold	--	--	--	3.2	1.6
copper	5.9	7.4	2.5	2.6	1.3
aluminum	4.5	5.5	3.7	3.7	1.8
iron ore	4.1	6.7	2.8	2.7	1.3
other 5/	7.5	11.2	3.0	2.9	1.4
Petroleum	--	--	--	--	50.6
Total	100.0	100.0	100.0	100.0	100.0

Source: Commodities Division, IMF.

1/ The base period for these weights is 1983-85.
2/ Includes soybean meal and soybean oil.
3/ Palm oil, coconut oil, groundnut oil, and groundnut meal.
4/ Hides, jute, and sisal.
5/ Tin, nickel, zinc, lead, and phosphate rock.

differ in coverage as well: both include gold, and the last column also includes petroleum.

Several conclusions may be drawn about the pattern of weights in Table 2. First, the crucial importance of petroleum is immediately clear. On the basis of 1983-85 prices and volumes, petroleum accounts for approximately half of the total consumption of the included commodities in the large industrial countries, and it would account for a similar proportion in the other columns if it were included. Second, gold is estimated to have about the same importance in consumption as other major metals. 1/ Third, from a comparison of the first three columns it may be seen that there are major variations in the patterns of trade and consumption. Notably, the industrial countries import proportionately less food and more metals than the world as a whole; the consumption of food in industrial countries is weighted relatively more toward meat and sugar; and timber is much more important in industrial country consumption than in trade. Fourth, there is very little difference between the pattern of consumption in the large industrial countries and the pattern in all industrial countries as a group. 2/

Even though the trade and consumption patterns differ substantially (first three columns of Table 2), the resulting indexes behave in a similar fashion over most time periods. These movements are shown in Chart 6. From 1958 through 1972, the consumption-weighted index shows slow inflation, while the other two indexes are roughly flat. Growth rates diverge somewhat from 1974-78, although the turning points are similar. Since 1979, the three indexes move quite closely together.

In view of the large weight for petroleum in consumption, should it be included in an index to be used as an indicator of inflationary pressures? There have been periods when oil prices have moved substantially in response to shifts in conditions specific to the oil market rather

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(Cont'd. from page 14) commensurate with the other metals shown in the table, because they are measured at an earlier stage of refinement. The use of crude steel (cold rolled sheets) would be more consistent; however, steel production has a much higher value added in relation to the value of the ore than do some of the other metals, and the use of data for crude steel would imply a weight nearly ten times that shown in the table. The preferred alternative would be to measure all metals at an early stage, but the requisite data are not all available.

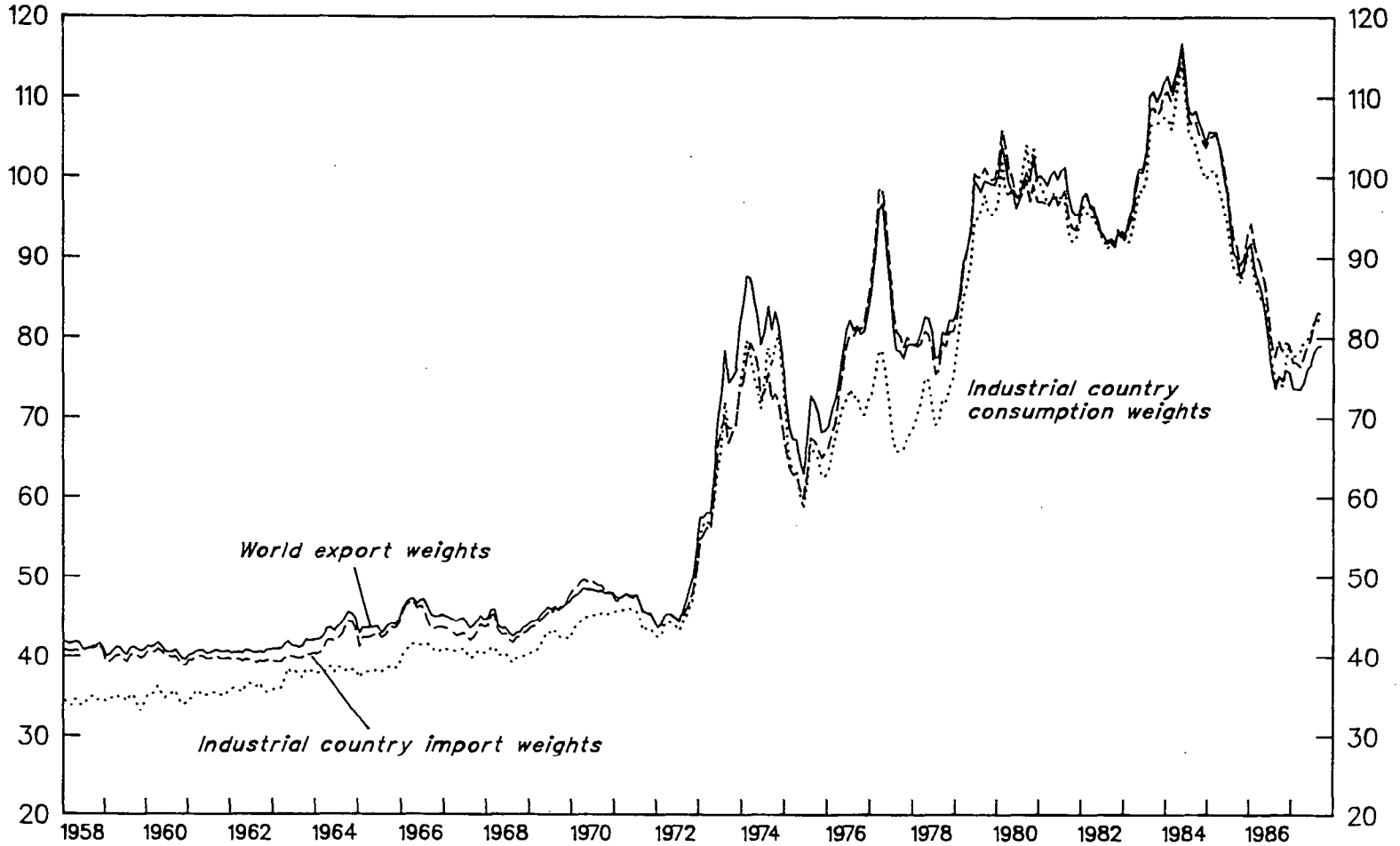
1/ Consumption of gold is estimated from data covering jewelry, industrial applications, coinage (including medallions, medals, and imitation coins), and changes in holdings of bullion (both official and private). There are problems of comparability between measured consumption of gold and that of other metals; see, for example, the preceding footnote.

2/ The seven large countries account for almost 85 percent of total measured consumption of primary commodities in all industrial countries.

CHART 6

COMMODITY PRICE INDEXES USING TRADE AND CONSUMPTION WEIGHTS, JANUARY 1958–SEPTEMBER 1987

(In SDRs, 1980=100)



than in response to shifts in financial conditions affecting inflation more generally. Nonetheless, those price movements have been important enough by themselves to induce shifts in monetary policies and have thereby contributed to more generalized and sustained changes in inflation rates. In order to allow for the possibility that the price of oil is a significant predictor of inflation, the tests reported below will include trade- and consumption-weighted indexes that include petroleum, as well as those that exclude it. In addition, oil will be included as a component of the indexes estimated econometrically in the following subsection.

The role of gold may be understated by the reported consumption data. To the extent that gold is regarded as a good hedge against inflation, its price may be expected to be quite sensitive to changes in inflationary expectations. As a durable and widely traded commodity that is desired to be held as an asset, its importance in stocks far exceeds its importance in consumption. 1/ As a result, the weight of gold in a freely estimated index could well be rather larger than the 1 1/2 percent to 3 percent derived from consumption data.

The three consumption-weighted indexes are plotted over time in Chart 7. It is immediately apparent that the addition of gold (with a small weight) makes very little difference, but that the addition of petroleum (with a large weight) makes a great deal of difference. Even so, the movements in these indexes are quite similar, at least through 1978. From 1979-83, the index that includes petroleum is much stronger than the other two; in 1985-86, it is much weaker.

3. Price indexes estimated econometrically

All of the commodity price indexes described above share the property that they show essentially zero inflation through 1972, a very rapid increase from early 1973 through 1974, and high volatility but again no inflation during the remainder of the 1970s and into the 1980s. Whatever the merits of these indexes might be, it is clear that this longer-run pattern is very different from that of the consumer price indexes of the large industrial countries. This subsection presents estimates of indexes for which the weights are chosen so as to provide as close as fit as possible with consumer prices over the past thirty years.

1/ The estimated value of gold consumption in industrial countries for the 1983-85 period was approximately U.S. $10.5 billion per annum. During the same period, the gold reserves of industrial countries, valued at then-current market prices, averaged $288.2 billion. Data on privately held stocks are not available.

A key choice to be made in constructing these indexes concerns the measurement of an aggregate CPI for the large industrial countries. 1/ One approach would be to construct an aggregate inflation rate in each period by averaging the rate in each country in local currency terms using relative GNPs as weights. This approach is used in the World Economic Outlook for discussions of short-run aggregate price developments. However, for the present purpose it has the drawback that the resulting index is not unambiguously denominated in terms of a currency unit; it thus is difficult to relate to an index of commodity prices. An alternative strategy, which has been adopted here, is to convert each country's CPI into a common currency unit, such as the SDR, and then average these indexes using GNP weights. This index also has drawbacks; notably, in the face of large exchange rate fluctuations, it may produce inflation estimates over some periods that are difficult to interpret as averages of the individual country data. 2/

In order to estimate an index of commodity prices that helps explain future movements in the aggregate CPI for the large industrial countries as well as possible, a two-step process has been adopted. 3/ First, changes in CPI inflation rates have been regressed on lagged values of the corresponding movements in individual commodity prices. These regressions show, in general, that the time profiles of the various relationships are not uniform, that the influence of some prices is negligible, and that some commodity prices take on negative weights because they are positively correlated with other commodity prices that are significant inflation predictors. The regressions do, however, reveal a number of significant relationships. For the second step, the coefficients from these regressions have been taken as estimates of the

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1/ A related issue is whether consumer prices are the most relevant measure of inflation in these countries. That issue is not examined here; the CPI has been chosen as an index for which comparable data are available and which plays a prominent role in the indicators exercise.

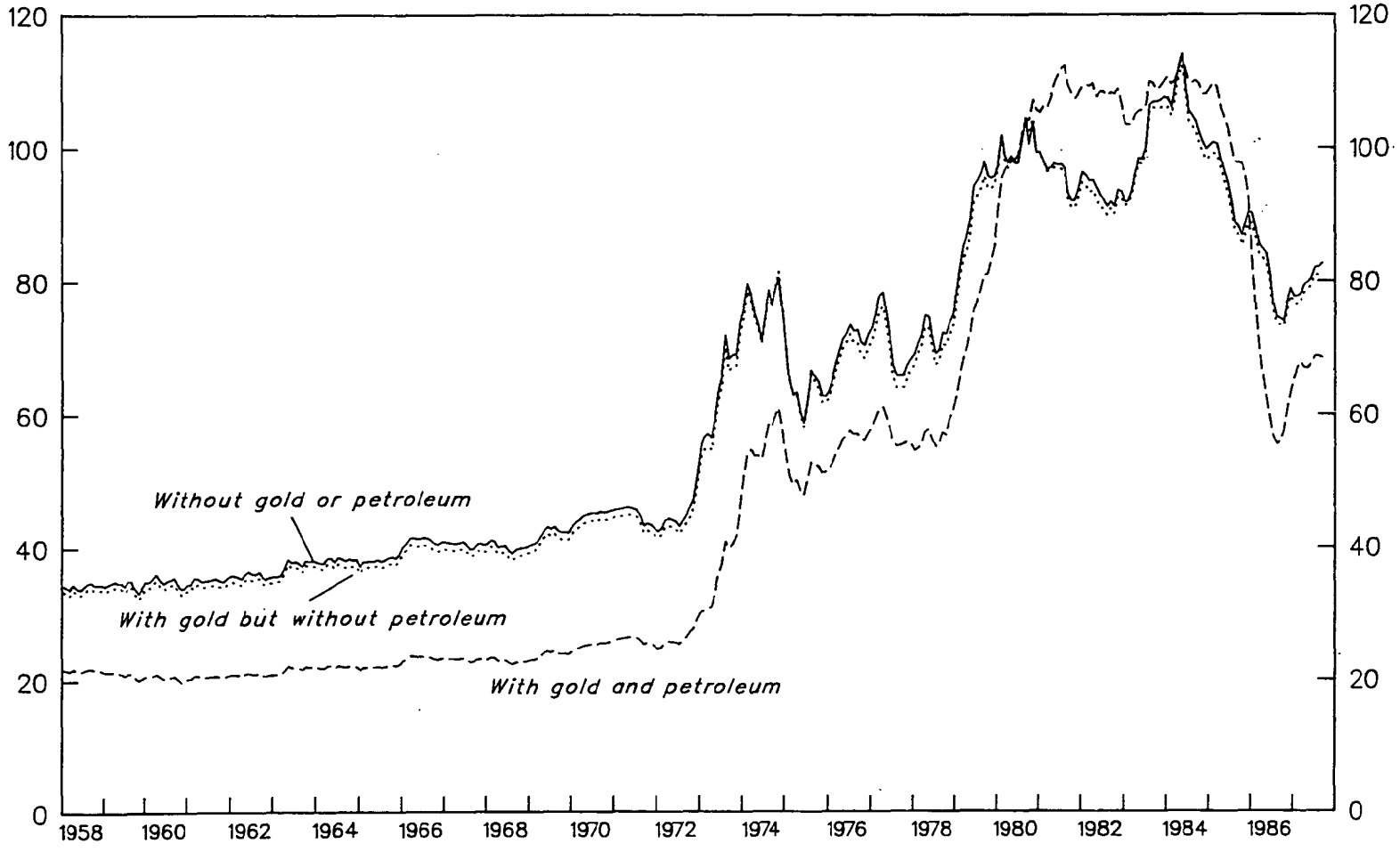
2/ From March 1985 through July 1987, the aggregate CPI measured in SDRs shows zero inflation. In local currency terms, all seven countries experienced positive (albeit, on average, very low) inflation rates. The discrepancy is attributable to the rapid depreciation of the U.S. dollar, which lowered the SDR prices in other countries by more than it raised them in the United States. During most other periods, this type of distortion appears to have been less serious. The aggregate CPI, like the individual country CPIs and the SDR, has been constructed as an arithmetic average; geometric averaging would give very similar results, except that it would show an earlier and more gradual slowing of inflation in the 1980s.

3/ This paragraph provides only a rough sketch of the actual estimation procedure. A somewhat more detailed explanation is provided in Appendix II. The full procedure will be discussed in a Working Paper that will be circulated at a later date.

CHART 7

COMMODITY PRICE INDEXES USING CONSUMPTION WEIGHTS, JANUARY 1958–SEPTEMBER 1987

(In SDRs, 1980=100)



relative importance of the various prices and have been used to derive weights for the index.

As a first approach, an index was constructed using the full set of 40 commodity prices. 1/ The weights for this index are shown in the first column of Table 3. As anticipated, some weights are negative, since the regression uses the positive covariance among the prices to minimize the residual variance. These weights were used to construct the index shown in the upper right-hand panel of Chart 8. A regression of changes in the inflation rate of the aggregate CPI on a 36-month distributed lag on the corresponding changes in this index showed a statistically significant relationship, but one that was much weaker than the combined explanatory power of the individual prices. This reduction in goodness of fit is a reflection of the loss of explanatory power when the component prices are forced into a relation with the CPI over a single time profile instead of being allowed to have varying lag distributions as in the first-stage estimates. 2/

The second estimated index was derived by eliminating the prices with negative weights. For this purpose, the negative weights in the first column of Table 3 were set to zero, and the positive ones (covering 22 prices) were recalibrated to sum to unity. The resulting weights are shown in the second column of Table 3, and the implied index is plotted in the lower left-hand panel of Chart 8. 3/ This index has a predictive power slightly greater than that of the first index, but still well below that of the unconstrained effect of the individual commodity prices.

1/ It will be recalled that the data set for the basic IMF indexes includes 39 prices for 34 commodities (see Section II.1). For the present exercise, fish meal has been excluded because the price data are not considered representative. That exclusion and the addition of gold and petroleum gives a set of 40 prices.

2/ Alternatively, one could use the estimation procedure to retrieve a weighting matrix for the 40-commodity price series for each forecast horizon out to 36 months. That is, rather than constructing a single index as an indicator of future inflation, one could note that the regression results show that the optimal weights linking commodity prices to CPI inflation vary depending on the forecast horizon. This more general approach has not yet been attempted.

3/ The weights listed in Table 3 are shown at a more aggregated level than was used for these calculations. For example, there are two prices for wool in the full data set. In the first index, one has a positive weight and the other is negative; the sum, as shown in the table, is negative. In the second index, the wool price with the negative weight is eliminated.

Table 3. Econometrically Estimated Weights for Primary Commodities 1/

Commodity	Using 40 Prices	Using 22 Prices	Using 8 Prices
Cereals	-38.7	0.4	27.5
wheat	-6.2	--	10.5
maize	1.4	0.4	15.1
rice	-33.9	--	1.9
Vegetable oils	13.2	27.1	--
soybeans 2/	-39.4	6.9	--
other 3/	52.6	20.2	--
Meat	-0.8	6.4	--
beef	22.3	6.4	--
lamb	-23.1	--	--
Sugar	19.9	8.4	--
Bananas	-0.1	--	--
Beverages	5.3	5.1	27.4
coffee	-12.6	--	18.7
cocoa	11.9	3.4	7.1
tea	6.0	1.7	1.6
Agricultural raw materials	78.1	30.7	--
timber	30.9	8.9	--
cotton	37.6	12.8	--
wool	-9.9	1.0	--
rubber	-8.5	--	--
tobacco	15.7	4.5	--
other 4/	12.3	3.5	--
Metals	10.2	18.1	11.1
gold	4.0	1.1	11.1
copper	8.2	2.4	--
aluminum	-14.8	--	--
iron ore	24.8	7.1	--
other 5/	-12.0	7.5	--
Petroleum	12.8	3.7	33.9
Total	100.0	100.0	100.0

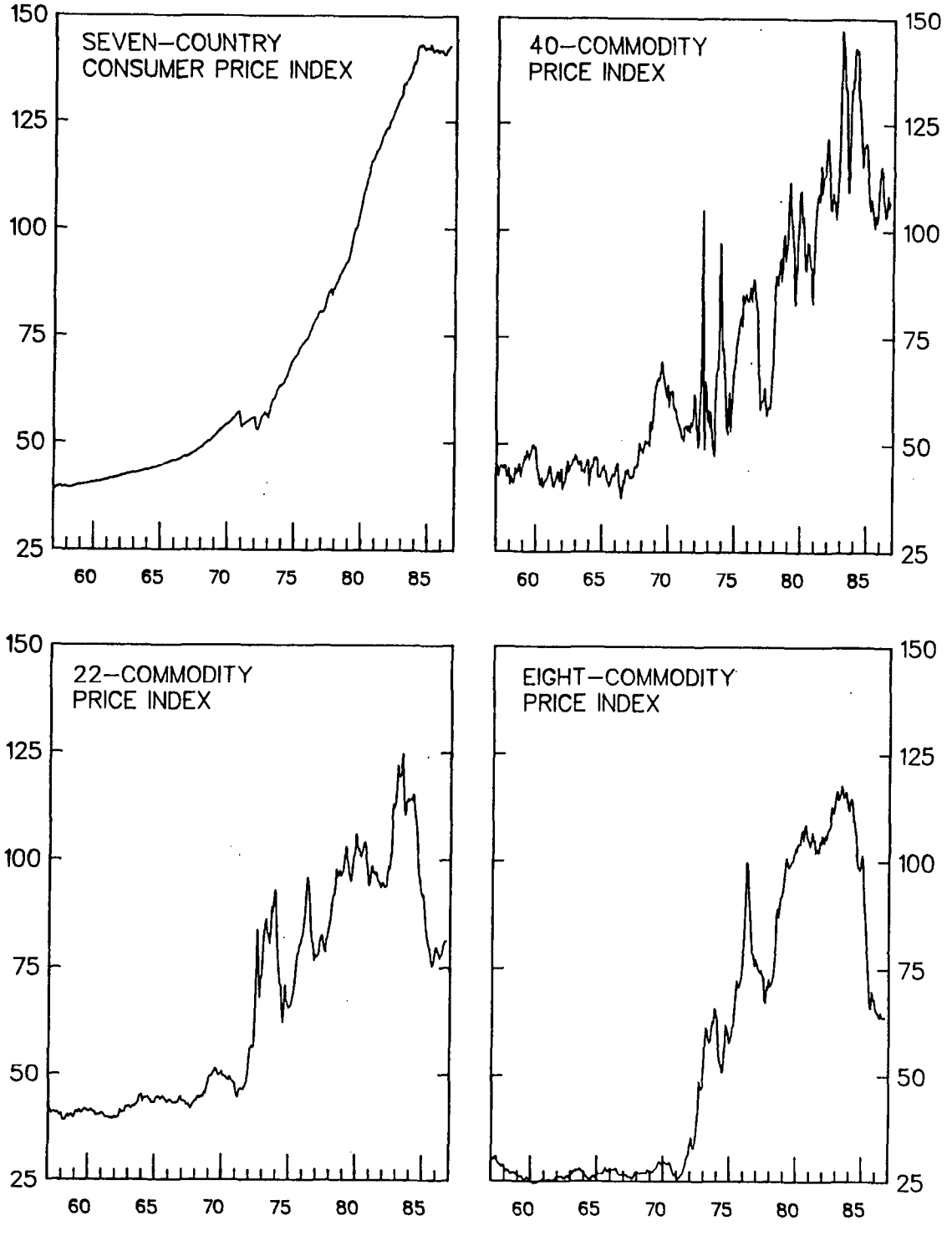
Source: Commodities Division, IMF.

1/ The base period for these weights is 1983-85.
2/ Includes soybean meal and soybean oil.
3/ Palm oil, coconut oil, groundnut oil, and groundnut meal.
4/ Hides, jute, and sisal.
5/ Tin, nickel, zinc, lead, and phosphate rock.

CHART 8

COMMODITY PRICE INDEXES USING WEIGHTS BASED ON ESTIMATED RELATIONSHIP WITH CONSUMER PRICES, JANUARY 1958–SEPTEMBER 1987 [1]

(In SDRs, 1980=100)



[1] Data for seven–country consumer price index extends through July 1987.

A third index has been derived by initially aggregating several of the commodity prices into broader categories, as was done for Chart 2, discussed in Section III. 1/ This third index drops all prices that were found to have an insignificant effect on CPI inflation, and--like the second index--all those whose influence was found to be negative. The weights for this index, which has a substantially better fit with the aggregate CPI than those of the first two indexes, are shown in the final column of Table 3. The index itself is plotted in the lower right-hand panel of Chart 8, along with the aggregate CPI from Chart 1 and the other two newly estimated indexes discussed above.

The most important price in this eight-commodity index is the price of oil, which accounts for about 1/3 of the total. Gold picks up another 11 percent, and the remainder is divided between cereals and beverages. Except for gold, these estimated relative weights are not greatly different from their relative importance in the pattern of industrial country imports; beverages, however, are much less important in consumption than in trade (see Table 2), and in that sense their significance in this index is somewhat surprising. It also may appear surprising that cereals and beverages, both of which have been subjected to a number of large supply disturbances, have significant predictive ability for general inflation; this finding is probably attributable to the commodities having been subjected to a range of disturbances at different times. The relatively large weight on the price of gold presumably is attributable to its sensitivity to shifts in inflationary expectations.

4. Evaluation of the various indexes

Examination of the plots of the various commodity price indexes reveals both similarities and differences vis-a-vis the aggregate CPI. Two of the three estimated indexes shown in Chart 8 clearly begin to show strong inflation in 1972 or 1973, ahead of the acceleration in the aggregate CPI; and all three clearly peak ahead of the CPI in the 1980s. All three indexes, in contrast with the conventional indexes discussed earlier, do show a pronounced inflation throughout the period 1973-84, when the CPI was also rising rapidly. At one time or another, each index tends to overshoot in the sense of showing more exaggerated swings than those in the CPI; these tendencies are most pronounced during the 1984-86 period, when the CPI was flattening out but commodity prices--by any measure--were falling rapidly. All three indexes tend to lead the major swings in the CPI by several months, but they also show much more volatility.

1/ This partial aggregation was done on the basis of the share of each commodity in the imports of the industrial countries. Preliminary tests suggest that similar results would be obtained using alternative weights from Table 2.

The 40-price index (which includes negative weights on a number of commodities) appears to mimic the broad movements of the CPI better than the other indexes, but it also is the "noisiest" of the three. The eight-price index has a little longer lead time for some of the major swings in inflation, and it is the least noisy; quantitatively, however, it exaggerates the swings more than the other two. Overall, the 22-price index may be the best compromise candidate from this group.

The remainder of this subsection presents some more formal tests of these relationships. 1/ In considering how to evaluate an indicator of inflationary pressures, a number of criteria need to be borne in mind. First, the indicator should lead movements in the general price level by at least a few months; otherwise, one could simply observe the price movements themselves. Second, the focus of the indicators exercise is the evaluation of medium-term trends, which in this context may perhaps be taken to mean movements covering a period of at least two to three years. It would not be helpful to find an indicator that was a good predictor of short-run fluctuations but that tended to miss broader movements. Third, inflation averaged over the large industrial countries is--as may be seen from Chart 1--highly trend-dominated; therefore, notwithstanding the need to focus on longer-term movements, it is necessary to abstract from such trends in empirical tests of correlations.

In view of these requirements, the correlations listed in Table 4 are based on one-year moving averages of the monthly data, and they are shown both for contemporaneous relationships between the commodity price indexes and the CPI and for the relationships when commodity prices lead the CPI by a year. In addition, the correlations are listed for the price levels, the 12-month inflation rates, and the monthly changes in those inflation rates. Table 4 suggests, first, that the correlations among the levels of the moving-average data are quite high, in spite of the differences among trends discussed above; on this basis, there is little footing for selecting among the different indexes. Second, the indexes that include petroleum have much higher correlations with inflation rates than the others. Third, the correlations are generally higher with the lagged data than with the contemporaneous data; in the case of the changes in inflation rates, the lagged correlations are much higher.

Other than this examination of simple correlations, the basic statistical procedure for evaluating various indexes--and other potential inflation indicators--has been to regress monthly changes in 12-month

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1/ The tests discussed in this section provide only a first look at the properties of the indexes and at their relationship to general price movements. More extensive tests would include, in particular, an examination of the stability of the estimates both within and outside the sample period.

Table 4. Simple Correlation of Commodity Price Indexes with the Aggregate Consumer Price Index, February 1962-July 1987 1/

	Contemporaneous			With 12-Month Lead		
	Price Levels	Inflation Rates	Changes in Inflation Rates	Price Levels	Inflation Rates	Changes in Inflation Rates
World export-weighted commodity price indexes						
Without gold or oil	.91	.03	-.09	.96	.44	.43
Including gold	.92	.03	-.11	.96	.47	.46
Including gold and oil	.94	.33	.29	.98	.66	.36
Industrial country import-weighted commodity price indexes						
Without gold or oil	.93	.06	-.12	.97	.47	.43
Including gold	.93	.07	-.13	.97	.48	.44
Including gold and oil	.94	.31	.21	.98	.65	.40
Consumption-weighted commodity price indexes						
Without gold or oil	.93	.02	-.14	.97	.48	.47
Including gold	.93	.03	-.13	.97	.49	.49
Including gold and oil	.94	.37	.32	.98	.68	.36
Econometrically estimated commodity price indexes						
Using 40 prices	.97	.28	--	.97	.46	.39
Using 22 prices	.92	.09	.03	.96	.44	.45
Using 8 prices	.93	.31	.23	.97	.59	.37

1/ All data are expressed as 13-month centered moving averages.

inflation rates for the aggregate CPI on lagged values of similarly transformed data for each index or other indicator. In each case, the regression uses distributed lags on the indicator. 1/ This procedure helps to capture most of the relevant relationship between the indicator and the CPI and to compensate for the tendency of commodity prices to overshoot in response to demand disturbances. In addition, it enables the estimation of the mean lag between movements in the indicator and movements in the CPI.

Current values of the indicators are excluded from these tests, on the grounds that data on the CPI are generally available about as quickly as data on the other indicators. The question therefore is whether, if one knows the history of CPI inflation up to and including the current period, the addition of information about related indicators will improve inflation forecasts (on average over time).

The regression results are summarized in Table 5. As expected, given the strict way the question was posed, the R^2 values (adjusted for degrees of freedom) are low in absolute terms. These apparently low values do not indicate that the indexes have a low correlation with future inflation, because they do not take into account the common trends between the two series. 2/ In most cases, the indicators do provide significant information about prospective movements in inflation rates.

When the tests are run over the full sample period from 1962 through 1987, the indexes that include gold and oil do much better than the others, and the eight-price index does better than the other two estimated indexes. Table 5 also shows results over the most recent eight years. This shorter sample permits a comparison of the stability of the results, and it also permits comparison with a number of alternative inflation indicators for which the early data are not complete. For this period, all of the indexes do substantially better than over the full period. Even though the recent years were broadly characterized by declining commodity prices and continuing inflation, it appears that the signals from the weakness of commodity prices did help to foretell the

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1/ The procedure is to estimate polynomial distributed lags; i.e., to constrain the pattern of effects from current and lagged values of the indicator to lie along a polynomial curve. This procedure has the advantage of flexibility while still producing a smoothly curved response over time and making efficient use of the available data.

2/ When the R^2 statistics are computed in relation to the variance of the levels of the aggregate CPI, all of the values are above 0.99. When they are computed in relation to the variance of inflation rates, all are still above 0.98. Only when computed in relation to the variance of changes in inflation rates can one begin to discriminate among the various indicators.

Table 5. Comparison of Several Inflation Indicators 1/

	1962-87		1979-87
	Correlation 2/	Mean lag 3/	Correlation 2/
World export-weighted commodity price indexes			
Without gold or oil	.036**	13	.182**
Including gold	.043**	13	.204**
Including gold and oil	.127**	8	.195**
Industrial country import-weighted commodity price indexes			
Without gold or oil	.032*	14	.176**
Including gold	.035**	14	.185**
Including gold and oil	.110**	9	.187**
Consumption-weighted commodity price indexes			
Without gold or oil	.036**	15	.171**
Including gold	.038**	14	.181**
Including gold and oil	.119**	8	.167**
Econometrically estimated commodity price indexes			
Using 40 prices	.051**	14	.176**
Using 22 prices	.046**	11	.135**
Using 8 prices	.114**	8	.180**
Other indicators 4/			
Unit labor costs			.070*
Narrow money			.023
Broad money			.024

Source: Staff estimates.

1/ For each indicator, the aggregate CPI for the Group of Seven countries, expressed in SDRs, is regressed on a polynomial distributed lag of the indicator, also in SDRs.

2/ Adjusted R^2 from a regression of changes in 12-month CPI inflation rates on lagged values of the corresponding changes in the listed variables. As noted in a text footnote, all of the R^2 statistics are above 0.98 when calculated with respect to inflation rates rather than their changes.

* = significant at 95 percent level;
** = significant at 99 percent level.

3/ In months. For the traded-weighted indexes plus gold and/or oil, the mean lag refers only to the index. Mean lags could not be reliably estimated for the shorter sample used in the last column.

4/ These data are not complete for the early part of the sample period.

slowdown in CPI inflation that began in 1982 and the cessation in aggregate inflation (measured in SDRs) after early 1985.

Another feature of the recent period is that the differences among the various indexes are greatly reduced. In fact, for this period the choice of weighting scheme seems to make little overall difference, and the inclusion of oil prices as separate indicators adds very little, in contrast to the results for the full period.

The final column of Table 5 also includes results for three alternative inflation indicators: money balances narrowly defined, money balances broadly defined, and normalized unit labor costs. As may be seen from Chart 9, these three series have shown broad movements since 1975 that are similar in some ways to those of the aggregate CPI. 1/ They would thus appear to be viable candidates to be indicators of global inflationary pressures. However, virtually all of the correlation is contemporaneous, as measured by the types of test conducted here. If this somewhat surprising result holds up under further scrutiny, these indicators would seem to contain little information other than what could be obtained by looking directly at inflation. 2/

Finally, tests have been conducted of the extent to which the various indexes significantly lead and/or lag consumer prices. The results of these tests are shown in Table 6, which corresponds to the tests for individual commodity prices shown in Table 1 (see Section III, above). As with the earlier results, which suggested that a number of commodity prices tended lead consumer prices and that there was significant feedback as well, most of the indexes show causation running in both directions. Thus the indexes do, by this standard, have value as leading indicators, and there is evidence of a significant influence from shifts in aggregate demand as reflected in the inflation rate.

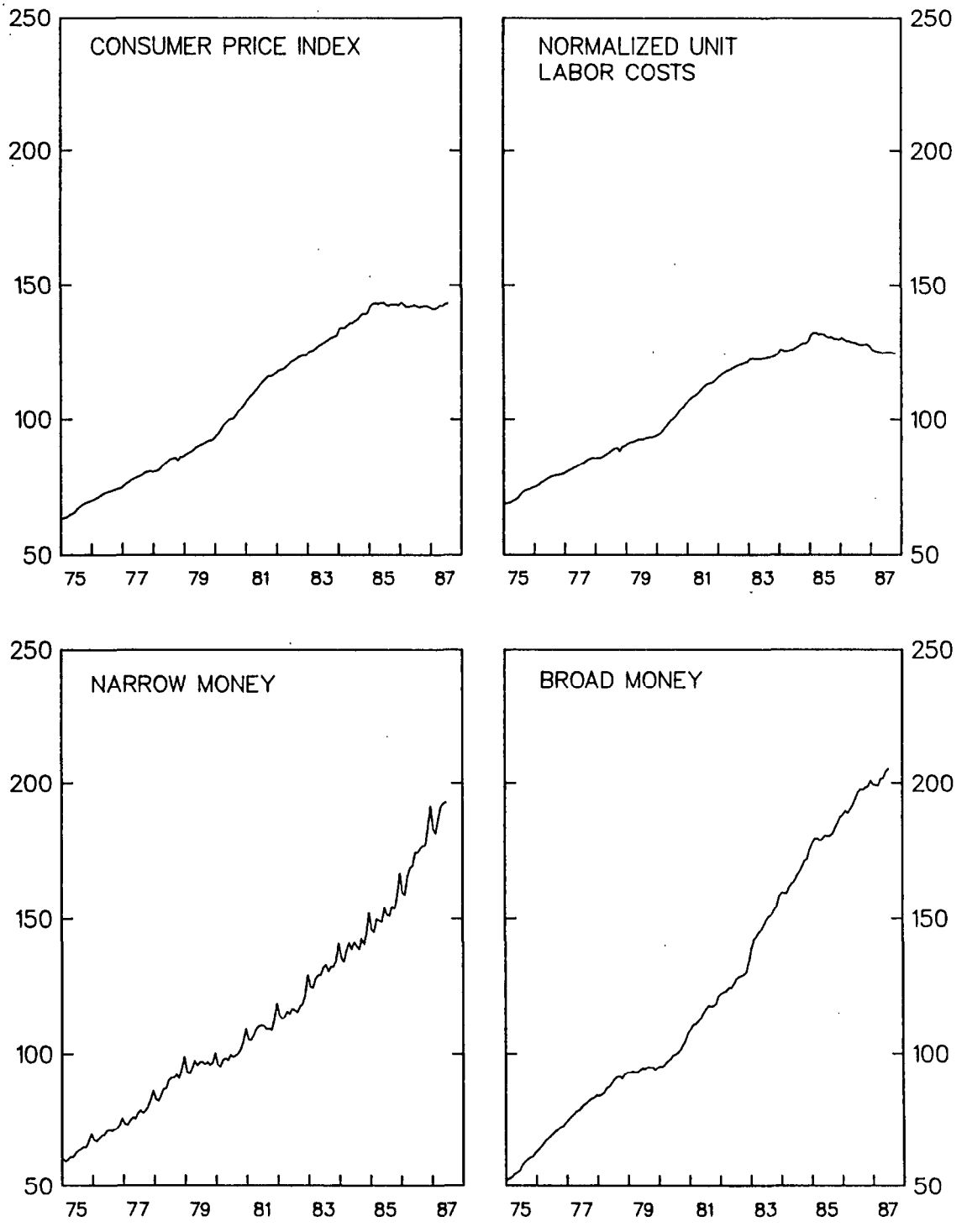
1/ The series for aggregate normalized unit labor costs (in SDRs) has been derived using the same weights as for the aggregate CPI. The aggregate money stock data have been calculated by adding up the individual country data, measured in SDRs.

2/ Most studies of the relationship between money and prices in individual countries have found that there are substantial lags between changes in monetary growth and changes in inflation. One would not necessarily expect to find the same result for a group of countries, because the aggregate stock of money balances may be more strongly affected by endogenous feedback; however, it is also possible that the differences are technical rather than fundamental. One possible explanation for the different result found in this test is that it does not take into account shifts in the demand for money; another is that the aggregation procedure across countries (which is the same for both money and prices) may have injected a strong common (and contemporaneous) factor via exchange rate changes.

CHART 9

ALTERNATIVE INDICATORS OF INFLATIONARY CONDITIONS IN THE GROUP OF SEVEN COUNTRIES, JANUARY 1975–OCTOBER 1987 [1]

(In SDRs, 1980=100)



[1] Data for narrow money, broad money, and consumer price index extend through May, June, and July of 1987, respectively.

Table 6. Test of Whether Commodity Price Indexes Lead and/or Lag Consumer Prices, January 1962-July 1987 1/

Index	Effect of Commodity Price Index on Consumer Prices	Effect of Consumer Price Index on Commodity Prices
World export-weighted commodity price indexes		
Without gold or oil	*	**
Including gold		**
Including gold and oil	**	**
Industrial country import-weighted commodity price indexes		
Without gold or oil	*	**
Including gold	*	*
Including gold and oil	**	**
Consumption-weighted commodity price indexes		
Without gold or oil	**	**
Including gold	**	**
Including gold and oil	**	**
Econometrically estimated commodity price indexes		
Using 40 prices	**	**
Using 22 prices	**	**
Using 8 prices	**	**

Source: Staff estimates.

1/ For a description of the CPI data and the regression methodology, see the footnotes to Table 1.

* = The null hypothesis that the aggregate effect of the lagging or leading values of the indicated variable is zero may be rejected with 95 percent confidence.

** = The null hypothesis may be rejected with 99 percent confidence.

V. Conclusions

This paper has discussed the properties of existing commodity price indexes and has presented several new indexes as well. The existing indexes--based on the weight of commodities in international trade--have been shown to have a significant relationship with subsequent consumer price developments over time, although the trends in these indexes have been rather different from those of consumer prices. New indexes based on the importance of commodities in consumption in industrial countries behave similarly to trade-weighted indexes as long as the commodity coverage is similar. The inclusion of petroleum in each of these indexes alters its behavior substantially and generally improves the correlation with consumer prices.

New indexes have also been estimated on the basis of the ability of each commodity price to predict future changes in consumer prices. These indexes do at least as well as the more traditional ones, and in some cases do better. These indexes have weights that are very different from those based on consumption or trade. There may be a trade-off between obtaining an index that has economically meaningful weights and obtaining one that is an optimal predictor of inflation. On the other hand, the estimated indexes may give weights for some key commodities--notably gold and petroleum--that incorporate their role in reflecting inflationary expectations or in affecting monetary conditions and thus that may be more relevant than those derived from trade or consumption.

The variability of commodity prices is much greater than that of consumer price indexes, both in the short run and over longer periods. As explained in the text and in Appendix I, this relationship can be explained at least in part by the tendency of commodity prices to overshoot in response to monetary shocks and to respond strongly to supply shocks as well as to shifts in demand. An implication is that one would not expect stability of consumer prices to follow from stability of commodity prices; instead, even if consumer prices were stable, one would still expect to see large movements in commodity price indexes as well as in individual commodity prices.

In spite of these limitations, the empirical tests suggest that a commodity price index could serve as a useful additional indicator of aggregate inflationary conditions. No single variable should be expected to provide, by itself, reliable predictions of future inflation. An optimal information set for this purpose should include a variety of information, including the current and past data on prices, monetary aggregates, and unit labor costs. The advantage of commodity price indexes, when compared with other aggregate indicators, is that they appear to provide relatively <u>early</u> indications of shifts in inflation. However, in order to interpret correctly the information from commodity price changes, it is necessary to take account of the sources of the

changes and to recognize that commodity prices frequently change relative to other prices as well as in absolute terms.

These conclusions suggest a number of topics for discussion. First, do Directors agree that commodity price indexes are a useful indicator of global inflationary pressures, as an adjunct to other indicators? Second, would it be appropriate to include gold and/or petroleum in such an index? Third, should indexes be selected primarily on the basis of the reasonableness of the pattern of weights, on the general behavior of the index over time, or on the ability of the indicator to predict inflation? Fourth, which (if any) of the indexes discussed here should be emphasized in the indicators exercise?

Models of the Relationship Between Commodity Prices and Consumer Prices

This Appendix presents the dynamic model of the interaction between commodity and industrial prices that treats commodities as either final goods or inputs, and emphasizes the role of expectations in determining movements of commodity prices. An important feature of the model is that commodity prices are determined in "auction" markets, actually financial markets that trade commodity contracts, while industrial prices are set by sellers and adjusted gradually. This permits commodity prices to react immediately to "news" about future inflation, and to lead adjustment of industrial prices. The two cases of commodities as final goods or as inputs are treated separately, but the basic results are the same in both cases. With unanticipated monetary disturbances, commodity prices overshoot and lead industrial prices, but with real disturbances the relationship is less clear.

1. Commodities as final goods

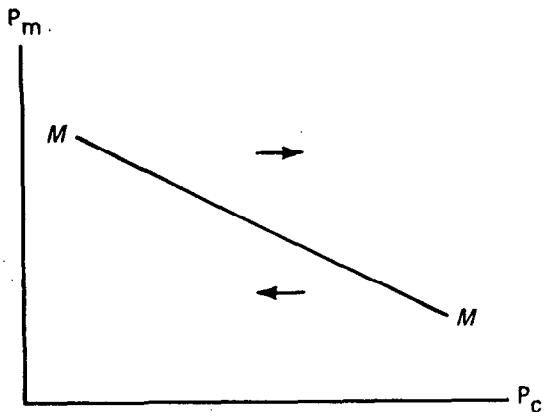
This section discusses a basic dynamic model of the interaction of commodity and industrial prices in which the two are final goods entering the CPI, and commodity prices are determined in flexible markets with forward-looking expectations. The model can be interpreted as one country with two sectors, or as two countries, one producing commodities and the other a perishable industrial output. The model includes a monetary sector, in which expectations of commodity price movements are important, and an industrial sector, in which prices adjust gradually following excess demand. To focus attention on price dynamics, the level of real output in the industrial sector is held constant. The model is an extension of Frankel (1986), which applies the Dornbusch (1976) overshooting model to the case of commodity price dynamics.

In the money market, the demand for real balances is a function of the nominal interest rate and the level of real GNP. The deflator for the money supply is the CPI, which is a weighted average of the industrial and commodity prices, with weights a and 1-a, respectively. The interest rate equals the expected rate of change of the commodity price plus constant storage costs. Therefore, in equilibrium with zero expected commodity price inflation, the interest rate equals the percentage storage cost. The relation between the industrial price P_m (m for manufactures) and the commodity price P_c that maintains equilibrium in the money market for a given level of the money stock and zero expected change in the commodity price is the negatively sloped MM line in panel (a) of Figure 1. 1/

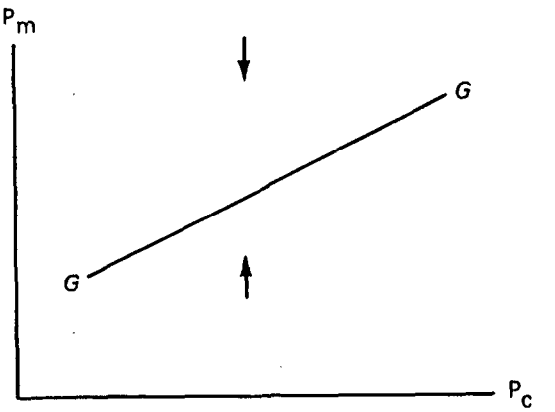
1/ The slope of the MM line is (a-1)/a.

FIGURE 1

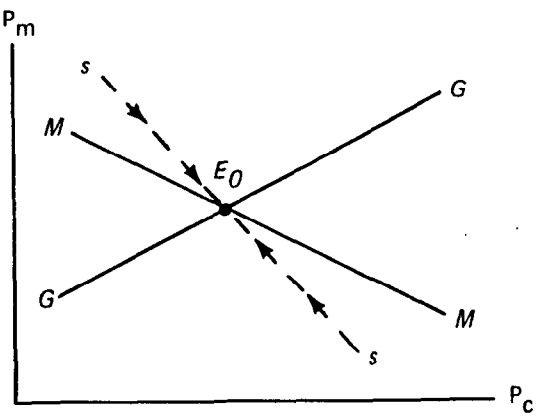
A SIMPLE MARKET MODEL OF COMMODITY AND MANUFACTURES PRICES



(a) Financial Market Adjustment



(b) Goods Market Adjustment



(c) Market Equilibrium

For a point above the MM line to be consistent with money market equilibrium, P_c must be expected to rise. This is because above the line the CPI is higher, and real balances lower, than on it. This makes the interest rate higher than storage costs above the MM line, so commodity prices must be expected to rise. If expectations exhibit perfect foresight, P_c must actually be rising above the MM line. In other words, a commodity price level above that consistent with zero expected inflation must be supported by a positive rate of commodity price inflation. Similarly, at any point below the MM line, commodity prices would be falling. These dynamics of P_c are shown by the horizontal arrows in panel (a) of Figure 1.

The supply of the industrial good is assumed to be constant. Demand is assumed to be an increasing function of the price of commodities relative to industrial goods, P_c/P_m, and a decreasing function of the interest rate and therefore of the expected rate of commodity price inflation. An increase in the cyclically adjusted budget deficit is assumed to increase the demand for industrial goods. Since supply is fixed, excess demand depends only on the relative price, the interest rate, and the budget position. The price of the industrial good is assumed to adjust gradually to eliminate excess demand. The positively sloped GG line in panel (b) of Figure 1 shows the relationship between the two prices that would maintain zero excess demand in the market for industrial goods for a given value of the money stock and budget deficit. The slope of the line is positive because an increase in the commodity price creates excess demand for industrial output, requiring an increase in the industrial price to eliminate it. The slope is less than unity because as prices rise, the interest rate also rises, reducing the demand for industrial goods. So as the price of commodities rises, the increase in industrial goods prices needed to eliminate excess demand is less than proportional. At points above the GG line, there is excess supply of industrial goods and the price is falling. Below the line, there is excess demand and the price is rising. The dynamics of adjustment of the industrial price are summarized by the vertical arrows in panel (b) of Figure 1.

The two equilibrium lines are put together in the bottom panel (c) of Figure 1 to show the equilibrium pair of prices at E_0 for a given money stock and real commodity supply conditions. The dynamic adjustment to equilibrium is along the stable ss path. 1/ This path has two essential properties. It leads to the equilibrium, and along it the expected rate of change of the commodity price is realized. All other paths explode away from the equilibrium; they are speculative bubbles. The assumption that the market seeks out the stable ss path is equivalent to

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1/ This is called the saddle path in the technical literature on dynamic adjustment.

assuming that speculative bubbles are unsustainable. Eventually they collapse, and the market moves back to the stable path.

The model of Figure 1 can be used to illustrate two properties of commodity price behavior that are important for constructing a leading indicator for inflation. Following an unanticipated increase in the money supply, commodity prices overshoot and lead the adjustment in prices of industrial goods. These two properties are seen in the top part of Figure 2, which shows the effects of an unanticipated increase in the money supply. If the model is interpreted as representing two countries, this would involve a proportional increase in both countries' money supplies. The original equilibrium from Figure 1 is at E_0 in Figure 2. An increase in the money supply shifts both the MM and GG lines, and the new long-run equilibrium moves proportionately out to E_1. In the long run, both prices rise by the same proportion as the money supply. In the short run, the gradually adjusting industrial price does not move, but the free commodities price jumps to the new ss path at E_0'. Then gradually the industrial price rises and the commodity price falls along the ss path to the new equilibrium at E_1.

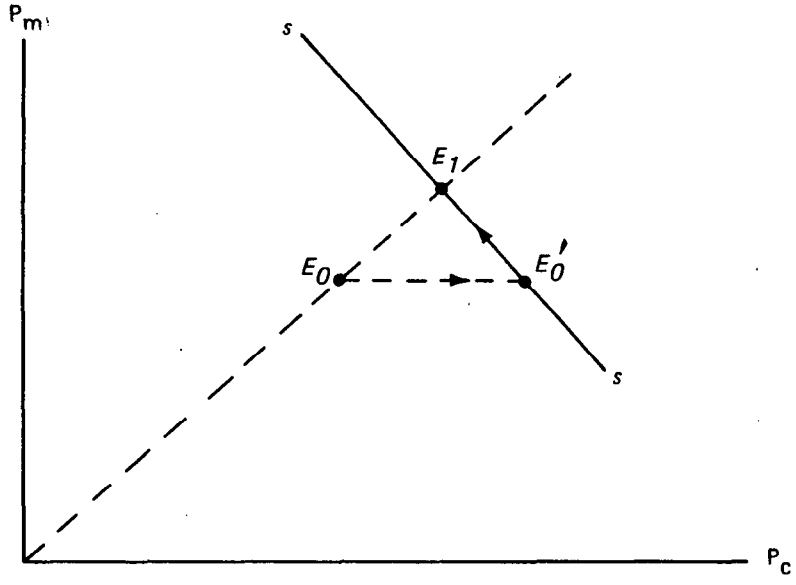
The initial jump in the commodity price is consistent with an initial decline in the interest rate. In the original equilibrium at E_0, the expected rate of commodity price increase was zero, and the interest rate was equal to the percentage storage cost. The rise in the money supply increases real balances initially, reducing the interest rate below storage cost. This is consistent with equilibrium only if commodity prices are expected to fall. So initially the commodity price must rise by enough to create the expectation that it will fall during the adjustment period. This generates the jump onto the new ss path, along which the commodity price falls as expected as the economy moves toward E_1. At that point, real balances and the interest rate are back to their original levels, and the expected rate of commodity price inflation is again zero.

The overshooting and leading behavior of commodity prices with monetary disturbances should be clear from the example of panel (a) of Figure 2. Commodity prices respond immediately in response to the disturbance, and industrial prices follow along a gradual adjustment path. In a situation in which the signals from the various monetary aggregates are unclear, the movements in commodity prices can be interpreted as distilling the information in the aggregates into a clearer signal.

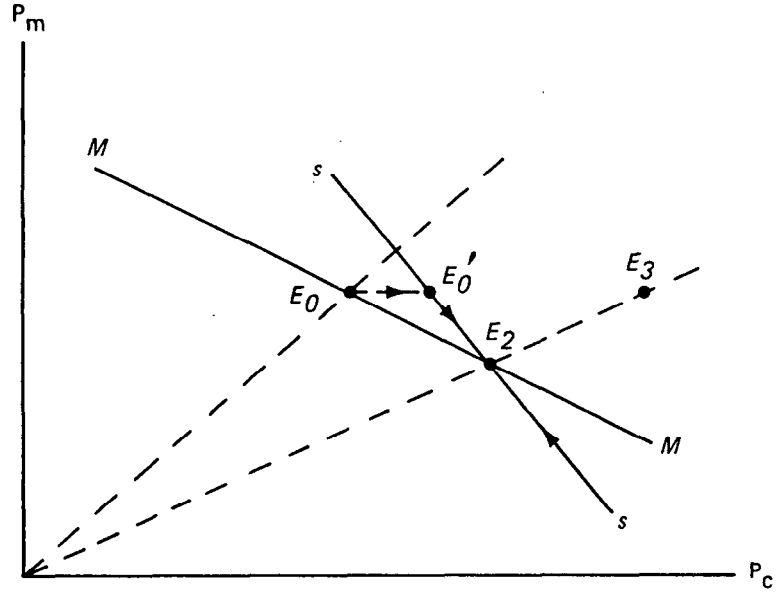
The reaction of the model to a real disturbance that alters the equilibrium relative price of commodities is shown in panel (b) of Figure 2. As one would expect, it is substantially different from the reaction to a monetary disturbance. Suppose that a supply shock, or a fiscal tightening that reduces the demand for industrial goods relative to commodities, raises the equilibrium relative price of commodities.

FIGURE 2

PRICE ADJUSTMENTS WITH COMMODITIES AS FINAL GOODS



(a) Monetary Disturbance (Overshooting)



(b) Real Disturbance (Undershooting)

This shifts the GG line down along the MM line to a new long-run equilibrium at E_2, which lies on a ray from the origin that characterizes the new higher ratio of commodity prices to industrial prices. With no monetary accommodation, the MM line does not move. The result is that commodity prices jump onto the new ss path at E_0', and then rise gradually as industrial prices fall in the movement toward the new equilibrium E_2. As is usual in this type of dynamic model, the commodity price undershoots in response to a real disturbance. The industrial price must fall if there is no monetary accommodation. So in this case commodity prices lead, but industrial prices move in the opposite direction.

A result of a general price increase from this relative price disturbance requires monetary accommodation. To prevent a fall in industrial prices, the money supply would have to be increased by enough to shift the new equilibrium out along the ray from the origin to E_2 in Figure 2 to a point horizontally across from E_0. This equilibrium is E_3 in panel (b) of Figure 2. This degree of accommodation would allow commodity prices to jump from E_0 to E_3 with no change in industrial prices. An increase in industrial prices would be generated by overaccommodation that moves the equilibrium out further than E_3.

It appears that commodity prices would not be a reliable indicator of future price developments in the presence of supply shocks, unless monetary policy systematically accommodated these shocks. This problem can be minimized, although probably not eliminated, by using an index of commodity prices that are subject to supply shocks from different, preferably independent, sources. Such an index would resemble a portfolio of commodities with a minimum aggregate variance from supply disturbances, since at any point in time positive and negative disturbances would be offsetting. Presumably movements in this index would be dominated by demand disturbances, actual or expected, which would be a desirable property of an inflation indicator.

2. Commodities as inputs

The case of commodities as inputs can be discussed more briefly, since only two minor modifications need to be made to the model, and the results are essentially the same. In the monetary sector, with commodities as inputs, a good candidate for the deflator for the money stock is the price of industrial goods. This change makes the MM line in the top panel of Figure 3 horizontal at the level of the industrial price that clears the money market with zero expected commodity price inflation. 1/ At points above the MM line, real balances are lower than on it, so the interest rate is higher than the percentage storage cost of

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1/ Movement to the right along the MM line in Figure 6 implies falling value added in the industrial sector, since input prices are rising against constant output prices. So if the vertical axis in Figure 6 measured the price of industrial sector value added instead of final output, the MM line would be downward-sloping, as before.

the commodity, and commodity prices are expected to rise. If expectations exhibit perfect foresight, then commodity prices are actually rising. Below the MM line, commodity prices are falling. These dynamics are illustrated by the horizontal arrows in the top panel of Figure 3.

The market for industrial output is slightly more complicated. The demand for industrial goods is a decreasing function of their price via a real balance effect, and a decreasing function of the interest rate. Again, an expansionary fiscal shift is assumed to increase demand. The supply of industrial goods is an increasing function of their price relative to commodities. Therefore, excess demand is a decreasing function of the relative price of industrial goods, their price level for a given money supply, and the interest rate, and is increased by a fiscal expansion. So to hold excess demand equal to zero in the market for industrial goods with a given increase in the commodity price, the industrial price would increase less than proportionately because it affects both supply and demand and because the interest rate rises. Thus, the GG line along which excess demand for the industrial good is zero has a slope less than unity in the top panel of Figure 3. Above this line, there is excess supply and P_m is falling. Below it, P_m is rising.

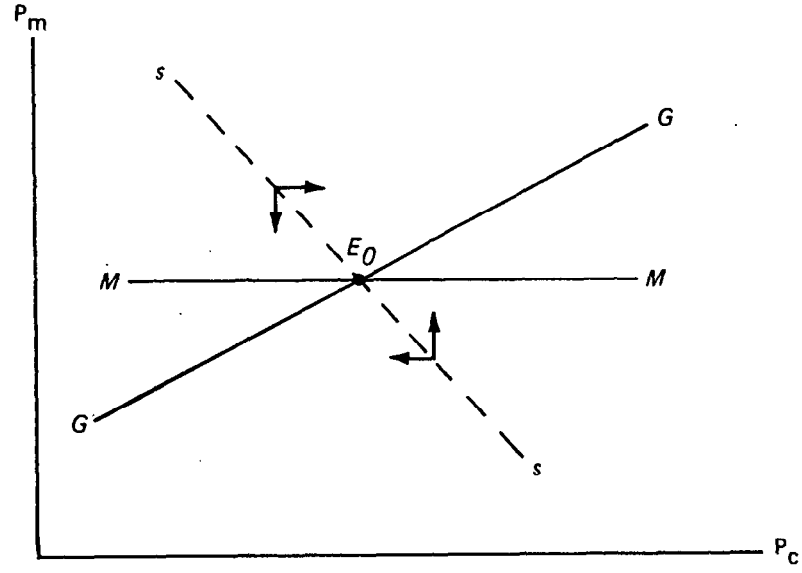
The stable dynamic adjustment path is ss in Figure 3, as in the case of commodities as final goods. The assumption again is that speculative bubbles are unsustainable, so that eventually they burst and the market seeks the stable path. So the dynamics in this case are essentially the same as in the case with commodities as final goods.

The analysis following an unanticipated increase in the money supply is the same as that in panel (b) of Figure 2. As before, the equilibrium intersection of the MM and GG lines shifts out along the ray from the origin. Eventually, both prices increase proportionately to the increase in the money stock. In the short run, the commodity price jumps to the stable ss adjustment path. Then the commodity price falls as the industrial price rises gradually to the new equilibrium. As in the case of commodities as final goods, the commodity price overshoots and leads the adjustment of the industrial price.

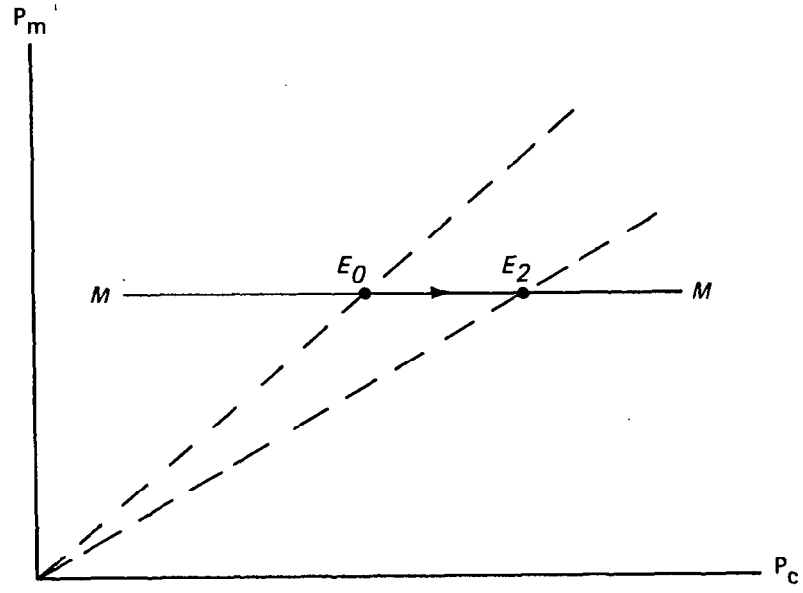
Adjustment to a supply shock or fiscal shift that raises the equilibrium relative price of commodities in terms of industrial output is illustrated in the bottom panel of Figure 3. The GG line shifts out to intersect the MM line at the new equilibrium price ratio. The commodity price rises, but, with no monetary accommodation the price of industrial goods remains unchanged. The price of value added in the industrial sector or country falls. Again, for a general inflation to ensue, monetary over accommodation is necessary. A broad index of commodity prices can essentially average out supply shocks, leaving monetary disturbances to dominate movements of the index.

FIGURE 3

PRICE ADJUSTMENTS WITH COMMODITIES AS INPUTS



(a) Market Equilibrium



(b) Real Disturbance

In these two models, commodity prices play the role of an inflation hedge. With gradual adjustment of industrial prices, agents can protect themselves against an anticipated inflation by buying commodities or, more generally, commodity futures contracts. The result falls naturally out of an analysis with two prices, one that adjusts gradually and one that can jump. The latter becomes the hedge against inflation in the former. A richer model would include more prices, such as foreign exchange or domestic equities, that can adjust instantaneously to inflationary expectations. In such a model, several variables can play the role of inflation hedge, with a wide variety of over-shooting and under-shooting behavior. This was shown in Frenkel and Rodriguez (1982). Then which price is the best indicator of future inflation becomes an empirical question. The point of the models here is to show that commodity prices are a reasonable candidate.

The models just reviewed treat commodity prices as an inflation hedge, and show them moving in anticipation of inflation. They deal with the role of commodity prices as an expression of the market's expectations of general inflation. An alternative view is that commodity prices would lead general prices because commodities enter at the first stage of the production process. It is easy to show that the proportional movement of prices that characterized reaction to monetary disturbances in those models is also consistent with the stage-of-processing view.

The point can be made in a framework that includes an imported commodity that combines with labor to produce an industrial good. The economy also produces a service using only labor. The CPI is a consumption-weighted average of the prices of the industrial good and the service. The nominal wage is tied to the CPI. In this case, shocks to the commodity price directly affect the cost and price of the industrial good in proportion to the share of the commodity in cost. The increase in the industrial price raises the CPI by the consumption weight of the industrial good, and this CPI increase feeds into the wage rate. The increase in wages raises costs and prices in both domestic sectors, further increasing the CPI and wages. The spiral ends when both domestic prices, the CPI, and wages all have increased by the initial percentage increase in the commodity price. In this framework, then, commodities combine with labor in producing industrial goods and services, and movements in commodity prices lead movements in the other prices and in the CPI. The eventual movement of all prices is proportional, as in the expectations-based models under monetary disturbances.

Estimation Procedure for the New Commodity Price Indexes

This Appendix provides additional information on the estimation procedures that are described briefly in Section IV.3 of the text. It will be recalled that two basic approaches have been used to estimate commodity price indexes on the basis of their relationship with the aggregate CPI. One is to allow the data to determine the weights freely, with all commodity prices as contenders for inclusion in the index. The other involves constraining the data, by eliminating negative weights and, in the final set of estimates, by initially aggregating commodities that have small weights in industrial-country trade or consumption into somewhat broader categories. The second approach was intended to check whether the efficiency of the estimates might be improved by the constraints.

1. Estimation using all available commodity price data

The objective of the first approach is to allow the maximum freedom for the data to "speak" in determining the "best" weights for commodities for the purpose of predicting CPI inflation. This approach uses the prices that are incorporated into the available IMF commodity price indexes, plus the prices of gold and petroleum, in an unconstrained regression framework. There are some 30 years of monthly observations on the 40 commodity price series, extending from January 1958 through September 1987. With a forecast horizon chosen to run from 1 to 36 months, the problem is to devise a procedure that narrows quickly to the most important explanatory variables over different forecast horizons with a minimum of loss in efficiency in utilizing the information in the data.

The next few paragraphs describe the procedure that was employed to derive the "40-commodity" index discussed in the text. First, the aggregate CPI and all 40 series, expressed as logarithms of SDR indexes, were transformed by taking the first differences of their 12-month differences (i.e., changes in inflation rates). This procedure produces stationary time series. Second, the forty principal components were extracted from the data matrix of the transformed commodity price data. This step produces orthogonal regressors for the regression analysis. Third, a multiple regression was estimated over the period February 1962 to July 1987 with the transformed CPI as the dependent variable and the forty principal components as independent variables (with the constant suppressed) separately at each lag length from 1 to 36 months.

These regression results were used to select significant principal components for the remaining analysis. Two selection criteria were used to narrow the set of principal components. The first was to rank them by average absolute t-ratio across lags. The second was to select principal components with coefficients that were significant at the 1 percent level at at least 4 different lags, of which at least one was longer than 12

months. The second criterion yielded 10 principal components, of which 7 coincided with the highest 7 on the t-ratio criterion. Thus the two criteria together yielded a list of 13 candidate principal components. These were chosen as the final principal components for the next stage.

Next, a series of regressions was estimated with the transformed CPI as the dependent variable, and fourth-order polynomial distributed lags with length 36 months (constrained to zero at the far end only) on the candidate principal components as independent variables. The search began with the seven principal components that met both selection criteria. Using overall goodness of fit and significance of individual principal components as criteria, the search procedure then tested each of the other six candidates against the original seven. The search quickly narrowed to seven principal components, of which five were among the original overlapping seven, and the other two of which had passed the second, but not the first, significance criterion (ranking eleventh and fourteenth by the average t-ratio criterion). After some adjustment of lag lengths, a final regression was obtained with 306 monthly observations and 35 regressors. This regression had a Durbin-Watson statistic of 2.15 and an adjusted R^2 of 0.29.

The lag distributions on the seven principal components in the final regression differ in length and shape. Therefore, when the implied weights on the commodity prices are retrieved, a weighting matrix is obtained, with a different set of weights for each lag length. Thus the distributed lag coefficients on the final principal components equation can be used to estimate a different set of weights for the commodity prices at each forecast horizon, reflecting differences in the information in the various commodity prices for explaining aggregate CPI inflation at different forecast horizons. This step has not been taken, at this stage.

As an alternative that yields a single set of weights, the coefficients of the lag distributions in the final principal components regression were aggregated across time. The sum of each lag distribution was applied to each principal component to retrieve a single set of weights that reflects the average information in the commodity price series across forecast horizons. 1/ These are the weights shown in the first column of Table 3.

1/ The sum of the lag coefficients on one principal component was insignificantly different from zero, but with positive and negative coefficients at different lags. Using the sums of the coefficients on the lagged values eliminated this principal component. Elimination of this principal component from the final regression reduced the adjusted R^2 from 0.29 to 0.22. The sums of the lag distributions on the other principal components were changed very little, however. These sums were used to calculate the time-aggregated weights, since this was the best-fitting regression under the constraint that the one principal component not be included.

A regression of the transformed aggregate CPI on a 36-month polynomial distributed lag on the single time-aggregated index using the weights in the first column of Table 3 yielded an adjusted R^2 of 0.09. The reduction from 0.29 is a measure of the cost of time aggregation into a single index.

2. Estimation subject to constraints

The second index (the "22-commodity" index discussed in the text) was derived from the first by simply eliminating all of the commodities whose prices had negative coefficients in the first index. A regression of the transformed aggregate CPI on a 36-month polynomial distributed lag on the transformed version of this second index yielded an adjusted R^2 of 0.11, compared with 0.09 for the first index. When the lag was shortened to 24 months, the adjusted R^2 rose to 0.13. This figure is still less than half the value obtained with the principal components rather than the index as regressors, which indicates that more than half of the explanatory power in the data is lost through aggregation of the lag distributions across time.

The third index (the "eight-commodity" index) was derived by a procedure that differed in several respects from the first. Most notably, a number of prices in the original set of forty were aggregated into broader categories, in order to eliminate the possibility that a commodity with relatively little importance in trade or consumption might have a large weight in the index. 1/ This aggregation procedure, using industrial-country import weights, produced six aggregates (cereals, vegetable oils, beverages, meat, metals other than gold, and fibers) and five single commodities (sugar, gold, petroleum, rubber, and timber). 2/

When these eleven prices were converted into stationary series by taking changes in 12-month rates of change, there was very little multicollinearity in the data matrix. Therefore, it was decided to compute the regressions using these transformed prices rather than their principal components. Thus the second stage of the procedure was to regress the transformed aggregate CPI on polynomial distributed lags of the eleven transformed price series. These distributions were fourth-order polynomials out to 36 months, constrained to zero at the far end only. That regression yielded an adjusted R^2 of 0.22.

1/ Bananas, which did not fit neatly into the sub-aggregates and which had a small weight in both consumption and trade, were eliminated from this data set.

2/ The price of sugar in this context is a weighted average of the three prices in the full data set (a free market price and the U.S. and European Community import prices). The composition of the other sub-aggregates may be seen in Table 2 of the text.

On inspection of these results, three commodity groups (vegetable oils, rubber, and "other metals") were eliminated as having insignificant or negative effects, and the lag lengths for the remaining prices were shortened to 12 months (except for petroleum, whose effect ran out to 24 months). The regression of the transformed aggregate CPI on this revised data set yielded an adjusted R^2 of 0.25, still somewhat smaller than the 0.29 obtained in the regression using principal components of the full data set. Finally, the coefficients on the sums of the lag distributions from this regression were normalized to sum to unity and were used as the weights for the third index.

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