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WP/89/72

INTERNATIONAL MONETARY FUND

Research Department

Commodity Prices and Inflation:
Evidence from Seven Large Industrial Countries

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September 14, 1989

Abstract

A two-country theoretical model is presented, showing the effects of monetary, fiscal, and supply-side disturbances on prices of primary commodities and manufactured goods, and on exchange rates. If monetary shocks dominate, then commodity prices should lead general price movements, and the level of commodity prices should be correlated with the general inflation rate. Country-specific commodity price indexes are developed for the major industrial countries. Several empirical tests broadly support the conclusions of the model. Commodity price levels tend to be cointegrated with consumer-price inflation rates. Commodity price movements contribute weakly to predictions of inflation rates but more strongly to predictions of turning points in inflation.

JEL Classification Numbers:
132, 134

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I. Introduction

Considerable interest has arisen regarding the relationship between commodity prices and broader measures of inflationary pressures. An earlier paper (Boughton and Branson, 1988) argued that a conventional trade-weighted index of world commodity prices contains useful information about future changes in the average inflation rate in large industrial countries. This paper extends that research in two directions: (1) by developing a theoretical open-economy model in which countries differ in the role that is played by commodity prices; and (2) by deriving commodity price indexes that are specific to each country and testing the relationships between those indexes and inflation in the countries concerned.

Section II describes the theoretical model and suggests a number of hypotheses to be tested. A conclusion of this section is that commodity price movements should lead general price movements as long as disturbances are predominantly monetary. If commodity prices jump in response to such disturbances, while other prices respond more gradually, then the level of commodity prices should be positively correlated (and cointegrated) with the rate of inflation in manufactures prices. These conclusions should apply more to broad commodity price indexes, on which the effects of supply shocks to specific commodities are relatively weak, than to narrow indexes. Even so, unaccommodated fiscal policies and other general real disturbances could create substantial noise in the relationships between general price inflation and movements in broad commodity price indexes.

The new commodity price indexes are presented and discussed in Section III. The distribution of weights among commodities varies markedly across countries, but as long as the indexes are denominated in the same currency the variation in their intertemporal movements is limited. The major source of contrast in the behavior of the individual-country indexes derives from exchange rate movements.

Empirical tests of the relationships between the commodity price indexes and general inflation rates are the subject of Sections IV and V. Section IV presents some cointegration tests that suggest the possibility that the level of commodity prices may be cointegrated with the rate of inflation in consumer prices; that is, low inflation in industrial countries appears to be associated with low levels of commodity prices, and conversely. Various single-equation tests of predictive power indicate that there is some tendency for movements in commodity prices to precede consumer price changes and to contribute to inflation predictions; this tendency, however, is not observed in all countries, nor in all time periods. Commodity price indexes have a stronger predictive relationship with turning points in consumer price inflation than with the level of the inflation rate.

Section V discusses evidence regarding the relationship between commodity prices and output deflators. No evidence is found to support the hypothesis that the linkages with output deflators are stronger in

countries that have a relatively large share of output attributed to primary commodities. In general, commodity prices contribute to predictions of output deflators with slightly less power than in the case of consumer prices. The paper concludes with a brief discussion of some econometric model simulations that broadly confirm the major predictions of the theoretical model and the single-equation tests.

II. A Two-Country Model of Commodity Prices, Exchange Rates, and Inflation

This section presents a dynamic model of commodity and industrial prices in a framework of two goods and two countries. The goods are commodities and manufactures, with their prices determined in a world market in a common currency, the Group Currency Unit (GCU). ^{1/} The two countries have a floating exchange rate and different structures of production. The exchange rate of each against the GCU translates the prices of the two goods into the home currencies. The weights of the two goods in production and consumption in each country then determine the movements of the GNP deflator and the CPI, respectively. The model has two levels. The world market (subsection 1) determines the relative goods prices, while a relative monetary model (subsection 2) determines exchange rates. The two together give home-currency prices.

1. World model of commodities and manufactures prices

This subsection discusses a dynamic model of the interaction of commodity and manufactures prices at the level of the world market. Commodity prices are determined in flexible world markets with forward-looking expectations. Manufactures prices are set by sellers and adjust gradually. The model is essentially the same as the one presented in Boughton and Branson (1988), interpreted now as a world model in GCU.

Equilibrium in the world money market is described in the standard form of equation (1):

$$(1) \quad m - \alpha p_m - (1 - \alpha) p_c = \phi y - \lambda i.$$

Here m , p_m , p_c , and y are the logarithms of nominal world money, the price of manufactures, the price of commodities, and world real output, all expressed in GCU; i is the average world nominal short-term interest rate; and α is the share of manufactures in world output, and in the world CPI. Commodity price inflation and the interest rate are related by the arbitrage condition:

$$(2) \quad i = \dot{p}_c + b,$$

^{1/} Conceptually, the GCU is an implicit weighted average of the two currencies. It is defined for the general multi-country case in Boughton and Branson (1988).

where b is the real return to holding commodities for final use, net of storage costs, and \dot{p}_C is the expected rate of change of the commodity price. Substitution of equation (2) into (1) yields the first dynamic equation:

$$(3) \quad m - \alpha p_m - (1 - \alpha) p_C = \phi y - \lambda(\dot{p}_C + b).$$

The downward-sloping locus of points where $\dot{p}_C = 0$ is shown in Figure 1; its slope is $-(1 - \alpha)/\alpha$.

For a point above the $\dot{p}_C = 0$ line to be consistent with money market equilibrium, P_C must be expected to rise. This is because above the line, P_C is higher, and real balances are lower, than on it, so the interest rate must exceed b , and P_C must therefore be expected to rise. If expectations exhibit perfect foresight, P_C must actually be rising above the line. These dynamics of the GCU commodity price are summarized by the horizontal arrows in Figure 1.

The supply of real industrial output y_m is assumed to be constant. Demand is assumed to be an increasing function of the price of commodities relative to manufactures, P_C/P_m , and a decreasing function of the real interest rate in terms of manufactures. Thus demand is given by

$$(4) \quad d = \delta(p_C - p_m) - \sigma(i - \dot{p}_m) + g,$$

where g is the logarithm of exogenous expenditure, which can represent aggregate world fiscal policy. We assume that a fiscal expansion increases the relative demand for industrial goods.

The price of manufactures is assumed to adjust gradually to eliminate excess demand:

$$(5) \quad \dot{p}_m = \pi[\delta(p_C - p_m) - \sigma(i - \dot{p}_m) + g - y_m].$$

The terms in p_m can be consolidated to yield the second dynamic equation:

$$(6) \quad \dot{p}_m = \eta[\delta(p_C - p_m) - \sigma i + g - y_m],$$

where $\eta = \pi/(1 - \pi\sigma)$. This term must be positive if a positive shock to excess demand is to raise the price of manufactures.

The positively sloped $\dot{p}_m = 0$ line in Figure 1 is the locus of points along which excess demand for manufactured goods is zero, given the value of the world money stock, which influences the world nominal interest rate i . The slope is less than unity because an increase in the price level raises the interest rate and reduces the demand for manufactured output. At points above the $\dot{p}_m = 0$ line, there is an excess world supply of manufactured goods, and their CGU price is falling, assuming $\eta > 0$. Below the line, there is excess demand and the price is rising. The dynamics of adjustment of the GCU manufactured price are summarized by the vertical arrows in Figure 1.

The intersection of the two equilibrium lines in Figure 1 gives the equilibrium pair of GCU world prices for given world money stock, fiscal policy, and real supply conditions. ^{1/} Dynamic adjustment to the equilibrium proceeds along the stable saddle path ss . This path has two essential properties: it leads to the equilibrium (technically, satisfies the transversality conditions implicit in the model), and along it the expected rate of change of the commodity price is realized. All other paths with expectations realized from period to period explode away from the equilibrium; they are speculative bubbles. The assumption that the market seeks out the stable ss path following a disturbance is the same as assuming that speculative bubbles are unsustainable.

The model of Figure 1 can be used to show the potential usefulness of movements of commodity prices as an indicator of future inflation. Consider an unanticipated increase in the world money supply, originating in either country. In the long run, both prices would increase proportionately in GCU. Thus in Figure 1 both the $\dot{p}_c = 0$ and the $\dot{p}_m = 0$ lines shift out, so that the long-run equilibrium moves out proportionately. This is shown as the movement from point 0 to point 2 in Figure 2, which also shows the new ss path into the new equilibrium. The commodity price can adjust instantaneously to reflect the expected inflation, while the manufactures price can adjust only over time. Thus in Figure 2, the flexible commodity price jumps onto the new ss path at point 1, and then the two prices adjust gradually along the ss path to point 2. In response to an unanticipated monetary shock, commodity prices jump and overshoot, and lead the subsequent inflation in industrial prices.

In response to repeated monetary shocks, jumps in the level of commodity prices would lead changes in the rate of inflation of industrial prices. This should produce a positive correlation between the level of world GCU commodity prices and the subsequent rate of inflation of manufactures prices if repeated monetary disturbances are empirically important. Cointegration of the level of commodity prices and the rate of inflation in consumer prices is not rejected in the statistical tests in Section IV (Table 4), below.

The effects of an unanticipated real disturbance that changes the equilibrium relative price P_m/P_c are shown in Figure 3. There we assume that the disturbance increases the equilibrium relative price. This could be due to a supply shock that increases commodity supply relative to the supply of manufactures; for example, an innovation in commodity production. It could also result from a shift in demand toward manufactures; for example, a fiscal expansion. This disturbance shifts the $\dot{p}_m = 0$ line up along the $\dot{p}_c = 0$ line to a new long-run equilibrium at point 2, which

^{1/} There is a difficulty in interpreting the model's equilibrium as a steady-state position, because interest rate data tend not to be stationary. Specifically, while money stocks, GNP, and GNP delators are generally integrated of degree zero, interest rates may be integrated of degree one.

Figure 1
COMMODITY AND MANUFACTURES PRICES:
WORLD EQUILIBRIUM AND DYNAMICS

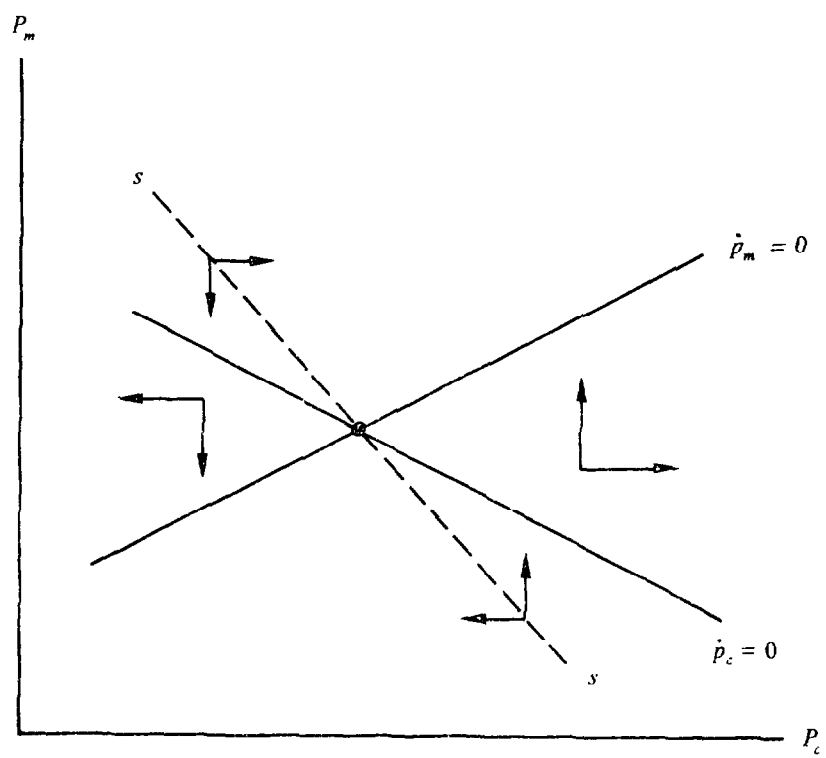


Figure 2
WORLD MARKET RESPONSE TO UNANTICIPATED
MONETARY EXPANSION

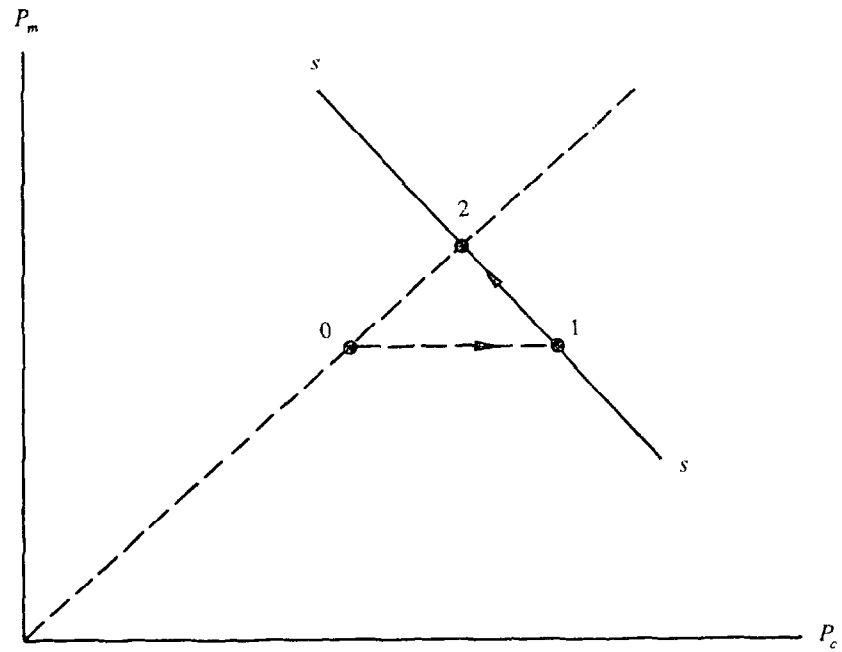
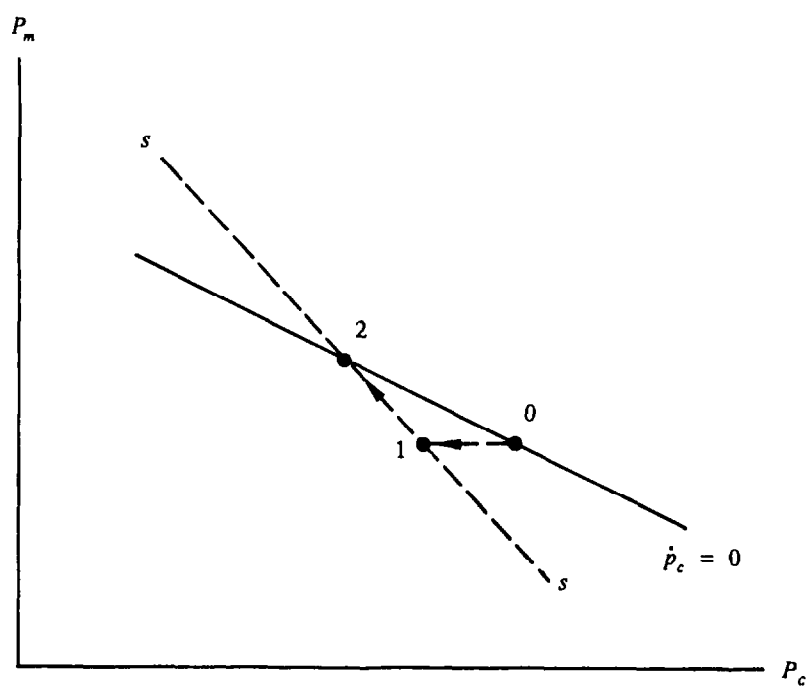


Figure 3
WORLD MARKET RESPONSE TO REAL
DISTURBANCE ALTERING RELATIVE PRICES



lies on a steeper ray from the origin that characterizes a higher P_m/P_c ratio. If there is no monetary accommodation to the disturbance, the $P_c = 0$ line does not move. The result is that the commodity price jumps down onto the new ss path at point 1, and then continues to fall, while the industrial price rises to the new equilibrium at point 2. The commodity price undershoots in response to a real disturbance. It moves before the industrial price, but in the opposite direction. With no monetary accommodation, for the P_m/P_c ratio to rise, P_m must increase and P_c must fall.

It could appear from this analysis that commodity prices would not be a useful indicator of future inflation in the presence of unaccommodated real disturbances. In fact, in this model, as long as the real disturbance is not accommodated, there is no general inflation. As one price rises, the other falls to keep the weighted CPI in GCU constant. Thus a stochastic series of aggregate real shocks would produce stochastic behavior of the commodity price with no general inflation. If in empirical implementation we use an index of a variety of commodity prices, real supply shocks would come from differing sources, depending on the commodity. To the extent that these are independent, offsetting negative and positive disturbances at the individual commodity level would minimize the contribution of supply shocks to the variance of the index. Thus the path of the index would be dominated by monetary disturbances, with real disturbances producing noise around that path. The contribution of real supply shocks to the variance of the index would be minimized to the extent that they are uncorrelated. This would improve the usefulness of the index as an inflation indicator.

At this point we can summarize the results from the world model of commodity and manufactures prices in GCU. Monetary disturbances lead to jumps in the commodity price index, followed by gradual movement in the manufactures price in the same direction. The long run movement of both prices is proportional to the monetary disturbance. Thus a series of positive monetary shocks would produce a series of jumps in the level of commodity prices and smoother inflation in manufactures prices, with a common trend to both. Real disturbances yield jumps in the commodity price, followed by gradual movement of the manufactures price in the opposite direction. If the real disturbances are not accommodated by monetary policy, they have no long-run effect on the CPI, but they produce noise in the commodity price series. If the real disturbances have in them a trend that raises the relative price of manufactures, they will generate noise around that trend.

2. Relative model of prices and exchange rates

The world model gives us the movements of commodity and manufactures prices in GCU, as functions of world monetary and real disturbances. To translate these into domestic price indexes in individual countries, we can use a model of the exchange rate and relative price levels between two countries. This will give us the relative effects of disturbances, depending on the country of their source. The relative effects can then

be combined with the world effects in GCU to obtain the results for CPIs and GDP deflators in home currencies. The relative model is an application of Aoki's (1981) average and difference method to the Dornbusch (1976) model of prices and the exchange rate.

We begin by defining relative variables between two "representative" countries as the differences between the logarithms of the variables for the domestic GNP deflators, money stocks, GNPs, and fiscal variables; and the arithmetic differences for interest rates, with each relative variable being the standard mnemonic with a subscript "r". Thus for relative prices, we have

$$p_r = \ln P - \ln P^*,$$

where P and P^* are the home and foreign GNP deflators, respectively. Relative money stocks (m_r), real GNP (y_r), and fiscal variables (g_r) are similarly defined. Each country's GNP will be a combination of commodity, manufactures, and services output, and its GNP deflator will be the corresponding weighted average. The interest differential, equal to the expected rate of change of the nominal exchange rate, E , is

$$i_r = i - i^* = \dot{e}.$$

In equilibrium with $\dot{e} = 0$, i_r would also be 0. ^{1/}

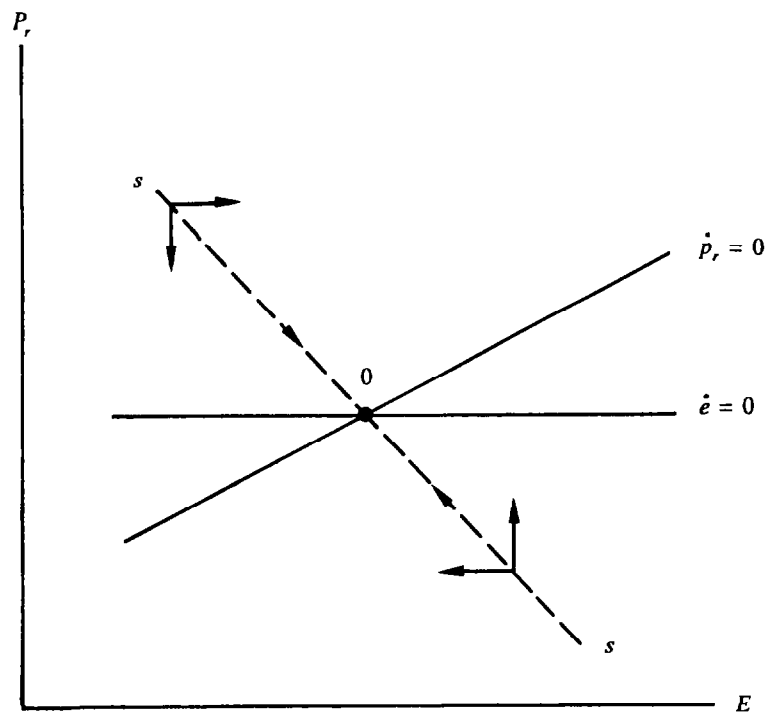
The model of relative prices and the exchange rate is specified similarly to the model of manufactures and commodity prices described above in subsection 1. Here the exchange rate is the forward-looking variable that jumps in response to unanticipated disturbances, and the relative GNP deflator adjusts slowly to relative excess demand. The relative equilibrium condition for the money market is

$$(7) \quad m_r - p_r = \phi y_r - \lambda i_r = \phi y_r - \lambda \dot{e},$$

using the uncovered interest parity condition to substitute \dot{e} for i_r . We can set $\dot{e} = 0$ (or $i_r = 0$) in equation (7) to obtain the $\dot{e} = 0$ line in Figure 4, which shows the relative price p_r that would clear the money market for given values of m_r and y_r . In contrast to the $\dot{p}_c = 0$ line in Figure 1, the $\dot{e} = 0$ line here is horizontal. For a point above the $\dot{e} = 0$ line to be consistent with money-market equilibrium, E must be rising. This is because p_r is higher than on the line, so i_r must be positive above the line. This would mean that E would be expected to rise (so \dot{e} is positive), and on the assumption of perfect foresight, E would actually

^{1/} A risk premium related to relative stocks of outstanding assets could be added to the interest differential. While that extension might provide additional insights, especially regarding the longer-run effects of fiscal policies, it would complicate the analysis without modifying the qualitative conclusions regarding the model's dynamics.

Figure 4
EQUILIBRIUM BETWEEN COUNTRIES



rise. This reasoning is exactly the same as that behind the p_c dynamics in Figure 1.

Relative demand, d_r , for the two real GNPs is specified as

$$(8) \quad d_r = \delta(e - p_r) - \sigma(i_r - \dot{p}_r) + g_r.$$

As in the earlier model, the relative GNP deflator adjusts gradually to excess demand, so that

$$(9) \quad \dot{p}_r = \pi(d_r - y_r).$$

Substituting (8) into (9) and solving for \dot{p}_r yields the second dynamic equation,

$$(10) \quad \dot{p}_r = \eta[\delta(e - p_r) - \sigma i_r + g_r - y_r],$$

where $\eta = \pi/(1 - \pi\sigma)$, which is required to be positive. Setting $\dot{p}_r = 0$ in equation (10) yields the positively sloped $\dot{p}_r = 0$ line in Figure 4, for relative GNP deflator equilibrium. As long as η is positive, p_r adjusts toward the $\dot{p}_r = 0$ line.

The two equilibrium lines in Figure 4 show the equilibrium relative price, measured in the ratio of the two currencies, and the equilibrium exchange rate at point 0 for given relative money stocks, fiscal positions, and supply conditions. Dynamic adjustment to equilibrium proceeds along the saddle path ss , as in the earlier model of Figure 1. The only analytical difference between Figure 1 and Figure 4 is the slope of the curve representing monetary equilibrium. In both models, the saddle path is negatively sloped, and the flexible price jumps horizontally onto the saddle path following an unanticipated disturbance, while the sticky price adjusts gradually along the saddle path.

The effects of a strictly relative monetary disturbance (an increase in the money supply in the home country and a decrease of the same percent in the foreign country) are shown in Figure 5. There is no change at the world level of subsection 1, since there is no effect on the world money stock. But in the relative model, the long run equilibrium moves out proportionately to point 2 in Figure 5, with the exchange rate and relative price both increasing in proportion to the change in the relative money supply. The home price level rises and the foreign price level declines. The home currency depreciates against the GCU and the foreign currency appreciates. In the short run, the exchange rate between the two countries jumps to point 1 on the new ss path, and then the exchange rate falls and the relative price rises to point 2. This is the basic result from Dornbusch (1976) for two countries.

The effects of a strictly relative fiscal disturbance, an increase in g_r in equation (10), are shown in Figure 6. We assume that the home government increases, and the other government decreases, expenditure on manufactures by the same amount. There is no change in the world market

in manufactures or commodities, but in the relative model, the $\dot{p}_r = 0$ line in Figure 6 shifts up. The equilibrium relative price level of the home country, where the fiscal expansion took place, increases for a given level of the exchange rate. There is no shift of the $\dot{e} = 0$ line, since the fiscal variable does not enter the money-market equilibrium condition, equation (7). As a result, the exchange rate falls in a jump from point 0 to point 1 in Figure 6. The home currency appreciates by enough to offset the effect of the fiscal shift on relative demand, with no effect on either price level in home currency. The nominal appreciation of the home currency produces a real appreciation of the same amount. This result is implicit in Dornbusch (1976), and explicit in Mundell (1963).

3. The two models combined

The model of the world markets in commodities and manufactures in GCU and the relative model of exchange rates and relative prices in home currencies can now be combined to analyze the effects of the various types of unanticipated disturbances originating in one country. We will consider, in turn, monetary, fiscal, and supply shocks. The final subsection will summarize with some examples.

Monetary Expansion in One Country

First we illustrate the effects of an unanticipated monetary expansion in one country. At the level of the world model of commodity and manufactures prices, the results are illustrated in Figure 2. Measured in GCU, the commodity price jumps, and then the manufactures price rises gradually, as the commodity price falls. The jump in the level of the commodity price leads the gradual increase in the manufactures price. Eventually both prices rise proportionately to the increase in the money stock, all measured in GCU.

The relative effect is shown in Figure 5. The exchange rate of the expanding country against the second country jumps from point 0 to point 1; that is, the expanding country's currency depreciates. Subsequently, that country's price level in home currency rises and its exchange rate falls, converging to point 2. In the new long-run equilibrium, the exchange rate and the price level in the expanding country rise proportionately to the monetary expansion.

Fiscal Expansion in One Country

The interesting case of an unanticipated fiscal expansion is one that alters world relative demand for manufactures and commodities, as well as the real exchange rate as shown in Figure 6. To use a specific example, consider a fiscal expansion in the manufacturing country that increases the world relative demand for manufactures. As a convenient simplification, think of this country as Japan, and the other country, specializing

Figure 5
RELATIVE EFFECTS OF MONETARY EXPANSION

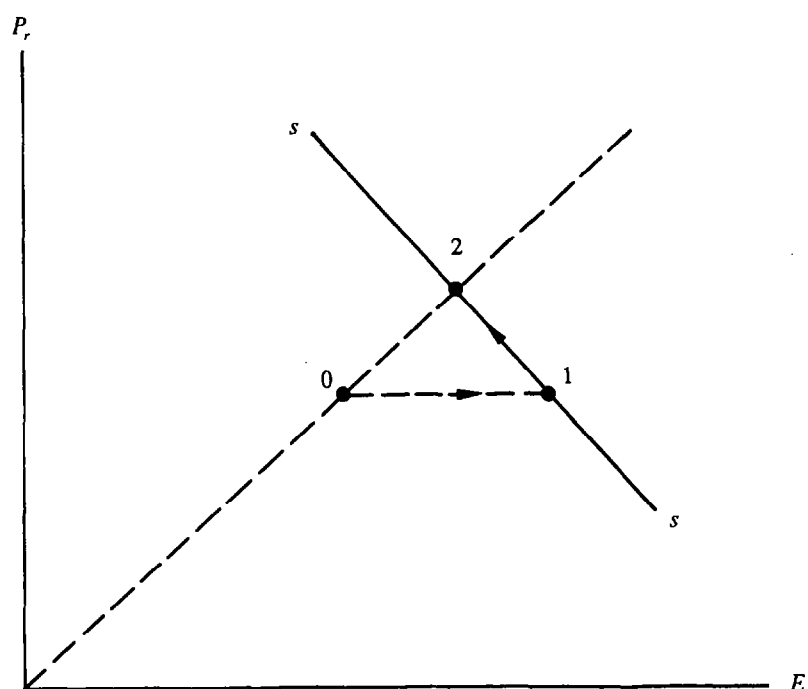
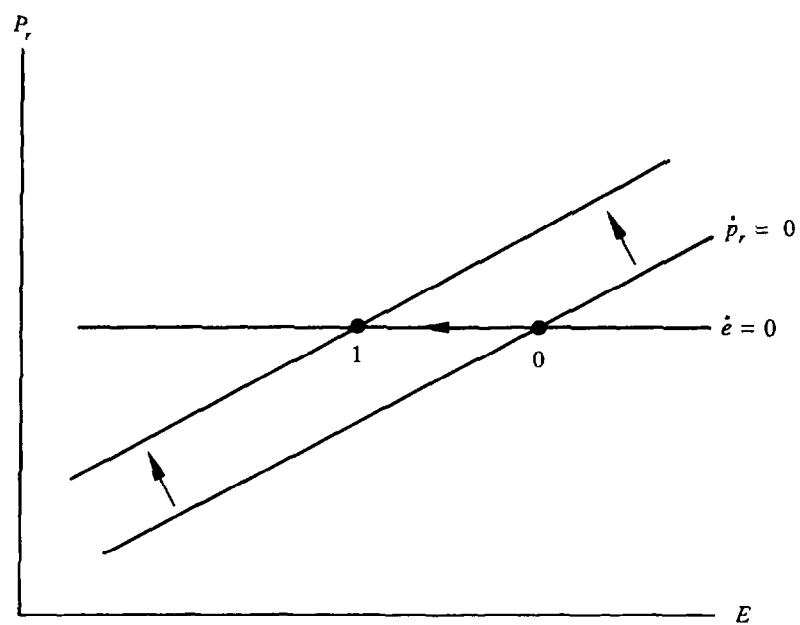


Figure 6
RELATIVE EFFECTS OF FISCAL DISTURBANCE



in commodities production, as Italy. ^{1/} The effects at the world level in GCU are shown in Figure 3. The commodity price jumps down, and then declines gradually further as the manufactures price rises. At the new equilibrium point 2, P_m has risen and P_c has fallen, in GCU.

The relative effects are shown in Figure 6. With no direct representation of the fiscal variable in the financial equilibrium equation (7), the $\dot{e} = 0$ line does not move. The fiscal expansion in Japan shifts the $\dot{p}_r = 0$ line left, moving the equilibrium point from 0 to 1 in a jump. The home real and nominal exchange rates appreciate, with no change in relative GDP deflators, in home currency. The appreciation of the yen just offsets the increase in P_m in GCU, and the depreciation of the lira just offsets the fall in P_c in GCU.

The effects of the fiscal expansion in the manufacturing country on prices in all three currencies are summarized in panel (a) of Table 1. P_m is up and P_c is down, in GCU. P_m in lira rises both because of the increase in GCU and because of the depreciation of the lira against the GCU, while in yen P_m is unchanged. P_c is unchanged in lira, while it falls in yen both from the fall in GCU and from the yen appreciation. Thus if both countries consume both goods, the CPI will fall in Japan and rise in Italy, reflecting the terms-of-trade effect, with both GDP deflators unchanged.

Supply Expansion in One Country

A supply shock also alters the world relative prices, as in Figure 3, and the equilibrium real exchange rate. The analysis is slightly more complicated than that of a fiscal expansion, though, since both equilibrium lines in Figure 6 shift with a supply shock. Consider an increase in productivity in the commodity-producing country (Italy) that increases the world relative supply of commodities. The effects at the level of the world market in GCU are again shown in Figure 3. The commodity price jumps down from point 0 to point 1 when the supply increase becomes known to the market. Then P_c falls gradually as P_m rises to point 2. In GCU the price of commodities falls and the price of manufactures rises.

The relative effects are shown in Figure 7, with Italy as the home country. The productivity shock increases y_r in both equations (7) and (10), shifting both equilibrium lines down. The $\dot{p}_r = 0$ line shifts down by a factor of $-1/\delta$ from equation (10), and the $\dot{e} = 0$ line shifts down by $-\phi$ from equation (7). If the shift in the $\dot{p}_r = 0$ line is sufficiently larger than the shift in the $\dot{e} = 0$ line, the new saddle path will pass to the right of the original equilibrium point 0, as shown in Figure 7. This would be the case if the supply shock's effects were felt mainly in the goods markets, compared with the effects in the money market via an

^{1/} Table 9 below shows that among the large industrial countries, Japan is the least intensive in production of primary commodities, and Italy the most.

Table 1. Theoretical Effects on Prices from Various Disturbances 1/

(a)				(b)			
Responses to a Fiscal Expansion in the Manufactures-Producing Country (Japan)				Responses to a Supply Increase in the Commodities-Producing Country (Italy)			
<u>Effect on</u>	<u>Measured in:</u>			<u>Effect on</u>	<u>Measured in:</u>		
	GCU	Lira	Yen		GCU	Lira	Yen
P _m	+	++	0	P _m	+	++	+
P _c	-	0	--	P _c	-	-	--

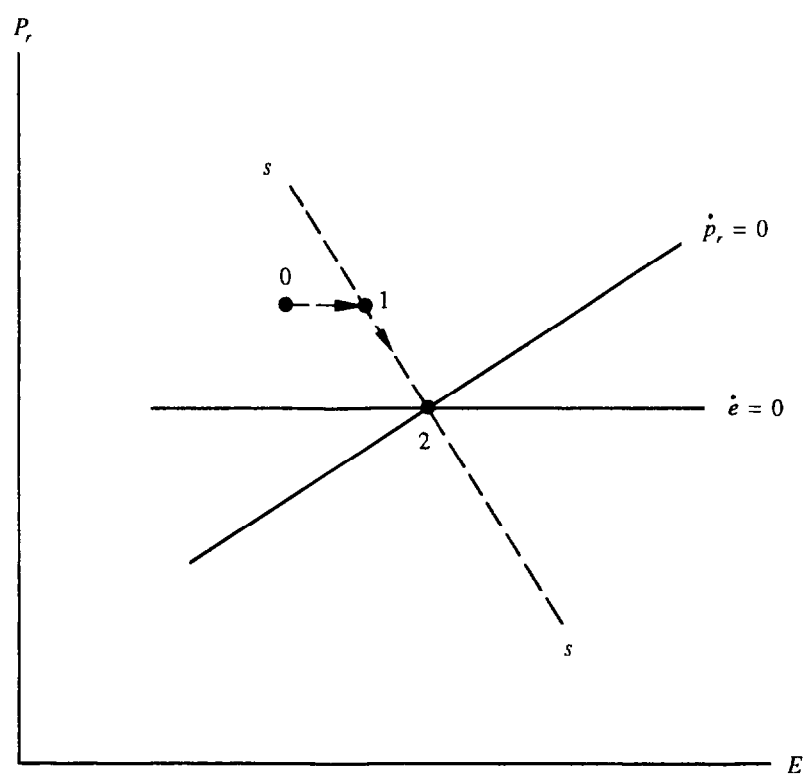
(c)

Summary of Effects of Disturbances on Home-Currency Prices

Shock	<u>Effects on Prices in:</u>					
	<u>Originating Country</u>			<u>Other Countries</u>		
	P _c	P _m	CPI	P _c	P _m	CPI
Increase in Money Stock	+	+	+	+	+	+
Fiscal Expansion in Manufactures Producer	-	0	-	0	+	+
Supply Increase in Commodities Producer	-	+	?	-	+	?

1/ Price increases are denoted by + and decreases by -; 0 indicates no change. The symbols ++ and -- indicate relatively large changes.

Figure 7
RELATIVE EFFECTS OF SUPPLY DISTURBANCE



increase in income. In this case, the exchange rate of Italy would jump up to point 1, and then rise further as P_R falls to point 2. That is, the lira would depreciate in both nominal and real terms against the GCU.

One cannot rule out the possibility that the downward shift in the $\dot{e} = 0$ line would be large enough that the new saddle path would pass to the left of point 0. In that case the exchange rate could jump down, and then rise as P_R fell to the new equilibrium. Equation (10) shows that in the new equilibrium the real exchange rate $(e - p)$ must rise with an increase in y_R by $d(e - p)/dy_R = 1/\delta$. We know, therefore, that in Figure 7, along the new equilibrium line $p_R = 0$ the lira has depreciated in real terms, regardless of the direction of its original jump. So the result from the relative model is that the real exchange rate of the country with the positive supply shock rises (home currency depreciates) relative to the GCU, and the other country's real exchange rate falls.

The results for the positive supply shock in the commodity-producing country are summarized in panel (b) of Table 1. The price of commodities falls and the price of manufactures rises in GCU. With the lira depreciating in real terms, the lira price of manufactures rises even more, and the lira price of commodities falls less than in GCU. As the yen appreciates in real terms, the yen price of commodities falls even more, and the yen price of manufactures rises less, than in GCU. With the two prices moving in opposite directions in both currencies, the effects on the two CPIs are ambiguous. However, since the movement in the real exchange rate adds to the downward movement in commodity prices in Japan, and to the upward movement of manufactures prices in Italy, it seems likely the the CPI would fall in Japan and rise in Italy.

Summary

The effects of the unanticipated disturbances in single countries are summarized in panel (c) of Table 1. The effects of an unanticipated expansion in the money supply are familiar; prices rise in all currencies, but more in the country where the expansion originated. The currency of the home country depreciates against the others and against the GCU. In this case the commodity price in GCU jumps and leads a general inflation in all countries.

The effects of a fiscal expansion or a supply shock are less familiar. A fiscal expansion in the manufacturing country that raises world relative demand for manufactures raises the GCU price of manufactures and reduces the GCU price of commodities. It also appreciates the currency of the expanding country and depreciates the currencies of the others, in nominal and real terms. The result is a negative effect on the CPI in the expanding country and a positive effect on the others, owing to the movement of the exchange rate. This is similar to the effect of the fiscal expansion in the United States on the U.S. inflation rate via the dollar exchange rate in the early 1980s. In this case the downward jump in the commodity price following the disturbance contains no general signal for inflation unless it includes a general shift in monetary

policy. If unaccommodated fiscal disturbances are randomly distributed across countries and over time, they will create noise in the relation between commodity price movements and subsequent inflation.

Finally, a positive supply shock lowers the price of the good whose supply has increased and depreciates the currency of the suppliers in real terms. The net result is to reduce the price of the good in question, and increase the prices of the others, in all currencies. The effects on home-currency CPIs depend on the weights of the goods in the CPI. In this case the initial downward jump in the GCU commodity price also contains no signal for subsequent inflation. By using an index over a large number of commodities, individual supply shocks such as these are averaged out to some degree in the empirical work that follows.

III. Country-specific Commodity Price Indexes

The empirical tests developed in Sections IV and V of this paper evaluate the relationships between general movements in world prices of primary commodities and inflation in the large industrial countries. In order to isolate the effects of global developments on individual countries, it is necessary to develop separate commodity-price indexes for each country. This task has two dimensions: determining the weights that each commodity should have in a country's index, and denominating the index in that country's currency. The first dimension is at least potentially important in order to take account of variation between countries in the shares of key commodities in consumption patterns; the second ensures that the commodity-price and general-price indexes are denominated in the same currency units.

The commodity-price indexes have been constructed using spot prices for major commodities and weights that reflect the pattern of consumption of these commodities in each country. A large number of price quotations are included (thirty-one primary commodities represented by thirty-six international price quotations), in order to minimize the effects of price fluctuations caused by supply shocks or other real disturbances in individual commodity markets. Weights are based on consumption, rather than production or imports, since these relate most directly to movements in the consumer price index.

Table 2 provides a comparison of patterns of consumption of primary commodities in the seven major industrial countries. ^{1/} These data indicate that the portion of total private consumption attributed to the consumption of primary commodities ^{2/} is quite uniform among countries, at about 8 percent (second row of Table 2). Consumption of individual

^{1/} For data sources and methodology, see Appendix I.

^{2/} This statement refers to the ratio of the value of consumption of the 31 selected primary commodities to the value of total private consumption.

Table 2. Consumption of Primary Commodities in Major Industrial Countries, 1983-85

Commodity	Canada	France	Germany	Italy	Japan	United Kingdom	United States	G-7
Total, All Primary Commodities								
In millions of U.S. dollars (yearly average)	17,515	27,749	36,225	24,545	55,566	22,284	183,172	367,055
In percent of total consumption	9.0	8.9	9.7	9.4	7.5	8.1	7.5	8.0
Weights (in percent)								
Cereals	10.5	14.0	6.5	16.3	15.5	11.3	15.4	14.0
Wheat	4.2	9.8	5.3	9.6	2.2	10.1	3.3	4.7
Maize	6.2	4.0	1.1	5.1	4.1	1.1	11.1	7.3
Rice	0.1	0.2	0.1	1.7	9.2	0.0	1.0	2.0
Vegetable oils	3.1	4.3	4.4	4.1	3.6	3.0	5.7	4.8
Soybeans	0.8	0.3	0.8	0.7	1.3	0.3	1.9	1.4
Soybean meal	1.5	3.0	2.1	2.2	1.2	1.5	2.0	1.9
Soybean oil	0.6	0.2	0.8	0.7	0.8	0.6	1.5	1.1
Palm oil	0.1	0.1	0.2	0.2	0.2	0.5	0.1	0.1
Coconut oil	0.1	0.2	0.3	0.1	0.1	0.1	0.2	0.2
Groundnut oil	0.0	0.5	0.1	0.1	0.0	0.0	0.0	0.1
Meat	14.5	18.6	9.7	16.2	2.6	15.1	14.9	12.9
Beef	14.3	17.0	9.4	15.5	2.4	11.7	14.8	12.4
Lamb	0.2	1.6	0.3	0.6	0.3	3.4	0.2	0.5
Sugar	0.7	2.8	2.3	2.5	0.7	4.0	2.0	2.0
Bananas	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.5
Beverages	2.2	3.9	6.2	3.8	1.9	4.8	2.4	3.0
Coffee	1.4	2.8	3.8	2.9	1.1	1.3	1.6	1.9
Cocoa	0.6	1.1	2.2	0.8	0.3	1.6	0.7	0.9
Tea	0.2	0.1	0.1	0.0	0.5	1.9	0.1	0.3
Agricultural Raw Materials	19.1	15.2	24.8	14.8	21.1	18.4	11.5	15.5
Timber	16.1	9.9	20.3	5.9	15.3	12.7	7.7	10.8
Fibers	0.6	2.2	1.5	3.1	3.0	2.7	1.3	1.8
Cotton	0.5	1.0	1.0	1.8	2.1	0.4	1.1	1.2
Wool	0.1	1.3	0.6	1.3	0.9	2.4	0.2	0.6
Natural rubber	0.5	0.5	0.5	0.4	0.9	0.5	0.4	0.5
Tobacco	1.4	1.5	0.9	1.9	1.2	1.2	1.0	1.2
Hides	0.5	1.0	1.5	3.4	0.6	1.2	1.1	1.2
Metals and Phosphate Rock	8.4	9.7	13.3	8.2	16.4	8.7	7.4	9.7
Copper	1.8	2.1	3.1	2.1	3.3	2.3	1.6	2.1
Aluminum	2.2	2.7	3.9	2.3	3.8	1.9	2.9	3.0
Iron ore	2.2	2.2	3.3	1.9	5.8	1.8	1.0	2.2
Tin	0.3	0.4	0.4	0.2	0.7	0.5	0.3	0.4
Nickel	0.2	0.6	1.0	0.4	1.1	0.6	0.4	0.6
Zinc	0.7	0.8	0.9	0.7	1.1	0.7	0.4	0.7
Lead	0.2	0.3	0.4	0.4	0.3	0.5	0.3	0.3
Phosphate Rock	0.7	0.7	0.2	0.3	0.2	0.3	0.5	0.4
Petroleum 1/	41.0	30.9	32.5	33.8	37.9	34.2	40.2	37.6

Sources: see text and Appendix I.
1/ 1986 data.

commodities, however, varies substantially from country to country. For example, while the consumption of grains is relatively constant as a share of primary consumption for most countries (about 14 percent except for Germany), the composition of grain consumption is more diversified. Weights representing the consumption of wheat in France, Italy, and the United Kingdom (each 10 percent); maize in the United States (11 percent); and rice in Japan (9 percent) are significantly higher than average consumption of these commodities by the group of seven countries.

Similarly, beef consumption is relatively low in Japan (2.4 percent) and Germany (9.4 percent), compared with the group (12.4 percent); these two countries consume relatively more seafood and pork products, respectively, which are not included in the indexes. 1/ Tea consumption, as might be expected, is relatively high in the United Kingdom (1.9 percent), as is coffee consumption in Germany (3.8 percent). The relatively low level of consumption of timber products in Italy (5.9 percent) reflects a preference for stone and cement in housing construction, compared with a greater preference for timber in construction in Germany (20.3 percent).

There is remarkable consistency in the share of consumption of primary commodities attributed to petroleum, which--at roughly 38 percent--is the largest of any commodity by far. Weights for petroleum were based on consumption and import unit values in 1986, rather than the 1983-85 average that was used for all other commodities. This ad hoc procedure is intended to avoid overstating the importance of petroleum, in light of the very sharp decline in oil prices that occurred in 1986 and again in 1988. 2/

A caveat on the estimates of the pattern of consumption in the large industrial countries relates to the difficulty in separating end-use consumption of primary commodities from intermediate use in the production of other primary commodities or manufactured products for export. Some adjustments were made to consumption values to avoid double counting of commodities at various stages of production, such as in the production of soybean and timber products. 3/ It was not generally possible, however, to adjust for the consumption of one commodity in the production of another. Hence there is some double counting for all countries, on account of maize and soybean meal used as cattle feed, and phosphate rock used in the production of grains, soybeans, and fibers.

1/ Broadly representative and timely price series are not available for seafood or pork products.

2/ The use of average 1983-85 data would give a weight to petroleum of around 50 percent in each country.

3/ The consumption weights in Table 1 were modified to prevent double counting of soybeans and soybean meal production; logs, timber, plywood, and paperboard production; and tobacco and cigarette production. The last two adjustments were needed to account for the export of commodities at a higher value-added level (principally plywood and paper exports from Canada and cigarette exports from the United States).

Consumption weights also may be overestimated for a few commodities in countries where there are significant exports of finished manufactures. Relatively high weights for metals in Japan (16.4 percent) and Germany (13.3 percent) compared with the group average (9.7 percent) reflect a greater rate of production of automobiles, more than half of which are exported. Relatively high weights for hides in Italy (3.3 percent) and sugar and cocoa in Germany (about 2 percent each) reflect the production of shoes and confectionery for export in these countries. The bias in the indexes caused by overestimated weights may not extend to the estimation of weights for the group of countries, however, since manufactures exported by one country are often imported by another country in the group. In addition, some underestimation of weights occurs, when commodities are imported at an advanced stage of production from outside the group of seven countries. 1/

A comparison of commodity price indexes, using weights from Table 2 and denominating commodity prices in a common currency, is presented in Chart 1. A casual inspection reveals the indexes to be quite similar, despite the differences in weights used to construct them. In particular, indexes for all countries that include large, similar weights for petroleum are found to be roughly identical, with only minor variations evident in the indexes that exclude petroleum. These variations, in turn, are caused by the presence or absence of large weights for commodities whose prices moved differently than did prices of the group.

As examples of differences in movements in prices, indexes for most countries rose in 1973-74 to 80 percent or more of their respective 1980 levels, largely owing to a more than doubling of grain prices from 1972. The exception to this was the price index for Germany, which remained below 80, on account of a weight for grains equal to roughly one half of that in other countries. Other distinctive movements in Germany's index include a sharp, extended rise in the index during 1978-80, owing in part to a doubling of the international price of logs, and a subsequent rise in 1988, to well over 100 percent of the 1980 level, again related to a rise in log prices. Distinctive movements, owing to unusually large weights, can also be seen in the v-shape of the indexes for France, Italy, and the United States, which correspond to a 20 percent fall and recovery in beef prices during part of 1980; a trough in the index for Japan corresponding to a decline in the price of rice in 1983; and a higher than average peak

1/ An example of underestimation of weights is given by iron ore, which is often imported and consumed as steel products. An adjustment to the iron ore weight to account for the import of steel products is difficult because of the variety of these products and their high value-added component; the value of steel at an advanced stage of production (cold rolled steel) is ten times that of iron ore. The United States is a significant importer of semi-finished and finished steel products, with an apparent consumption nearly equal to that of Japan, in tonnage terms; this compares with an estimated weight for iron ore consumption in the United States that is about one fifth that in Japan.

in the index for the United States, corresponding to high prices for vegetable oils in 1984.

Greater differences among commodity price indexes are apparent when the indexes are expressed in local currency terms (Chart 2). At the extremes, these differences include sharp increases in the indexes for France and Italy (of about 150 percent, from 1972-85), which contrast with a general decline in the index for Japan (of about 50 percent, from 1980-88). Cyclical increases in the dollar indexes for France and Italy were smoothed in local currencies in 1973-74 and 1980, owing to appreciations of the franc and lira during these periods; subsequently, a halving of the value of these currencies by 1985 compared with 1980 contributed to a doubling of the price indexes over the same period. Cyclical movements were apparent in the yen-denominated index for Japan, owing to a more steady rate of appreciation of the yen during 1973-74 and 1980 compared with the franc and the lira; in contrast with the franc and the lira, however, the yen continued to appreciate after 1980, nearly doubling in value by 1988. Indexes for remaining countries lie between the extremes recorded for the indexes for Italy, France, and Japan.

IV. Evidence Pertaining to Consumer Price Inflation ^{1/}

1. Cointegration tests

It was shown in Boughton and Branson (1988) that the aggregate CPI for the G-7 countries was $I(2)$ (integrated of order 2), based on an augmented Dickey-Fuller test, while the commodity price index was $I(1)$. On that basis, it was not necessary to test further for the cointegration of the two indexes. That test is extended here in several ways, leading to somewhat less clear conclusions about the order of integration of the data but just as clear a conclusion regarding the lack of cointegration.

Table 3 illustrates the ambiguity regarding the order of integration for consumer prices. Four tests are reported: Dickey-Fuller and Sargan-Bhargava tests, using both monthly and annual data. The monthly Dickey-Fuller tests are augmented using two lags. No tests for commodity price indexes are shown in the table, because all tests indicate that commodity prices are $I(1)$. In general, the monthly tests on consumer prices lead one to accept the hypothesis that the CPIs are $I(1)$, while the annual data are consistent only with second-order stationarity. In the case of the augmented Dickey-Fuller tests, the results are mixed: only for Germany, Japan, and the United Kingdom can one reject the hypothesis of nonstationarity at the $I(1)$ level, while the other indexes appear to be $I(2)$.

^{1/} All of the tests reported in Sections IV and V use the local-currency indexes described in Section III.

Chart 1. Seven Large Industrial Countries: Commodity Prices,
In a Common Currency, 1957-88.

(Index: 1980=100)

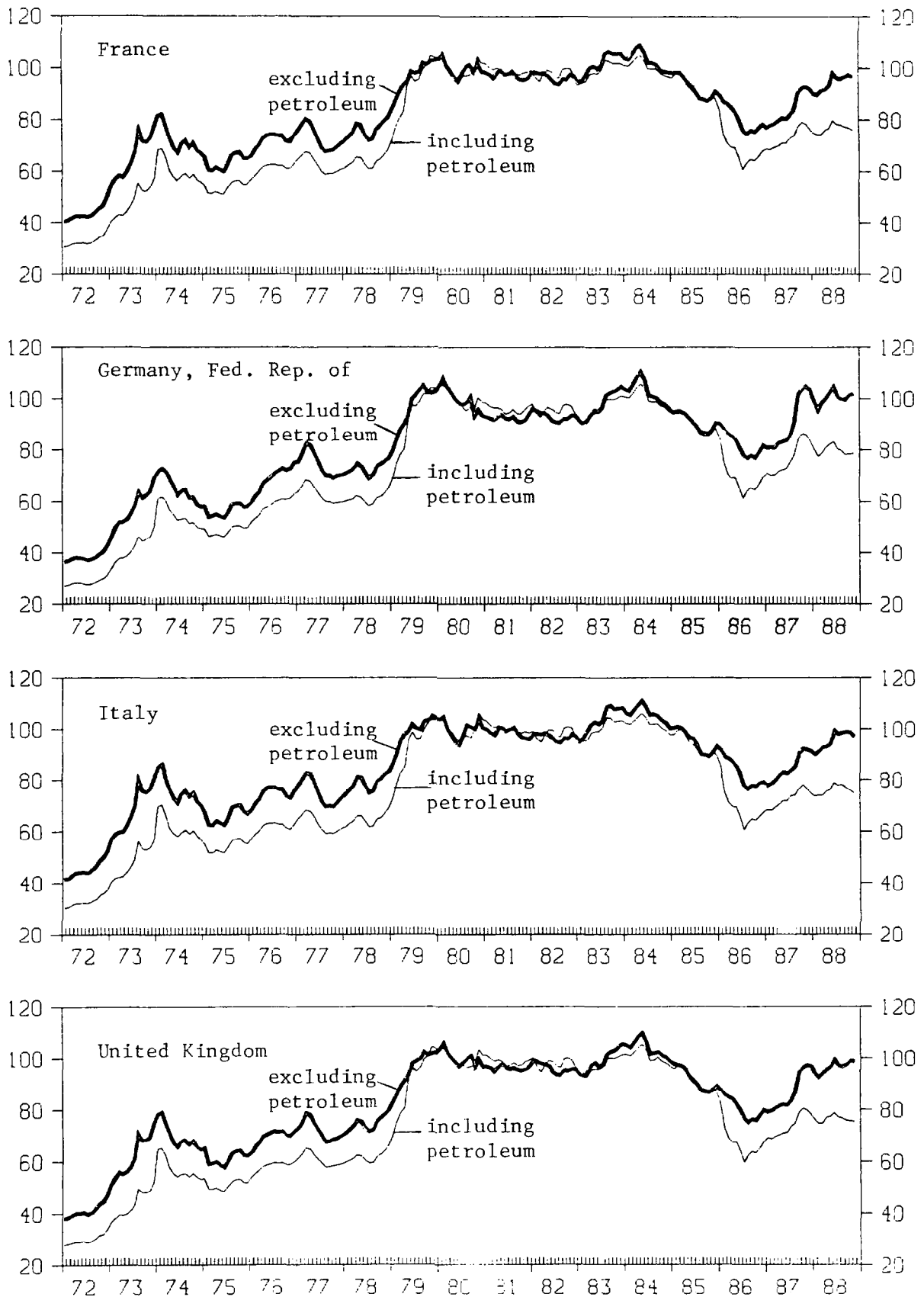


Chart 1 (continued). Seven Large Industrial Countries: Commodity Prices,
In a Common Currency, 1957-88.

(Index: 1980=100)

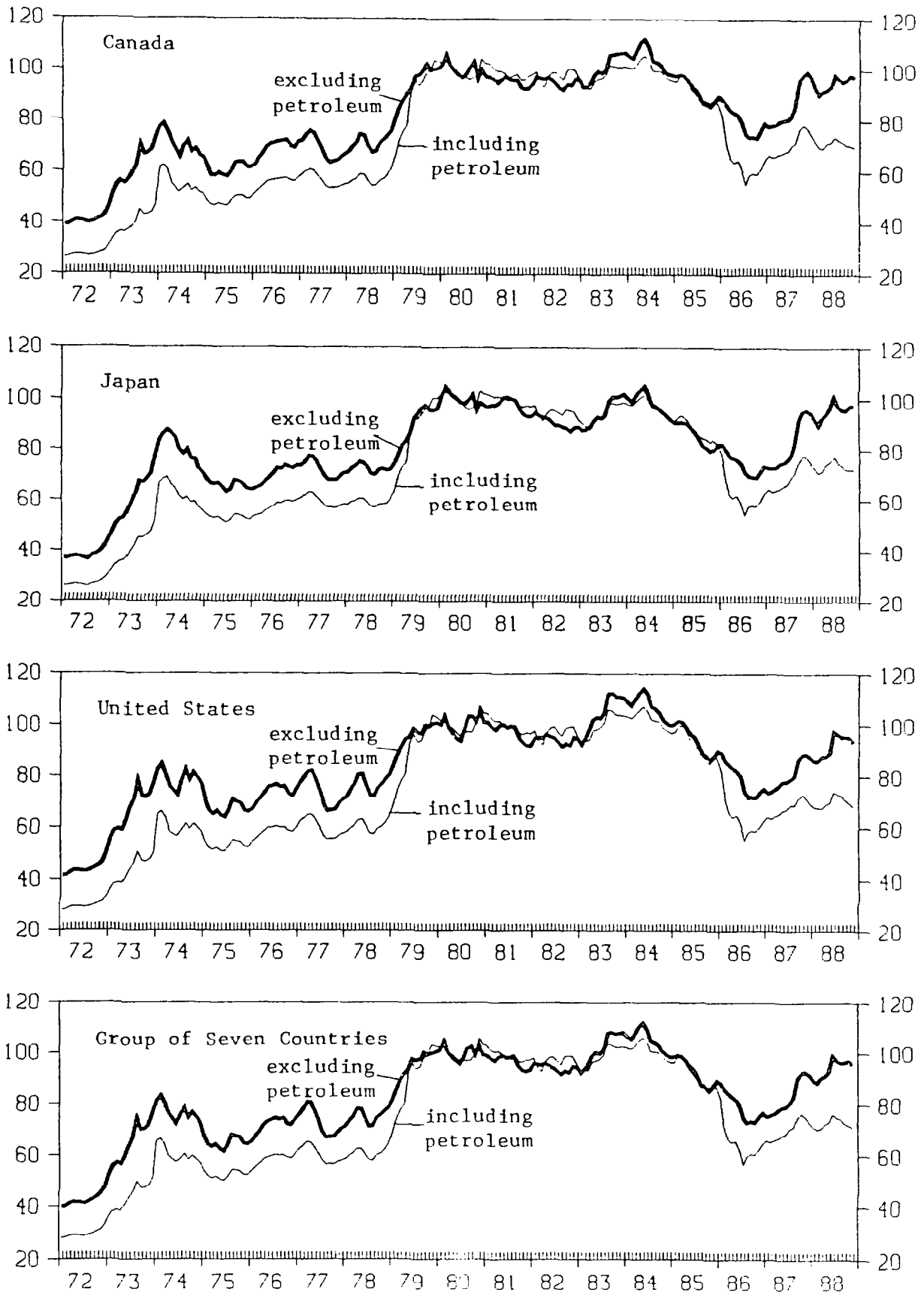


Chart 2. Seven Large Industrial Countries: Commodity Prices,
In Local Currencies, 1957-88.

(Index: 1980=100)

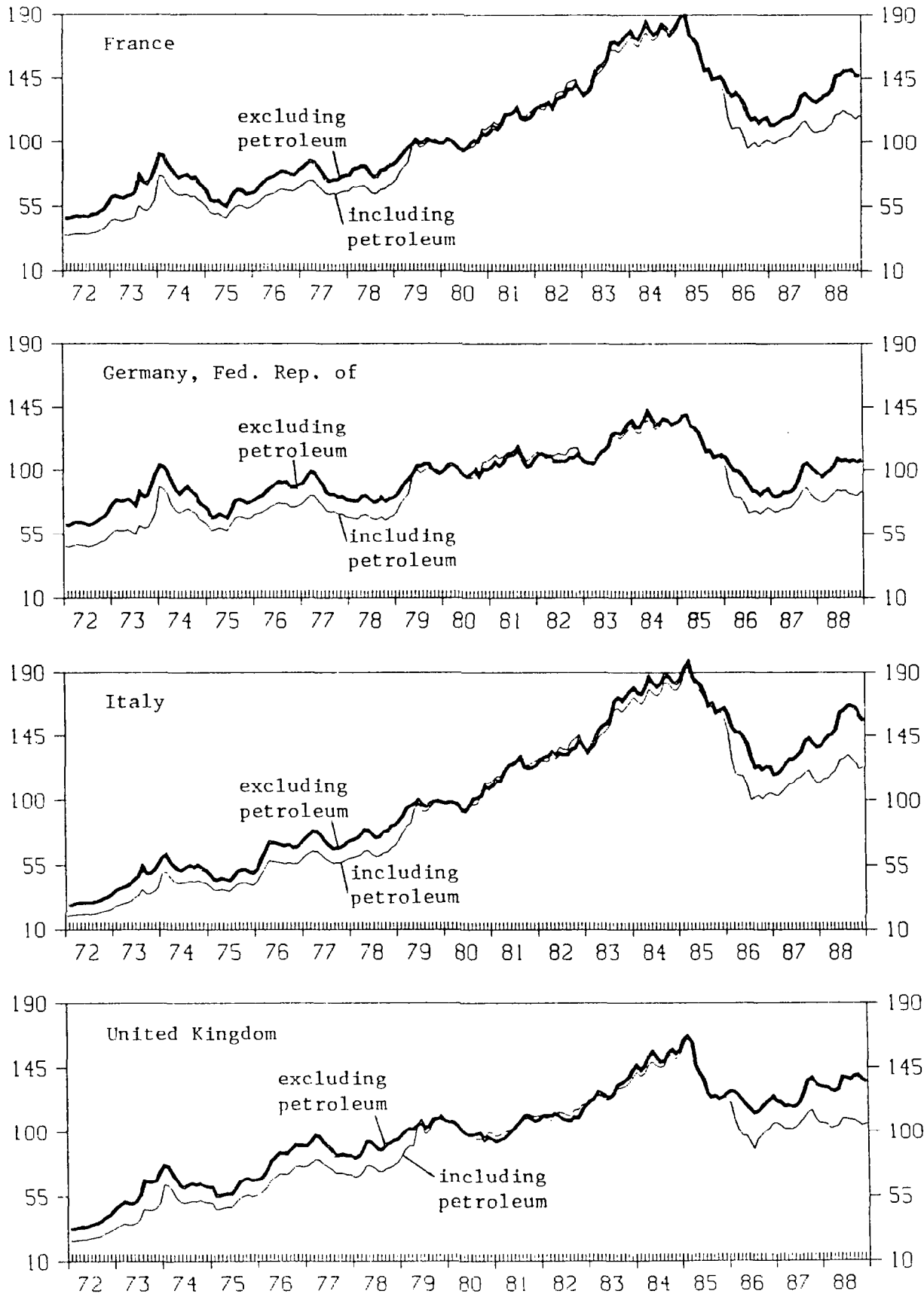


Chart 2 (continued). Seven Large Industrial Countries: Commodity Prices,
In Local Currencies, 1957-88.

(Index: 1980=100)

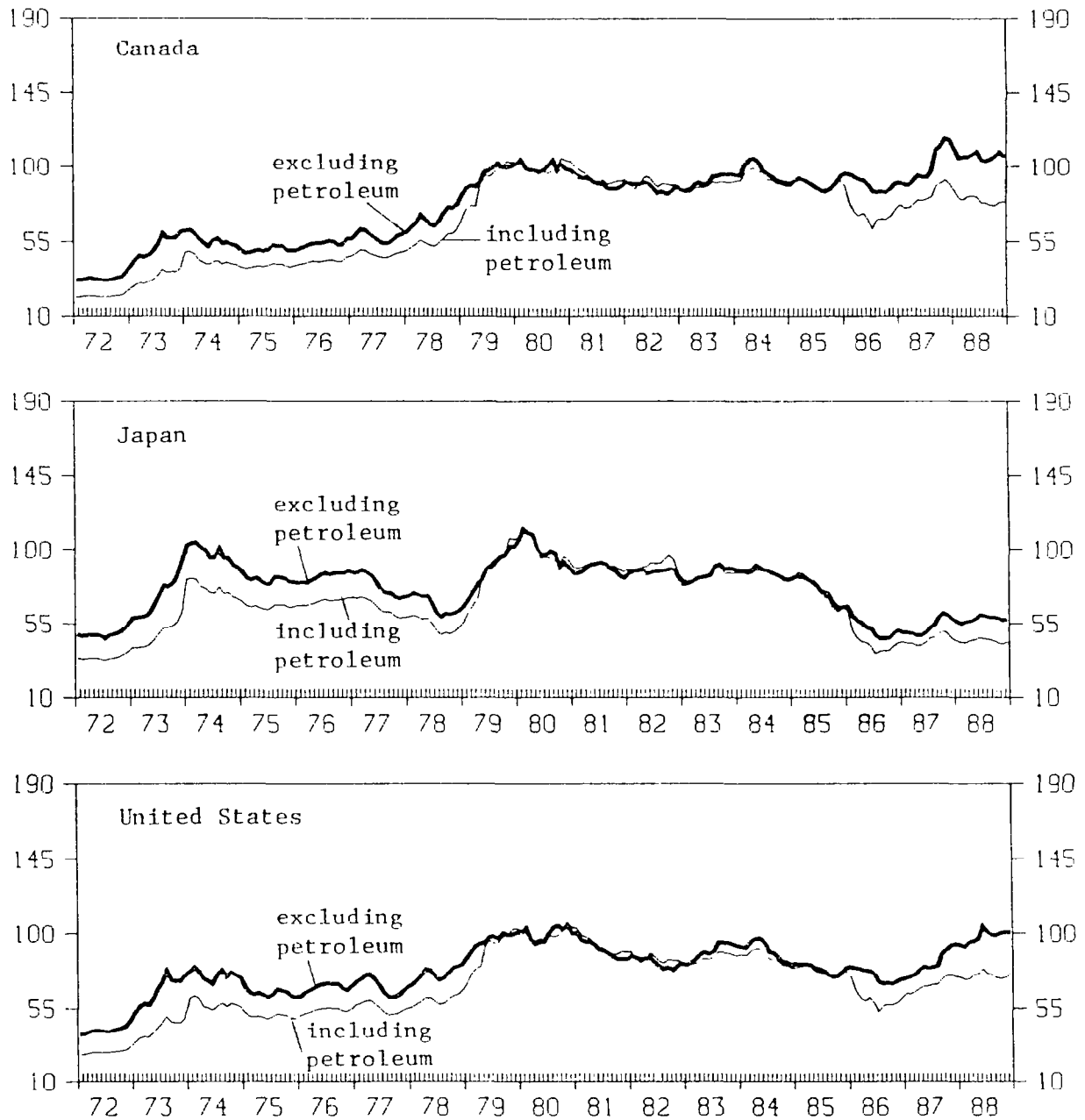


Table 3. Tests on Consumer Price Indexes for
First-Order Integration, 1959-1988

Country	Augmented Dickey-Fuller	Dickey-Fuller (annual) 2/	Sargan-Bhargava	
	(monthly, 2 lags) 1/		monthly 3/	annual 4/
Canada	-3.21	-0.59	1.02 **	0.22
France	-3.02	-1.90	0.82 **	0.43
Germany	-5.25 **	-0.86	1.22 **	0.35
Italy	-2.89	-0.70	0.67 **	0.22
Japan	-6.49 **	-1.37	1.71 **	0.63
United Kingdom	-4.01 **	-0.96	1.12 **	0.39
United States	-2.61	-0.85	0.65 **	0.36

1/ T-statistic on β_0 in the regression $\Delta^2 \ln(\text{CPI})_t = \beta_0 \Delta \ln(\text{CPI})_{t-1} + \sum_{i=1}^2 \beta_i \Delta^2 \ln(\text{CPI})_{t-i}$. The 95 percent confidence level (*) for rejecting the null hypothesis of nonstationarity (N=379) ≈ 3.65 ; the 99 percent level (**) is approximately 4.17. These values are extrapolated from Table 2 in Engle and Yoo (1987).

2/ T-statistic on β in the regression $\Delta^2 \ln(\text{CPI})_t = \beta \Delta \ln(\text{CPI})_{t-1}$. The 95 percent confidence level (N=31) is approximately 1.95.

3/ Durbin-Watson statistic for the regression $\Delta \ln(\text{CPI})_t = \text{constant}$. The 99 percent confidence level for rejecting the null hypothesis of nonstationarity is given as 0.376 for N=101 in Table 1 of Sargan and Bhargava (1983); for N=379, the critical value would be substantially lower.

4/ The 95 percent confidence level (N=31) = 0.77.

These integration tests suggest that the long-run processes governing the behavior of commodity and consumer prices are rather different. Nonetheless, there is enough ambiguity about the order of stationarity to warrant testing directly for cointegration. This task has been carried out in three steps, as illustrated in Table 4. First, we ran both Durbin-Watson and augmented Dickey-Fuller tests in order to determine whether the levels are cointegrated, conditional on the acceptance of consumer and commodity prices both being $I(1)$. Those tests (first two columns of Table 4) almost uniformly failed to reject the null hypothesis of non-cointegration. Second, we repeated those tests with broad money growth as an additional explanatory variable in order to determine whether there might be a cointegrating relationship between commodity prices and the portion of consumer prices that is not explained by monetary growth. Those tests (middle of Table 4) gave essentially the same results as the first.

The third set of tests (last two columns in Table 4) may reveal the nature of the underlying long-run relationship between commodity and consumer prices. For this exercise, we repeated the tests using the CPI inflation rate as the dependent variable; that is, if the CPIs are $I(2)$ while commodity prices are $I(1)$, it is natural to suspect that the level of commodity prices may be cointegrated with the CPI inflation rate. As predicted by the theoretical model of Section II, this would imply that low inflation in the industrial countries tends to be associated with low levels of commodity prices, and conversely. This suspicion is confirmed for all seven countries, both by the high Durbin-Watson statistics and by the high t-ratios in the residual regressions.

2. Granger causality

One way of examining the shorter-run relationships between commodity and consumer prices is to ask whether commodity prices Granger-cause consumer prices, or the reverse. Such tests are summarized in Table 5. As a very restricted but simple test of whether the results are sensitive to changes in the sample period, three overlapping samples have been selected for this table. The first covers the full period for which data are available monthly, from mid-1960 through the end of 1987. ^{1/} The second starts in January 1972, eliminating the period when there was very little movement in the commodity price indexes. The third starts in January 1974, eliminating the 1972-73 boom in commodity prices. This third sample is more homogeneous than the others and may be somewhat more representative of the behavior of the data in recent years. On the other hand, consumer prices were also more quiescent in the 1960s and experienced a sudden upsurge in the early 1970s; it is therefore not obvious that the relationship between the two series has changed significantly over time.

^{1/} The complete data set begins in January 1958, but 13 months are used to construct first differences in 12-month inflation rates, and 18 months are used as lags in the regressions. Thus the first observation on the dependent variable is for August 1960.

Table 4. Cointegration Tests, January 1957-September 1988

Country	<u>Bivariate Tests on Price Levels ^{1/}</u>		<u>Trivariate Tests on Price Levels ^{2/}</u>		<u>CPI Inflation Against Commodity Price Level ^{3/}</u>	
	Durbin- Watson ^{4/}	Augmented Dickey-Fuller ^{5/}	Durbin- Watson ^{4/}	Augmented Dickey-Fuller ^{5/}	Durbin- Watson ^{4/}	Augmented Dickey-Fuller ^{5/}
Canada	0.04	-2.37	0.07	-1.88	1.25 **	-9.56 **
France	0.07	-3.07	0.04	-2.08	0.85 **	-7.27 **
Germany	0.05	-3.38 *	0.05	-2.98	1.22 **	-10.29 **
Italy	0.04	-2.59	0.02	-1.25	0.84 **	-7.05 **
Japan	0.01	-1.27	0.04	-2.00	1.75 **	-13.71 **
United Kingdom	0.04	-2.98	0.03	-1.36	1.19 **	-8.98 **
United States	0.02	-1.94	0.01	-1.74	0.89 **	-6.95 **

^{1/} Cointegrating equation: $\ln \text{CPI}_t = \alpha + \beta_1 \ln X_t + \varepsilon_t$, where X_t is the commodity price index (excluding oil).

^{2/} Cointegrating equation: $\ln \text{CPI}_t = \alpha + \beta_1 \ln X_t + \beta_2 \ln M_t + \varepsilon_t$, where M_t is the stock of money. For these tests, the sample period begins in January 1964.

^{3/} Cointegrating equation: $\Delta \ln \text{CPI}_t = \alpha + \beta_1 \ln X_t + \varepsilon_t$.

^{4/} Durbin-Watson statistics from the cointegrating equation. For 100 observations, the 95 (*) and 99 (**) percent confidence levels for rejecting nonstationarity are 0.39 and 0.51, respectively; see Table 2 in Engle and Granger (1987).

^{5/} T-statistic on β_1 in the regression $\Delta \varepsilon_t = \beta_1 \varepsilon_{t-1} + \beta_2 \Delta \varepsilon_{t-1} + \mu_t$. For 100 observations, the 95 and 99 percent confidence levels are 3.17 and 3.77, respectively.

Table 5. Granger Causality Tests for Relationships between
Commodity Price and Consumer Price Indexes ^{1/}

(Confidence levels)

	Canada	France	Fed. Rep. of Germany	Italy	Japan	United Kingdom	United States
I. Tests for whether commodity prices Granger-cause consumer prices, using changes in inflation rates							
<u>Sample period</u>							
1960-87	0.695	0.955*	0.721	1.000**	1.000**	0.960*	1.000**
1972-87	0.952*	0.999**	0.990	0.995**	1.000**	0.971*	0.985*
1974-87	0.883	0.999**	0.843	0.987*	1.000**	0.923	0.969*
II. Tests for reverse causation, using changes in inflation rates							
<u>Sample period</u>							
1960-87	0.545	0.191	0.460	0.160	0.125	0.834	0.884
1972-87	0.480	0.557	0.844	0.166	0.194	0.218	0.541
1974-87	0.364	0.571	0.714	0.308	0.405	0.147	0.797
III. Tests for whether commodity prices Granger-cause consumer prices, using levels of inflation rates for commodity prices							
<u>Sample period</u>							
1960-87	0.835	0.956*	0.407*	1.000**	1.000**	0.981*	1.000**
1972-87	0.959*	0.999**	0.662	1.000**	1.000**	0.976*	0.980*
1974-87	0.901	0.999**	0.600	0.999**	0.999**	0.923	0.949*
IV. Tests for reverse causation, using levels of inflation rates for commodity prices							
<u>Sample period</u>							
1960-87	0.455	0.252	0.386	0.513	0.043	0.853	0.627
1972-87	0.392	0.716	0.832	0.489	0.064	0.107	0.297
1974-87	0.194	0.772	0.684	0.596	0.194	0.226	0.617

^{1/} Significance at the .05 and .01 levels is denoted by * and **, respectively. The variables are the consumption-weighted commodity price index (excluding oil) for each country, denominated in that country's currency, and the country's consumer price index. All data are pre-whitened by taking first differences in 12-month inflation rates, except in parts III and IV, where the filter for commodity prices is the level of the 12-month inflation rate.

Very simple stationarity filters have been employed for these tests. For the top half of Table 5, all data are in the form of first differences in 12-month inflation rates ($\Delta X_t = \ln X_t - \ln X_{t-1} - \ln X_{t-12} + \ln X_{t-13}$). This filter produces a reasonably flat correlogram for each time series. However, in view of the finding that the order of stationarity for consumer prices may be higher than that for commodity prices, this procedure raises the possibility that the commodity price data may have been over-differenced. To check for the significance of this possibility, the tests reported in the bottom half of the table have been conducted using levels of 12-month inflation rates for commodity prices and changes in inflation for consumer prices. In no instance is the conclusion about the significance of the hypothesized direction of causality altered by the choice of filter.

The Granger causality tests shown in Table 5 indicate that commodity prices precede movements in consumer prices in most of these countries; but not in all, nor in all sample periods. Specifically, there seems to be no effect in Germany, nor in Canada except for the 1972-87 sample period. There is no evidence at all of reverse causation (consumer prices Granger-causing commodity prices). Overall, these results are somewhat clearer than the results reported in Boughton and Branson (1988), where--vis-a-vis the average CPI inflation rate for the seven countries as a group--there was mixed evidence for Granger causation in both directions, with the results depending on the currency in which the data were denominated.

3. In-sample predictive ability

A second way of looking at the short-run relationships is to estimate forecasting equations based on distributed lags (rather than unrestricted lags, as in the Granger causality tests). The in-sample results of such estimates are reported in Table 6. The regressions underlying Table 6 differ from those used for Table 5 in the following ways. First, the unrestricted 18-month lags have been replaced by fourth-order polynomial distributed lags (PDLs). Second, growth in broad money stocks has been added as a second possible explanator of CPI inflation. Third, the first sample period is shorter, because the money stock data for some countries start--for reasons of consistency and comparability--in 1964.

These more restricted estimates cloud the picture somewhat, in that commodity prices now seem to be insignificant for both France and the United Kingdom, in addition to Canada and Germany. That is, instead of being significant in five of the seven countries, they are significant only in three. Nonetheless, in most cases, commodity prices add more to these equations than do money stocks. This result, which certainly seems

Table 6. Contribution of Commodity Prices and Monetary Growth
to In-Sample Inflation Predictions 1/

(Confidence levels)

	Canada	France	Fed. Rep. of Germany	Italy	Japan	United Kingdom	United States
I. Commodity Prices (excluding oil):							
Sample period							
1966-87	.089	.714	.200	.982*	1.000**	.317	.993**
1972-87	.049	.639	.158	.978*	1.000**	.330	.978*
1974-87	.221	.496	.335	.949	1.000**	.410	.922
II. Monetary growth:							
Sample period							
1966-87	.629	.154	.116	.984	.756	.646	.930
1972-87	.208	.215	.105	.974	.813	.576	.752
1974-87	.149	.240	.752	.970	.939	.729	.659

1/ Confidence levels for F statistics calculated for the marginal contribution made by a 12-month polynomial distributed lag on the indicated variable, in a regression of each country's CPI. A 12-month PDL on the CPI is also included in each regression, and all data are pre-whitened by taking first differences in 12-month inflation rates. Significance at the .05 and .01 levels is denoted by * and **, respectively.

counterintuitive, may reflect a high contemporaneous correlation between consumer prices and money growth--in which case the latter might not add much to a regression that already includes lagged consumer prices--or it may reflect the deterioration in money-inflation linkages that has been observed in the 1980s.

4. Post-sample predictive ability

A much stricter test of the usefulness of commodity prices as leading inflation indicators is whether the equations improve the forecasts *ex ante*; that is, beyond the end of the estimation period for the regressions. One approach to this task would be to begin by estimating optimal forecasting equations for each sample. That procedure would be too time-consuming for the present study, and it would produce results that would not be transparent. As a simplification, we have estimated equations of the type used in Table 5 for six overlapping sample periods and then have generated *ex ante* dynamic forecasts for the 24 months following the end of each sample. The shortest sample runs from February 1968 through December 1975, with forecasts for 1976-77. ^{1/} This sample is then extended by two years at a time, with the final sample ending in December 1985.

These post-sample predictions are summarized in Table 7; more detail is given in a set of tables in Appendix II. The first section of Table 7 indicates that for four of the seven countries (France, Italy, the United Kingdom, and the United States), the average post-sample prediction errors are smaller when past commodity prices (including oil prices) are included than they are on the basis of past CPI inflation alone. For Italy and the United Kingdom, money growth must be included along with commodity prices in order to get the best improvement. These comparisons, of course, may be sample-specific.

The lower sections of Table 7 indicate the consistency of the improvement (if any) in the post-sample predictions. Whereas the results just discussed are averages over the six 24-month prediction periods, these rows show the number of periods in which an improvement is observed, first for the mean average prediction error (MAPE) and then for the root mean squared error (RMSE). The two comparisons are interesting in that the MAPE is a measure of the error in predicting the 2-year inflation rate, whereas the RMSE is a measure of the average error in predicting 24 monthly inflation rates. In general, these figures show that the inclusion of commodity prices--in forms that vary across countries--reduces prediction errors in more than half of the six selected forecast periods, although (except for Italy) not in all periods.

^{1/} The initial period is determined by availability of the shortest time series (the money data), allowing for the need to filter the data and estimate distributed lags.

Table 7. Summary of Inflation Prediction Errors, 1976-8/ 1/

	Canada	France	Fed. Rep. of Germany	Italy	Japan	United Kingdom	United States
Mean absolute Prediction error (MAPE) <u>2/</u>							
baseline	1.32	1.31	1.10	2.23	1.49	1.81	1.61
using non-oil commodity prices	1.40	1.15	1.22	1.66	1.93	1.83	1.54
using all commodity prices	1.47	1.09	1.20	1.57	2.67	1.77	1.27
using money growth	1.64	1.30	1.08	1.70	1.82	1.81	1.74
using all variables <u>3/</u>	1.76	1.11	1.23	1.00	2.63	1.67	1.50
Number of periods (out of 6) with:							
reduction in MAPE							
using non-oil commodity prices	3	4	1	6	2	2	3
using all commodity prices	4	4	1	5	3	3	4
using money growth	1	4	3	5	1	3	2
using all variables <u>3/</u>	2	4	2	5	3	5	4
reduction in RMSE							
using non-oil commodity prices	3	3	3	5	4	2	3
using all commodity prices	4	4	3	4	3	4	4
using money growth	1	4	4	5	1	3	2
using all variables <u>3/</u>	2	4	3	6	3	4	3

1/ Post-sample 24-month dynamic prediction of the CPI for each country for six two-year periods; for detailed predictions, see Appendix II.

2/ Arithmetic mean of the absolute prediction errors for six two-year periods, in percent.

3/ For this row, predictors include both money growth and commodity price inflation (including oil prices), as well as past CPI inflation.

5. Turning points

The final test is more qualitative than the others, but it may be the most relevant in practical terms. This test concerns the ability of commodity prices to foretell turning points in CPI inflation in the various countries. The previous tests have all treated each observation in the CPI as equally relevant and assumed that the objective was to improve the ability to forecast the rate of inflation. An alternative objective is to project turning points in the CPI inflation rate, based on turning points in selected leading indicators.

The definition of a turning point is inherently arbitrary for any series that is not completely smooth; it is necessary to weed out temporary departures from trends from the more sustained shifts in direction. The procedure that we have adopted is to select a set of rules that is able to replicate reasonably well a selection that appears reasonable based on visual inspection of plots of the time series on CPI inflation in the various countries. The rule is as follows: A turning point is defined as a point where the 3-month moving average of the 12-month inflation rate moves in one direction for at least 2 months and then in the other direction for 2 months, with a cumulative change since the last turning point and a cumulative change within 6 months after the turn that exceed a specified minimum amount. That is, if

$$x_t \neq x_{t-1} \text{ and } x_t = x_{t+1},$$

where x is the sign of the moving average inflation rate (y); and if

$$y_t - y_0 \text{ and } y_{t+i} - y_t \geq k \text{ for some } i, 0 < i \leq 6,$$

where y_0 is the value of the moving average inflation rate at the preceding turning point and k is an arbitrary minimum percentage change, then x_t is defined to be a turning point. ^{1/}

For the purpose of defining a turning point in the CPI, k is set at 75 basis points for an increase and 50 basis points for a decrease, the difference reflecting the downward rigidity in the data. For the commodity price index, where the data are more flexible and more volatile, $k = 5$ percentage points in both directions. For money growth, $k = 1.5$ percentage points in both directions. Smaller values of k for commodity prices or money growth generally produce a small increase in correct calls, but at the expense of a large increase in false signals.

^{1/} If the turning point is sustained for six months, then the requirement k is reduced by half (i.e., the criterion becomes $y_{t+6} - y_t \geq .5k$). Also, if $y_{t+i} - y_t \leq 0$ for some date before a turning point is found, then y_t is determined not to be a turning point.

It should also be noted that a prediction of a turning point is recorded, not at the date of the turning point in the indicator (t), but rather at the date when the turning point is fully recognized ($t+1$ or $t+2$, whichever comes later). Thus the table does not indicate the actual lead time, but rather the shorter lead time after the status of the indicator is clarified. A simple comparison of turning points would give a much more favorable impression. Finally, a correct prediction requires that the indicator be continuing to move in the right direction when the CPI turning point is observed.

Suppose, for example, that a trough in commodity price inflation occurs in January and is confirmed in April, and that a trough in CPI inflation occurs in September. This would be recorded as a 5-month correct lead time, unless a subsequent peak in commodity price inflation was confirmed by September. In that case, the indicator would be giving conflicting signals, and the original call would be listed in the table as a false signal.

Table 8 summarizes the results of the turning-point calculations; more detailed information is given in Appendix II. These results illustrate the limited usefulness of relying on any single leading indicator for making forecasts, but they also demonstrate that commodity prices do have a role to play. Overall, it appears that commodity prices do about as well as money growth in predicting turning points in CPI inflation, making timely predictions in a little less than half the cases and making a little less than one false signal for every timely one. The average lead prediction times are about the same for money and for commodity prices, but the variances around those means are a little wider when money is the indicator. In no case is there a systematic advantage to using the two indicators together. 1/ The performance of these indicators differs across countries. For perhaps three to five of the seven countries (Germany, Japan, and the United Kingdom; and possibly Canada and/or France), commodity prices are superior to money growth. 2/ Except for

1/ For the joint-prediction test (summarized at the bottom of Table 7), a CPI turning point is predicted only when both money growth and commodity prices (including oil) are pointing in the same direction. The alternative rule, by which one would call a turning point if either index showed a clear turn, does not work because it leads to a very large number of false signals.

2/ The ambiguity in this conclusion arises when there is a need to weigh increases in correct calls against increases in false signals and/or against decreases in the average lead time. For Canada, the money indicator gives 10 correct calls, against 5 for non-oil commodity prices, but it also raises the number of false signals from 2 to 5 and shortens the mean lead time from 15 months to 8. For France, there is a proportional rise in false signals and timely calls when money is used instead of non-oil commodity prices, although the lead time in this case is raised somewhat.

Table 8. Predictions of Turning Points in CPI Inflation, 1965-87 1/

Commodity	Canada	France	Germany	Italy	Japan	United Kingdom	United States
Number of turning points	15	11	14	17	23	16	12
Predictions using non-oil commodity prices							
Number of calls:							
on time	5	5	4	7	8	11	5
late	5	2	6	3	4	2	2
missed	5	4	4	7	11	3	5
Number of false signals	2	10	7	3	4	4	8
Lead time for correct calls (in months)							
mean	15	5	3	7	4	4	8
standard deviation	7.8	5.4	2.0	2.5	2.9	3.3	6.5
Predictions using all commodity prices							
Number of calls:							
on time	5	3	3	8	8	10	5
late	4	2	7	2	5	3	3
missed	6	6	4	7	10	3	4
Number of false signals	4	8	7	8	1	4	5
Lead time for correct calls (in months)							
mean	10	7	3	5	6	4	8
standard deviation	8.3	7.0	1.0	2.6	3.6	2.8	7.3
Predictions using money growth							
Number of calls:							
on time	10	6	2	8	5	9	7
late	0	0	5	3	3	1	1
missed	5	5	7	6	15	6	4
Number of false signals	5	12	3	2	3	7	2
Lead time for correct calls (in months)							
mean	8	8	9	5	6	4	13
standard deviation	8.6	6.7	2.1	5.6	5.4	5.1	9.8
Predictions using all data 2/							
Number of calls:							
on time	8	4	2	7	7	10	5
late	2	1	6	2	3	3	5
missed	5	6	6	8	13	3	2
Number of false signals	5	10	6	7	2	5	4
Lead time for correct calls (in months)							
mean	9	9	3	4	6	3	8
standard deviation	7.2	8.9	1.4	3.7	4.0	4.4	7.1

1/ For definitions of turning points and criteria for predictions, see text. For dates of turning points and predictions.

2/ For this row, predictors include both money growth and commodity price inflation (including oil prices).

Japan, the preferred index in this context excludes oil prices, in contrast to the quantitative prediction tests reported above. For the United States and Italy (and perhaps for Canada and/or France), money growth alone appears to be the best indicator of turning points in CPI inflation.

V. Evidence Pertaining to Output Deflators

1. Introduction

This section turns attention from consumer prices to output prices in the large industrial countries. A priori, there is reason to suspect that the relationship between primary commodity prices and general output prices (such as GNP or GDP deflators) may differ from the relationship with consumer prices. First, the large industrial countries are, broadly speaking, net importers of primary commodities; consequently, primary commodities make up a larger portion of the consumption basket than they do of the output basket in these countries, and one might expect a somewhat weaker relationship with output deflators. Second, the importance of primary commodity production differs across these countries; France, for example, is a far more agricultural country than Japan. Since--as a consequence of international trade--consumption patterns are less varied across countries than production, one might expect the relationship between primary commodity prices and output deflators to vary across countries by more than is the case with CPIs.

Table 9 provides estimates of the importance of cross-country differences in the role of primary commodities, derived from the 1979 or 1980 input-output tables for the various countries. Italy, France, and the United Kingdom have relatively high coefficients for the direct contribution of primary commodities to the output deflators (ranging from 11.3 to 13.0 percent), and Japan has the smallest coefficient (zero). These relative positions hold regardless of whether oil is included in the list of primary commodities. In spite of limitations in the commensurability in these estimates, the data in Table 9 do help quantify some important propositions about the role of primary commodities in these countries: (a) there are very substantial differences in the composition of output, (b) the differences are relatively minor regarding the composition of consumption, and (c) in most cases, primary commodities are a bigger portion of consumption than of output.

2. Single-equation tests

When the various econometric tests that were described in Section IV were rerun using output deflators rather than CPIs, the results largely confirmed those already discussed. These tests are shown in Appendix II, Tables A15 through A20. There are a few notable differences for individual countries (summarized in the Appendix), but they may result from the use of quarterly rather than monthly data and slightly different sample periods, owing to more limited data availability.

Table 9. Portion of Consumer Spending and Domestic Output
Attributable to Primary Commodities, 1980

	<u>Consumer Spending</u>		<u>Domestic Output</u>	
	total	net of oil and gas	total	net of oil and gas
Canada (1979)	8.1	5.3	7.5	5.4
France	12.8	8.3	11.7	8.1
Germany, Fed. Rep. of	8.8	6.5	8.8	7.0
Italy	14.3	11.1	13.0	10.4
Japan	8.0	7.2	--	2.5
United Kingdom	11.7	8.5	11.3	7.5
United States (1979)	6.7	4.2	3.6	3.6

Source: national input-output tables. The derivation of these estimates is described in Appendix III.

Overall, there does not seem to be a systematic difference in performance between the ability of commodity price movements to foretell movements in GNP deflators and in consumer price indexes. A close comparison of the appendix tables with the text tables discussed above seems to suggest that the significance and reliability of some of the statistical relationships linking commodity prices and output deflators may be slightly less than for the relationships with consumer price indexes. The differences, however, are less striking than might have been anticipated, judging from the smaller weights on primary commodities in output deflators (Table 9). It may well be that the observed correlations arise more from general expectational forces than from direct effects reflected in the weights.

3. Model simulations

All of the tests performed up to this point are based on reduced-form relationships between commodity and other prices. One limitation of that approach is that commodity prices, as well as other prices, are endogenous variables that respond in different ways to different shocks. It is therefore of interest to examine the role of commodity prices within a larger, more structural model. Table 10 summarizes a set of simulations using MULTIMOD, taken from Masson et al. (1988).

In this version of MULTIMOD, the demand for total imports of non-oil primary commodities in each of 5 industrial-country blocks (the United States, Japan, Germany, the rest of the Group of Seven, and the smaller industrial countries as a group) is a function of the country's GNP and the world price of commodities relative to the country's GNP deflator. There is also a supply equation that is highly autoregressive. Changes in inventory stocks are ignored, so the price of commodities is a volatile price that equilibrates the market.

It should be emphasized that MULTIMOD is not an expanded version of the theoretical model developed in Section II. In particular, the key arbitrage condition in the theoretical model is on commodities rather than on bonds, and this gives the required absolute decline in the commodities price in response to an unaccommodated shock. In the MULTIMOD simulations, the movements in relative prices are similar to what the theoretical model would predict, but the absolute price movements differ in that there is no absolute decline.

The first part of Table 10 shows the effects of monetary shocks. In each case, the overshooting of commodity prices is apparent, as expected. After 2 years, the rise in commodity prices is 2 to 6 times the rise in the GNP deflator; after 6 years, the two indexes show similar changes. In response to fiscal shocks, however, no such overshooting is observed. This relationship is consistent with the predictions of the theoretical model described in Section II, except that the simulations allow for a change in absolute as well as relative prices (i.e., nonaccommodation is less strictly defined than in the theoretical model).

Table 10. Movements in Commodity Prices and GNP Deflators in
Response to Various Shocks: MULTIMOD Simulations

(Percentage Deviation from Baseline)

	After 2 years	After 4 years	After 6 years
A. Increase in Money Supply			
1. In United States			
commodity prices	4.6	5.0	5.6
U.S. GNP deflator	0.8	2.4	5.9
2. In Japan			
commodity prices	3.4	3.8	4.9
Japanese GNP deflator	1.7	3.8	4.3
3. In Germany			
commodity prices	5.3	4.8	4.5
Germany GNP deflator	1.7	3.8	4.2
B. Increase in Government Spending			
1. In United States			
commodity prices	0.5	2.1	5.8
U.S. GNP deflator	1.0	3.5	10.5
2. In Japan			
commodity prices	0.3	2.5	4.2
Japanese GNP deflator	1.6	3.9	5.1
3. In Germany			
commodity prices	0.3	0.5	1.7
Germany GNP deflator	0.9	2.2	3.4
C. Decrease in World Oil Prices			
commodity prices	1.1	0.0	-1.1
U.S. GNP deflator	-0.1	-0.1	-1.5
D. Increase in Financing to Developing Countries			
commodity prices	1.5	0.9	-0.3
U.S. GNP deflator	0.3	0.8	1.3

The last two simulations involve disturbances that are more complex than those illustrated in our theoretical model. A decline in the dollar price of oil, with no change in monetary policy, raises other prices, including non-oil commodity prices. In the longer run, however, relative prices move back toward initial values. Thus there is some overshooting. In a sense, this case illustrates the "real shock" effect described by the theoretical model: commodity prices lead output prices, but in the wrong direction. Finally, an increase in financing flows to developing countries is similar to a more general fiscal stimulus, except that it raises output of developing countries and thus eventually depresses commodity prices. In this case, there is a tendency for overshooting.

Data Sources and Methodology

This Appendix describes the estimation of the weights in the commodity price indexes. The weights (shown in text Table 2) are based on estimated values of average annual consumption from 1983 to 1985, except for petroleum (for which 1986 values have been used, owing to the sharp decline in oil prices after 1985). The figures for total private consumption used to calculate the coverage of selected primary commodities were taken from International Financial Statistics.

Estimates of consumption of most agricultural goods and raw materials were based on FAO data on production, plus imports minus exports, valued at the average import unit value for the group of industrial countries. Group rather than individual-country unit values were used, since the latter often differed remarkably from world prices and displayed volatile short-run fluctuations. Consumption for remaining goods (sugar, rubber, and all metals except iron ore) was taken from published sources and valued at world or regional market prices. Consumption of two goods (timber and tobacco) was adjusted to account for the trade of these goods in a more manufactured form (e.g., plywood, paper and cigarettes). Iron ore consumption was estimated based on the ratio of world iron ore to world pig iron production, and on pig iron consumption in individual countries (data on iron ore consumption being unavailable). The remainder of this Appendix provides more detail on these calculations.

1. Estimation of apparent consumption

Commodities:

Wheat, Maize, Rice Paddy + Rice Husked, Soybeans, Soybean Cake, Soybean Oil, Palm Oil, Coconut oil, Groundnut Oil, Groundnut Cake, Beef/veal, Meat/mutton/lamb, Bananas, Coffee Green, Cocoa Beans + Cocoa Paste + Cocoa Powdercake, Tea, Cotton Lint, Wool Greasy + Wool Scoured, Tobacco Leaves, Cattle Hides Fresh + Cattle Hides Dry Salted + Cattle Hides Wet Salted, Jute, Sisal, Natural Phosphate.

- a. Sources: World Bank BESD Data Base, containing data from FAO

Production Yearbook and FAO Trade Yearbook, various issues.

USDA World Tobacco Situation, August 1987.

- b. Methodology: Consumption value = consumption volume times import unit value for 7 major industrial countries. Apparent consumption volume = Production minus exports plus imports.

Apparent consumption of soybeans reduced by production of soybean meal divided by .8 (volume ratio of soybean to soybean meal production).

Apparent consumption of leaf tobacco (FAO) reduced by exports minus imports of cigarettes (USDA, with no adjustment for the weight of the paper used to wrap filterless cigarettes).

2. Consumption data from trade journals

Commodities:

Sugar, rubber, copper, aluminum, tin, nickel, zinc, lead.

- a. Sources: USDA World Sugar Situation and Molasses Situation and Outlook, May 1986 and May 1987, ISO Monthly Statistical Bulletin, various issues, IRSG Rubber Statistical Bulletin, July 1988, Metal Bulletin, various issues, IMF Commodities Division.
- b. Methodology: Consumption value = consumption volume (respective sources above) times international commodity price (Commodities Division).

Sugar consumption data (USDA) for all countries except Japan on year-ending August basis, valued at year-ending August U.S. sugar price (United States) or EC sugar price (European countries). Consumption for Japan (ISO), on calendar year basis, valued at world sugar price.

3. Remaining commodities

- a. Timber
 - i. Source: FAO Yearbook of Forest Products, 1986.
 - ii. Methodology: Consumption value = consumption volume times import unit value of coniferous industrial roundwood for each country. Consumption volume = production of coniferous and non-coniferous industrial roundwood, plus imports minus exports of coniferous and non-coniferous sawlogs and veneer logs, plus net imports of coniferous and non-coniferous sawnwood and sleepers, plus net imports of pulpwood, paper and paperboard, wood based-panels and wood pulp.
- b. Iron Ore
 - i. Source: Metal Bulletin, various issues.
 - ii. Methodology: Consumption value = estimated consumption volume times international price of iron ore. Production of pig iron, multiplied by ratio of world iron ore to pig iron production, used as proxy for iron ore consumption.
- c. Petroleum
 - i. Source: OECD Energy Balance, various issues.
 - ii. Methodology: Consumption of refined products (WEO) times import unit value of crude petroleum and refined products (WEO) in 1986, for each major industrial country.

Detailed Calculations for Individual Countries

This Appendix presents detailed calculations for individual countries that underly the results discussed in the main text. There are three sets of tables. First, Tables A1 through A7 provide details on the post-sample predictions for individual countries that are summarized in text Table 7. For example, Table A1 shows the post-sample prediction errors for Canada from four equations over six different time periods. These six periods are then averaged in text Table 7.

Second, Tables A8 through A14 provide background information on the summary statistics given in text Table 8. For example, text Table 8 notes that there were 15 turning points (as defined in the text) in the CPI inflation rate for Canada during the 1965-87 period. Of those 15, there were 5 cases where the non-oil commodity price index for Canada correctly predicted the turning point on time; 5 where the prediction came late; and 5 that were missed altogether. In addition, there were 2 false signals. Table A8 lists the dates of each turning point and the timing of the prediction (if any), using each of the four candidate indicators.

Continuing with the example, one of the correct calls listed in the first column of Table A8 is the trough in December 1976, which was preceded by 19 months by a trough in the inflation rate of the non-oil commodity price index. The next turning point, however (the peak in July 1978), was missed, and there was an intervening false signal. That is, between December 1976 and July 1978, the commodity price index first peaked and then hit a trough, so that when the CPI peak inflation rate arrived, the commodity-price inflation rate was still rising. Finally, because the commodity-price inflation rate was still rising when the CPI inflation rate hit its next trough (in November 1978), the July peak is listed as having been missed altogether rather than called late.

Third, Tables A15 through A20 may be compared with text tables 3 through 8. They differ in that these tables report tests using GNP deflators rather than consumer price indexes. The results are broadly the same, with a few principal exceptions, as follows:

Table A17 (cf. text Table 5). For Canada, the commodity price index Granger-causes the GNP deflator but not the CPI; for France and the United Kingdom, the reverse holds.

Table A18 (cf. text Table 6). There are a few cases, especially for the shorter samples, where there is less in-sample significance than in Table 6.

Table A19 (cf. text Table 7). The only major change is that for the United States, there is no overall gain here, whereas in the text table, the use of all commodity prices does reduce the mean average prediction error for the CPI.

Table A20 (cf. text Table 8). These two tables are harder to compare, because the predictions based on monetary growth have been omitted owing to the relative shortage of observations. Comparing the performance of commodity prices alone, it may be seen that for France and Germany, the nonoil commodity price index does better here than in the text table. For Canada and Italy, the same index does worse here. For Japan and the United States, the nonoil index does better here than the inclusive index does with the CPI. For the United Kingdom, the inclusive index does about as well here as the nonoil index does with the CPI. Thus there is no systematic difference one way or the other.

Table A1. Canada: Inflation Predictions, 1976-87 1/

(In percent)

	1976-77	1978-79	1980-81	1982-83	1984-85	1986-87
Actual Inflation	7.6	9.1	11.6	6.9	4.1	4.2
Baseline Prediction	9.5	8.7	10.2	9.4	5.6	4.4
Baseline Prediction Error	1.8	-0.4	-1.4	2.5	1.5	0.2
<u>Predictions Using Non-oil Commodity Prices:</u>						
Predicted Inflation	10.0	8.5	10.3	9.5	5.5	4.3
Reduction in:						
In-Sample Error	-1.6	-1.2	0.2	-0.1	-0.4	-0.3
Prediction Error <u>2/</u>	--	--	0.1	--	0.1	0.1
RMSE	--	--	6.1	--	9.0	24.8
<u>Predictions Using All Commodity Prices:</u>						
Predicted Inflation	10.4	8.8	9.8	9.4	5.5	4.3
Reduction in:						
In-Sample Error	--	-0.2	-0.4	-0.4	-0.3	-0.1
Prediction Error <u>2/</u>	--	0.1	--	--	0.1	0.1
RMSE	--	33.9	--	1.1	7.1	69.6
<u>Predictions Using Broad Money Balances:</u>						
Predicted Inflation	10.2	8.8	9.9	10.1	5.9	4.4
Reduction in:						
In-Sample Error	1.5	0.2	0.5	0.1	0.3	0.3
Prediction Error <u>2/</u>	--	0.1	--	--	--	--
RMSE	--	12.6	--	--	--	--
<u>Predictions Using All Variables:</u>						
Predicted Inflation	10.7	9.2	9.4	10.2	5.8	4.3
Reduction in:						
In-Sample Error	2.1	0.5	0.4	--	0.3	0.4
Prediction Error <u>2/</u>	--	0.3	--	--	--	0.1
RMSE	--	28.7	--	--	--	58.9

1/ Post-sample 24-month dynamic predictions of the CPI from equations as described in the text. The estimation sample is from February 1968 (plus prior lagged data) to December of the year preceding the listed forecast period.

2/ In percentage points.

Table A2. France: Inflation Predictions, 1976-87 1/

(In percent)

	1976-77	1978-79	1980-81	1982-83	1984-85	1986-87
Actual Inflation	9.4	10.7	13.7	9.5	5.7	2.6
Baseline Prediction	10.7	9.8	12.9	11.6	7.3	3.8
Baseline Prediction Error	1.3	-0.9	-0.8	2.1	1.6	1.2
<u>Predictions Using</u> <u>Non-oil Commodity Prices:</u>						
Predicted Inflation	10.7	10.2	12.9	11.3	7.3	3.5
Reduction in:						
In-Sample Error	-0.2	1.4	1.9	2.3	0.5	0.4
Prediction Error <u>2/</u>	--	0.4	--	0.3	--	0.4
RMSE	--	54.9	--	8.8	--	35.3
<u>Predictions Using</u> <u>All Commodity Prices:</u>						
Predicted Inflation	10.1	10.4	12.6	11.3	7.4	3.4
Reduction in:						
In-Sample Error	0.8	1.9	2.3	2.7	0.9	1.0
Prediction Error <u>2/</u>	0.6	0.6	--	0.3	--	0.4
RMSE	19.8	74.3	--	6.2	--	47.0
<u>Predictions Using</u> <u>Broad Money Balances:</u>						
Predicted Inflation	10.4	9.4	13.0	11.5	7.4	3.7
Reduction in:						
In-Sample Error	-1.4	-0.2	-0.8	-0.4	-0.6	-0.7
Prediction Error <u>2/</u>	0.3	--	0.1	0.1	--	0.1
RMSE	30.7	--	12.2	7.8	--	6.3
<u>Predictions Using</u> <u>All Variables:</u>						
Predicted Inflation	10.1	10.1	12.7	11.2	7.6	3.2
Reduction in:						
In-Sample Error	1.1	2.6	2.7	3.6	0.7	0.7
Prediction Error <u>2/</u>	0.6	0.2	--	0.4	--	0.6
RMSE	6.7	73.0	--	14.4	--	61.7

1/ Post-sample 24-month dynamic predictions of the CPI from equations as described in the text. The estimation sample is from February 1968 (plus prior lagged data) to December of the year preceding the listed forecast period.

2/ In percentage points.

Table A3. Federal Republic of Germany: Inflation Predictions, 1976-87 ^{1/}

(In percent)

	1976-77	1978-79	1980-81	1982-83	1984-85	1986-87
Actual Inflation	3.6	3.9	6.1	3.6	1.9	--
Baseline Prediction	4.9	3.4	5.6	5.5	3.0	1.1
Baseline Prediction Error	1.3	-0.5	-0.5	1.9	1.2	1.1
Predictions Using <u>Non-oil Commodity Prices:</u>						
Predicted Inflation	5.6	3.4	5.6	5.6	2.9	1.1
Reduction in:						
In-Sample Error	0.1	-0.8	-0.9	-0.7	-0.3	0.2
Prediction Error ^{2/}	--	--	--	--	0.1	--
RMSE	--	--	22.0	--	13.0	1.4
Predictions Using <u>All Commodity Prices:</u>						
Predicted Inflation	5.4	3.4	5.5	5.6	2.9	1.2
Reduction in:						
In-Sample Error	-1.7	-1.3	-1.1	-0.1	-0.1	0.4
Prediction Error ^{2/}	--	--	--	--	0.1	--
RMSE	--	7.9	--	--	10.5	0.5
Predictions Using <u>Broad Money Balances:</u>						
Predicted Inflation	4.6	3.2	5.8	5.7	3.2	1.0
Reduction in:						
In-Sample Error	-0.9	-0.9	-1.1	-1.0	-1.0	-0.9
Prediction Error ^{2/}	0.3	--	0.2	--	--	0.1
RMSE	35.3	85.4	7.0	--	--	5.6
Predictions Using <u>All Variables:</u>						
Predicted Inflation	5.2	3.1	5.8	5.9	3.2	1.0
Reduction in:						
In-Sample Error	-2.8	-2.7	-2.2	-0.9	-0.7	0.1
Prediction Error ^{2/}	--	--	0.2	--	--	0.1
RMSE	--	53.6	2.1	--	--	13.4

^{1/} Post-sample 24-month dynamic predictions of the CPI from equations as described in the text. The estimation sample is from February 1968 (plus prior lagged data) to December of the year preceding the listed forecast period.

^{2/} In percentage points.

Table A4. Italy: Inflation Predictions, 1976-87 1/

(In percent)

	1976-77	1978-79	1980-81	1982-83	1984-85	1986-87
Actual Inflation	18.1	15.1	19.7	14.3	9.1	4.8
Baseline Prediction	17.7	17.3	17.5	17.4	12.0	7.4
Baseline Prediction Error	-0.4	2.2	-2.3	3.1	2.8	2.5
Predictions Using <u>Non-oil Commodity Prices:</u>						
Predicted Inflation	18.2	16.2	17.8	16.7	11.9	6.6
Reduction in:						
In-Sample Error	3.9	4.1	4.7	4.1	2.0	2.0
Prediction Error <u>2/</u>	0.3	1.2	0.4	0.8	0.1	0.7
RMSE	67.7	52.6	13.1	29.5	--	33.5
Predictions Using <u>All Commodity Prices:</u>						
Predicted Inflation	18.1	16.0	17.3	16.2	11.9	6.4
Reduction in:						
In-Sample Error	5.2	5.0	6.9	4.4	2.5	2.5
Prediction Error <u>2/</u>	0.4	1.4	--	1.2	0.1	1.0
RMSE	57.4	64.7	--	44.6	--	55.0
Predictions Using <u>Broad Money Balances:</u>						
Predicted Inflation	20.9	15.1	21.1	16.9	11.0	6.3
Reduction in:						
In-Sample Error	9.4	7.2	3.1	0.9	-0.2	-0.1
Prediction Error <u>2/</u>	--	2.1	0.9	0.6	1.0	1.0
RMSE	--	64.2	82.4	29.6	49.3	40.6
Predictions Using <u>All Variables:</u>						
Predicted Inflation	19.3	14.4	19.8	15.4	11.3	5.6
Reduction in:						
In-Sample Error	13.0	10.6	8.9	4.4	1.9	2.0
Prediction Error <u>2/</u>	--	1.5	2.2	2.0	0.7	1.7
RMSE	36.9	97.0	65.2	90.8	22.0	83.0

1/ Post-sample 24-month dynamic predictions of the CPI from equations as described in the text. The estimation sample is from February 1968 (plus prior lagged data) to December of the year preceding the listed forecast period.

2/ In percentage points.

Table A5. Japan: Inflation Predictions, 1976-87 ^{1/}

(In percent)

	1976-77	1978-79	1980-81	1982-83	1984-85	1986-87
Actual Inflation	7.8	4.8	5.7	1.9	2.1	0.2
Baseline Prediction	11.2	4.1	7.1	4.2	1.8	1.2
Baseline Prediction Error	3.4	-0.6	1.3	2.4	-0.3	1.0
<u>Predictions Using Non-oil Commodity Prices:</u>						
Predicted Inflation	9.3	7.4	0.5	2.5	1.7	1.6
Reduction in:						
In-Sample Error	18.8	18.9	12.6	9.0	8.7	8.5
Prediction Error ^{2/}	1.9	--	--	1.7	--	--
RMSE	49.8	--	--	58.0	92.5	58.8
<u>Predictions Using All Commodity Prices:</u>						
Predicted Inflation	11.5	9.3	0.2	3.0	2.3	1.2
Reduction in:						
In-Sample Error	20.9	22.0	10.7	7.6	7.3	7.1
Prediction Error ^{2/}	--	--	--	1.3	--	--
RMSE	--	--	--	38.7	34.7	90.5
<u>Predictions Using Broad Money Balances:</u>						
Predicted Inflation	12.7	4.0	5.7	5.3	1.8	1.7
Reduction in:						
In-Sample Error	-0.1	0.7	1.5	0.7	0.3	0.4
Prediction Error ^{2/}	--	--	1.3	--	--	--
RMSE	--	--	86.4	--	--	--
<u>Predictions Using All Variables:</u>						
Predicted Inflation	10.2	9.2	-0.1	3.5	2.1	1.6
Reduction in:						
In-Sample Error	19.8	21.7	10.7	7.2	7.1	6.8
Prediction Error ^{2/}	1.0	--	--	0.7	0.2	--
RMSE	--	--	--	20.6	94.4	45.6

^{1/} Post-sample 24-month dynamic predictions of the CPI from equations as described in the text. The estimation sample is from February 1968 (plus prior lagged data) to December of the year preceding the listed forecast period.

^{2/} In percentage points.

Table A6. United Kingdom: Inflation Predictions, 1976-87 1/

(In percent)

	1976-77	1978-79	1980-81	1982-83	1984-85	1986-87
Actual Inflation	13.6	12.7	13.6	5.4	5.1	3.7
Baseline Prediction	17.3	13.1	13.2	10.3	5.8	4.5
Baseline Prediction Error	3.7	0.4	-0.4	4.9	0.7	0.7
<u>Predictions Using Non-oil Commodity Prices:</u>						
Predicted Inflation	16.4	13.7	13.2	10.5	6.0	4.5
Reduction in:						
In-Sample Error	-1.1	-0.2	-0.8	-1.1	-0.9	-1.0
Prediction Error <u>2/</u>	0.9	--	0.1	--	--	--
RMSE	36.4	--	12.1	--	--	--
<u>Predictions Using All Commodity Prices:</u>						
Predicted Inflation	16.7	13.4	13.3	10.5	5.8	4.4
Reduction in:						
In-Sample Error	0.4	-1.3	-1.7	-1.5	-1.4	-1.2
Prediction Error <u>2/</u>	0.6	--	0.2	--	--	--
RMSE	29.4	--	13.5	--	0.4	1.3
<u>Predictions Using Broad Money Balances:</u>						
Predicted Inflation	17.0	13.2	13.0	11.1	5.5	4.0
Reduction in:						
In-Sample Error	-0.7	-0.8	-0.4	1.2	1.3	1.3
Prediction Error <u>2/</u>	0.3	--	--	--	0.3	0.4
RMSE	3.2	--	--	--	60.9	38.5
<u>Predictions Using All Variables:</u>						
Predicted Inflation	16.6	12.8	13.2	11.6	5.5	3.7
Reduction in:						
In-Sample Error	1.4	-2.0	-1.9	0.1	0.1	0.2
Prediction Error <u>2/</u>	0.7	0.3	0.1	--	0.3	0.7
RMSE	22.4	--	31.1	--	60.7	76.1

1/ Post-sample 24-month dynamic predictions of the CPI from equations as described in the text. The estimation sample is from February 1968 (plus prior lagged data) to December of the year preceding the listed forecast period.

2/ In percentage points.

Table A7. United States: Inflation Predictions, 1976-87 1/

(In percent)

	1976-77	1978-79	1980-81	1982-83	1984-85	1986-87
Actual Inflation	5.8	11.1	10.7	3.8	3.9	2.7
Baseline Prediction	7.5	8.3	12.2	5.8	4.5	3.7
Baseline Prediction Error	1.7	-2.8	1.6	2.0	0.6	1.0
Predictions Using <u>Non-oil Commodity Prices:</u>						
Predicted Inflation	7.2	8.9	12.4	5.8	3.7	4.5
Reduction in:						
In-Sample Error	6.8	5.1	5.8	4.1	4.3	3.7
Prediction Error <u>2/</u>	0.3	0.6	--	--	0.5	--
RMSE	26.4	17.3	--	--	95.4	--
Predictions Using <u>All Commodity Prices:</u>						
Predicted Inflation	7.0	9.3	11.4	6.0	4.0	4.3
Reduction in:						
In-Sample Error	10.6	7.4	7.7	7.7	6.6	6.0
Prediction Error <u>2/</u>	0.5	1.0	0.8	--	0.5	--
RMSE	33.7	26.7	55.3	--	87.6	--
Predictions Using <u>Broad Money Balances:</u>						
Predicted Inflation	7.4	8.2	12.1	6.5	4.6	3.8
Reduction in:						
In-Sample Error	6.5	3.9	2.9	3.5	3.2	3.2
Prediction Error <u>2/</u>	0.1	--	0.1	--	--	--
RMSE	24.9	--	30.9	--	--	--
Predictions Using <u>All Variables:</u>						
Predicted Inflation	6.8	8.6	11.5	6.4	4.2	4.4
Reduction in:						
In-Sample Error	18.1	13.0	11.6	11.6	10.3	10.1
Prediction Error <u>2/</u>	0.7	0.3	0.7	--	0.3	--
RMSE	65.8	--	67.9	--	53.1	--

1/ Post-sample 24-month dynamic predictions of the CPI from equations as described in the text. The estimation sample is from February 1968 (plus prior lagged data) to December of the year preceding the listed forecast period.

2/ In percentage points.

Table A8. Canada: Predictions of Turning Points in
CPI Inflation, 1965-87

Turning Point in CPI Inflation <u>1/</u>	<u>Lead Time (in Months) for Prediction, Using : <u>2/</u></u>			
	Non-oil Commodity Prices	Commodity Prices	Broad Money	All Data
P Sep 1986	-3	--	--	--
T Mar 1967	--	--	--	--
P Feb 1968	--	--	-- x	-- x
T Jul 1968	3	3	1 x	1 x
P Jul 1969	-12	-12	0	-12
T Jan 1971	-14	-21	3	-21
P Dec 1974	12	8	1 x(2)	1 x
T Dec 1976	19	19	12	12
P Jul 1978	-- x	-- x	17	12
T Nov 1978	--	--	0	0
P Jul 1981	21	19	20	19
T Nov 1983	21	2 x(2)	-- x	-- x
P Feb 1984	-6	-6	--	--
T Feb 1985	-8	-8	9	9
P Jun 1987	-- x	-- x	21	15 x

1/ P and T refer to peaks and troughs, respectively.

2/ Non-negative numbers indicate timely predictions. Negative numbers indicate late predictions. A double dash indicates that the turning point was not predicted at all. False signals prior to the turning point are indicated by an x; if there were multiple false signals, the number of such is given in parentheses.

Table A9. France: Predictions of Turning Points in
CPI Inflation, 1965-87

Turning Point in CPI Inflation <u>1/</u>	Lead Time (in Months) for Prediction, Using : <u>2/</u>			
	Non-oil Commodity Prices	Commodity Prices	Broad Money	All Data
P Jun 1965	--	--	--	--
T Jul 1966	5	--	--	--
P May 1970	-- x	-- x	20 x	20 x(2)
T Feb 1971	--	--	4	--
P Nov 1974	6 x	6 x	4 x(4)	4 x(3)
T Jul 1976	13 x	14 x	12 x(2)	12 x
P Oct 1981	0 x(6)	-- x(3)	-- x(3)	-- x(3)
T May 1983	0 x(2)	0 x(3)	4 x	0 x
P Oct 1983	-6	-7	4	-7
T Aug 1986	-1	-2	-- x	--
P Jul 1987	--	--	--	--

1/ P and T refer to peaks and troughs, respectively.

2/ Non-negative numbers indicate timely predictions. Negative numbers indicate late predictions. A double dash indicates that the turning point was not predicted at all. False signals prior to the turning point are indicated by an x; if there were multiple false signals, the number of such is given in parentheses.

Table A10. Federal Republic of Germany: Predictions
of Turning Points in CPI Inflation, 1965-87

Turning Point in CPI Inflation <u>1/</u>	Lead Time (in Months) for Prediction, Using : <u>2/</u>			
	Non-oil Commodity Prices	Commodity Prices	Broad Money	All Data
P Mar 1966	-7	-7	--	-7
T Nov 1967	0	-1	-2	-1
P Oct 1971	4 x(2)	3 x(2)	-- x	-- x(2)
T May 1972	-1	-2	--	-2
P Jun 1973	--	--	-1	--
T Sep 1973	--	--	--	--
P Jan 1974	-3	-4	--	-4
T Oct 1978	4 x(2)	4 x(2)	10 x(2)	4 x(2)
P Apr 1980	4	2	7	2
T Oct 1980	-2	-2	-3	-3
P Oct 1981	-1	-1	-28	--
T Sep 1984	-- x(3)	-- x(3)	-6	-- x(2)
P Apr 1985	--	--	--	--
T Nov 1986	-3	-1	--	-1

1/ P and T refer to peaks and troughs, respectively.

2/ Non-negative numbers indicate timely predictions. Negative numbers indicate late predictions. A double dash indicates that the turning point was not predicted at all. False signals prior to the turning point are indicated by an x; if there were multiple false signals, the number of such is given in parentheses.

Table All. Italy: Predictions of Turning Points in
CPI Inflation, 1965-87

Turning Point in CPI Inflation <u>1/</u>	<u>Lead Time (in Months) for Prediction, Using : <u>2/</u></u>			
	Non-oil Commodity Prices	Commodity Prices	Broad Money	All Data
T Feb 1967	--	--	--	--
P Feb 1968	--	--	11	11
T Dec 1968	8	8	--	--
P May 1970	-2	--	--	--
T Aug 1970	--	--	--	--
P Nov 1970	--	--	--	--
T Apr 1972	-3	-3	16	-3
P Nov 1974	12	6 x(2)	3	3 x
T Dec 1975	7	7	4	4
P Jan 1977	5	5	6	5
T Nov 1978	5	5	6	5
P Aug 1980	8	7	--	--
T Feb 1981	5	3	0	0 x
P May 1981	-5	-6	-1	--
T May 1982	--	--	-1	--
P Sep 1982	--	--	-15	--
T Dec 1986	-- x(3)	0 x(6)	0 x(2)	0 x(5)

1/ P and T refer to peaks and troughs, respectively.

2/ Non-negative numbers indicate timely predictions. Negative numbers indicate late predictions. A double dash indicates that the turning point was not predicted at all. False signals prior to the turning point are indicated by an x; if there were multiple false signals, the number of such is given in parentheses.

Table A12. Japan: Predictions of Turning Points in
CPI Inflation, 1965-87

Turning Point in CPI Inflation <u>1/</u>	<u>Lead Time (in Months) for Prediction, Using : <u>2/</u></u>			
	Non-oil Commodity Prices	Commodity Prices	Broad Money	All Data
T Jun 1967	--	--	--	-- x
P Aug 1968	2 x	2 x	--	2
T Jan 1969	-4	-4	-4	-4
P Jul 1969	--	--	--	--
T Oct 1969	--	--	--	--
P Mar 1970	-3	--	--	--
T Aug 1970	--	--	--	--
P Nov 1970	--	--	--	--
T Mar 1971	--	--	-1	--
P Aug 1971	--	4	--	--
T Jan 1972	-8	-9	--	--
P Mar 1974	--	--	6 x(2)	-- x
T May 1974	--	--	--	--
P Oct 1974	4	--	--	--
T Dec 1975	3	5	3	3
P Jan 1977	-5	-5	0	-5
T Mar 1979	3	3	9	3
P Sep 1980	5	7	14	7
T Jun 1982	-- x	12	-- x	12
P Sep 1982	--	-4	--	-4
T Sep 1983	2 x(2)	-4	-17	--
P Jul 1985	11	10	--	10
T Feb 1987	3	3	--	3

1/ P and T refer to peaks and troughs, respectively.

2/ Non-negative numbers indicate timely predictions. Negative numbers indicate late predictions. A double dash indicates that the turning point was not predicted at all. False signals prior to the turning point are indicated by an x; if there were multiple false signals, the number of such is given in parentheses.

Table A13. United Kingdom: Predictions of Turning Points in CPI Inflation, 1965-87

Turning Point in CPI Inflation <u>1/</u>	<u>Lead Time (in Months) for Prediction, Using : <u>2/</u></u>			
	Non-oil Commodity Prices	Commodity Prices	Broad Money	All Data
T Sep 1967	--	--	3 x	-- x
P Feb 1969	2 x	2 x	2	2 x
T Jan 1970	7	6	0	0
P Jul 1971	8	8	1	-1
T Jun 1972	0	-1	4	-1
P Aug 1975	-- x	-- x(3)	17 x(2)	15 x(2)
T Jul 1976	--	--	-1	-1
P Jun 1977	9	9	4	4
T Jun 1978	1	1	5	1
P May 1980	3 x(2)	3	-- x(3)	3 x
T Jul 1981	3	3	-- x(3)	3 x
P Dec 1981	-6	-3	--	-3
T May 1983	5	4	1	1
P May 1985	8	4	1	1
T Jul 1986	1	1	--	1

1/ P and T refer to peaks and troughs, respectively.

2/ Non-negative numbers indicate timely predictions. Negative numbers indicate late predictions. A double dash indicates that the turning point was not predicted at all. False signals prior to the turning point are indicated by an x; if there were multiple false signals, the number of such is given in parentheses.

Table A14. United States: Predictions of Turning Points in
CPI Inflation, 1965-87

Turning Point in CPI Inflation <u>1/</u>	<u>Lead Time (in Months) for Prediction, Using : <u>2/</u></u>			
	Non-oil Commodity Prices	Commodity Prices	Broad Money	All Data
P Oct 1966	--	--	--	--
T Sep 1967	-8	-8	3	3
P Jan 1970	-7	-7	16	--
T Jul 1972	3	1	22	1 x
P Nov 1974	12	6 x(2)	27	6 x
T Dec 1976	-- x(3)	18	-- x	18
P Apr 1980	5 x(3)	2 x(2)	--	-- x
T May 1981	-- x	--	6	--
P Aug 1981	--	--	-1	-1
T Jul 1983	17	13	13	13
P Mar 1984	2	-5	1	15
T Dec 1986	-- x	-- x	-- x	-- x

1/ P and T refer to peaks and troughs, respectively.

2/ Non-negative numbers indicate timely predictions. Negative numbers indicate late predictions. A double dash indicates that the turning point was not predicted at all. False signals prior to the turning point are indicated by an x; if there were multiple false signals, the number of such is given in parentheses.

Table A15. Tests on GNP Deflators for
First-Order Integration, 1958-1988 1/

Country	Augmented Dickey-Fuller <u>2/</u>	<u>Sargan-Bhargava</u>	
		quarterly <u>3/</u>	annual <u>4/</u>
Canada	-1.19	0.79**	0.40
France	-2.34	1.50**	0.62
Germany	-2.03	1.86**	0.67
Italy	-1.26	0.49**	0.19
Japan	-2.29	0.65**	0.68
United Kingdom	-3.83	1.81**	1.28**
United States	-0.88	0.47**	0.26

1/ Quarterly data, through 1988 Q3.

2/ T-statistic on β_0 in the regression $\Delta^2 \ln(P)_t = \beta_0 \Delta \ln(P)_{t-1} + \sum_{i=1}^2 \beta_i \Delta^2 \ln(CPI)_{t-i}$. The 95 percent confidence level (*) for rejecting the null hypothesis of nonstationarity ($N=123$) ≈ 3.9 . This value is extrapolated from Table 2 in Engle and Yoo (1987).

3/ Durbin-Watson statistic for the regression $\Delta \ln P_t = \text{constant}$. The 99 percent confidence level for rejecting the null hypothesis of nonstationarity is given as 0.376 for $N=101$ in Table 1 of Sargan and Bhargava (1983).

4/ The 95 percent confidence level for $N=31$ is 0.77; the 99 percent level is 1.08.

Table A16. Cointegration Tests, Using GNP Deflators, 1957 Q1 to 1988 Q3

Country	Bivariate Tests <u>1/</u> on Price Levels		Inflation in GNP Deflator Against Commodity Price Level <u>2/</u>	
	Durbin- Watson <u>3/</u>	Augmented Dickey-Fuller <u>4/</u>	Durbin- Watson <u>3/</u>	Augmented Dickey-Fuller <u>4/</u>
Canada	0.17	-2.90	0.95 **	-3.96 **
France	0.20	-3.35 *	1.54 **	-5.76 **
Germany	0.16	-3.43 *	1.91 **	-6.60 **
Italy	0.14	-3.06	0.65 **	-3.11
Japan	0.06	-1.93	0.71 **	-4.14 **
United Kingdom	0.10	-2.03	1.90 **	-6.74 **
United States	0.09	-2.28	0.68 **	-3.08

1/ Cointegrating equation: $\ln P_t = \alpha + \beta_1 \ln X_t + \varepsilon_t$, where X_t is the commodity price index (excluding oil) and P_t is the GNP deflator.

2/ Cointegrating equation: $\Delta \ln P_t = \alpha + \beta_1 \ln X_t + \varepsilon_t$.

3/ Durbin-Watson statistics from the cointegrating equation. For 100 observations, the 95 (*) and 99 (**) percent confidence levels for rejecting nonstationarity are 0.39 and 0.51, respectively; see Table 2 in Engle and Granger (1987).

4/ T-statistic on β_1 in the regression $\Delta \varepsilon_t = \beta_1 \varepsilon_{t-1} + \beta_2 \Delta \varepsilon_{t-1}$. For 100 observations, the 95 and 99 percent confidence levels are 3.17 and 3.77, respectively.

Table A17. Granger Causality Tests for Relationships between
Commodity Prices and GNP Deflators, 1959 Q4 to 1988 Q3 1/

(Confidence levels)

	Canada	France	Fed. Rep. of Germany	Italy	Japan	United Kingdom	United States
I. Tests for whether commodity prices Granger-cause consumer prices	.980 *	.290	.630	1.000 **	.959 *	.555	.981 *
II. Tests for reverse causation	.777	.157	.500	.891	.384	.235	.675

1/ Significance at the .05 and .01 levels is denoted by * and **, respectively. The variables are the consumption-weighted commodity price index (excluding oil) for each country, denominated in that country's currency, and the country's GNP deflator. All data are pre-whitened by taking first differences in 12-month inflation rates.

Table A18. Contribution of Commodity Prices
to In-Sample Inflation Predictions 1/

(Confidence levels)

	Canada	France	Fed. Rep. of Germany	Italy	Japan	United Kingdom	United States
Sample period							
1959 Q2 to 1988 Q3	.937	.168	.670	.976*	.995**	.304	.937
1972 Q1 to 1988 Q3	.779	.788	.657	.930	.970*	.929	.962*
1974 Q1 to 1988 Q3	.334	.720	.682	.830	.802	.895	.969*

1/ Confidence levels for F statistics calculated for the marginal contribution made by a 4-quarter polynomial distributed lag on commodity prices (excluding oil), in a regression of each country's GNP deflator. A 4-quarter PDL on the GNP deflator is also included in each regression, and all data are pre-whitened by taking first differences in 4-quarter inflation rates. Significance at the .05 and .01 levels is denoted by * and **, respectively.

Table A19. Summary of Inflation Prediction Errors, 1976-87 1/

	Canada	France	Fed. Rep. of Germany	Italy	Japan	United Kingdom	United States
Mean absolute Prediction error (MAPE) <u>2/</u>							
baseline	2.02	3.30	0.77	3.08	1.13	4.02	1.21
using non-oil commodity prices	2.37	3.29	1.73	2.23	1.40	3.75	
	1.23						
using all commodity prices	2.40	3.20	1.44	1.96	1.37	4.06	1.28
Number of periods (out of 6) with:							
reduction in MAPE							
using non-oil commodity price	2	3	1	4	2	2	2
using all commodity prices	3	3	1	5	2	1	2
reduction in RMSE							
using non-oil commodity prices	1	3	--	3	2	4	3
using all commodity prices	1	3	1	4	5	2	3

1/ Post-sample 8-quarter dynamic prediction of the GNP deflator for each country for six two-year periods.

2/ Arithmetic mean of the absolute prediction errors for six two-year periods, in percent.

3/ For this row, predictors include both money growth and commodity price inflation (including oil prices), as well as past CPI inflation.

Table A20. Predictions of Turning Points in Inflation, 1958 Q2 to 1988 Q2 1/

	Canada	France	Fed. Rep. of Germany	Italy	Japan	United Kingdom	United States
Number of turning points	13	14	17	10	18	15	11
Predictions using non-oil commodity prices							
Number of calls:							
on time	3	7	9	5	8	9	6
late	0	1	1	1	4	2	1
missed	10	6	7	4	6	4	4
Number of false signals	6	7	5	8	0	5	4
Lead time for correct calls (in quarters):							
mean	3	2	2	3	3	3	2
standard deviation	2.6	1.0	2.3	3.7	3.0	3.5	1.6
Predictions using all commodity prices							
Number of calls:							
on time	2	6	8	4	6	10	3
late	2	1	2	2	4	2	2
missed	9	7	7	4	8	3	6
Number of false signals	5	7	5	6	1	2	4
Lead time for correct calls (in quarters):							
mean	3	2	3	1	1	3	3
standard deviation	3.5	0.6	2.3	1.4	1.6	3.4	0.6

1/ For definitions of turning points and criteria for predictions, see text.

Input-Output Calculations for Table 9

Table 9 contains estimates of the portion of consumer spending and of domestic output that is attributable to primary commodities in each country. These estimates require assumptions about where to cut off the production process; that is, where to draw the line between primary and manufactured products. The same kind of decision has to be made in order to compute the weights (see Appendix I), but here the process is complicated by the aggregation in the national input-output tables.

The first column of Table 9 is conceptually similar to the row of percentages at the top of Table 2, except that the figures in Table 9 relate more closely to consumption deflators than to CPIs. There are, however, a number of empirical differences, associated principally with commodity coverage and time period. Here, the primary commodity sector comprises agriculture, coal and coke, metals and other minerals, and (for the "total" columns) petroleum and natural gas.

The percentages in Table 9 were derived by summing (1) for the primary-commodity sectors in the input-output tables: intermediate purchases from the primary commodity sectors plus value added, as a percentage of total inputs for the sector, multiplied by the domestic output for that sector; and (2) for all other sectors: intermediate purchases from the primary commodity sectors as a percentage of total inputs, multiplied by domestic output. The sum of these amounts across all sectors as a percentage of total domestic output (generally identified in the tables as aggregate final demand) is shown in the last two columns of Table 9. For the first two columns, the domestic output column is replaced by the consumer spending column in the input-output tables.

There are differences in coverage across countries that introduce some uncertainty into the comparisons. Data for the four European countries have been compiled by the Statistical Office of the European Communities and therefore are reasonably comparable, but the tables for the other three countries have been derived independently by national authorities. It is difficult to assess the importance of variations in the treatment of primary and manufactured commodities. In addition, the definition of value added differs somewhat across countries--for example, as to the treatment of indirect taxes--owing to differences in the availability of data.

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