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Real Exchange Rates and Commodity Prices

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Abstract

This paper examines the relations between fluctuations in real exchange rates among the major currencies and fluctuations in real commodity prices. Increased exchange rate volatility calls for a better understanding of these relations. To the best of our knowledge, no systematic study of those effects has been performed on a wide range of commodities, although Sjaastad and Scacciavillani (1993) have done so for gold. We build on their approach and construct a supply and demand multi-country model, with world market clearing, which incorporates speculative and non-speculative demands for inventories and "static" and "rational" expectations. We estimate the model using several econometric methods on monthly data from January 1972 to January 1992 for 65 commodity prices. The paper finds that, for a small group of commodities, the dollar-denominated price is significantly influenced by the deutsche mark and the yen. The empirical results show that geographical proximity matters, and that supply and demand elasticities are important in determining the commodity price in world markets above and beyond the size of the share of those commodities in world trade.

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E30, F39

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Summary

Since the breakdown of the Bretton Wood system, nominal and real exchange rates between major currencies as well as nominal and real prices of internationally traded commodities, have displayed increasing volatility. Policy makers and economists have claimed that "excessive" variability in real commodity prices might have disruptive effects in developing and industrial countries.

In the last two decades, a number of theoretical and empirical contributions have dwelt on the phenomenon of increasing instability in commodity prices. On the theoretical side, those studies provided a link between exchange rate and commodity price fluctuations by using a standard supply-demand framework and world-market-clearing conditions; however, little attention has been placed thus far on the role of both inventory and expectations in determining commodity prices. On the empirical side, some studies analyzed the actual time-series properties of commodity prices, while others tested the fit and predictive power of reduced-form equations resulting from theoretical models.

This paper formalizes a model that provides a role for expectations, flows and stocks in determining commodity prices. The model features flows demand and supply on the part of consumers and producers, as well as inventory demand on the part of speculators and producers. Speculators hold inventories to exploit expected profits, and producers hold inventories when production is "high" as a precaution for periods when it is "low." This "precautionary" inventory allows producers to maintain the level of ex ante committed deliveries when production falls because of adverse shocks. The paper assumes that commodities are traded on world markets, that their prices obey the law of one price and that the world market clears.

The model is estimated by using several econometric methods on monthly data from January 1972 to January 1992 for 65 commodity prices. Short- and long-term elasticities of the U.S. dollar-deutsche mark and U.S. dollar-yen bilateral real exchange rates are estimated. The paper finds that, for a small group of commodities, the dollar-denominated price is significantly influenced by the deutsche mark and the yen. The empirical results show that geographical proximity matters, and that supply and demand elasticities are important in determining the commodity price in world markets above and beyond the size of the share of those commodities in world trade.

I. Introduction

Since the breakdown of the Bretton-Wood system, nominal and real exchange rates between major currencies as well as nominal and real prices of internationally traded commodities have displayed increasing volatility. Policy makers and economists have claimed that "excessive" variability in real commodity prices might have disruptive effects in developing as well as in industrialized countries. In developing countries, often "price variability results in large swings in export earnings that can be disruptive of investment and growth" [Winters and Sapsford (1988)].

In the last two decades, a number of theoretical and empirical contributions have dwelt on the phenomenon of increasing instability in commodity prices. On the theoretical side, those studies provided the link between exchange rates fluctuations and commodity prices fluctuations, using a standard supply-demand framework and world market clearing conditions; however, little attention has been placed thus far on the role of both inventory and expectations on commodity prices determination. On the empirical side, some studies concentrated on analyzing the actual time series properties of commodity prices, while others tested the fit and prediction power of reduced form equations resulting from theoretical models.

Along the lines developed by Sjaastad (1985), we formalize a model, which allows for a role for expectations, flows and stocks in commodity prices determination. The model features flows demand and supply on the part of consumers and producers, as well inventory demand on the part of speculators and producers. Speculators hold inventories to exploit expected profits and producers hold inventories when production is "high" as a precaution for periods when it is "low". This "precautionary" inventory allows producers to keep the level of ex ante committed deliveries when production falls because of adverse shocks. We assume that commodities are traded at world markets, that their prices obey the law of one price and that world market clears.

The model's reduced form equation allows us to estimate the "market power" that each of the main blocs--The United States, European Union and Japan--possesses in determining commodity prices, the degree of market integration, and the role of inventory and real interest rate in the determination of the real prices of commodities. The gain in building a new, complete structural model is that the derived reduced form equation should reflect more the underlying economic factors. The reader should keep in mind that the quality of the estimates of each bloc's market power is conditional on the quality of the reduced form equation as a whole. 1/

In the empirical section of the paper, we confront the theory with the evidence. The main theoretical and empirical conclusions include: (i) the blocs' relative market power are not uniform across commodities. The country or bloc that has the most influence in determining the world price

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1/ Of course, previous models that generated non-dynamic reduced forms still used regressions with lags on the independent and/or dependent variables, but the present model gives an economic justification and interpretation to that procedure.

of a commodity is not always the country or bloc in whose currency the commodity price is denominated, or the country or bloc with the largest market share in world trade, or the country or bloc producing the commodity in question; (ii) relative elasticities can play an important role in determining the price of commodities in world markets; (iii) the degree of market integration is perceived in the reaction of a commodity price to changes in the exchange rates. Market integration can arise because of geographic proximity or because of state intervention; (iv) the magnitude of the response of a commodity price to fluctuations in exchange rates is affected by the presence of precautionary and speculative demand for inventories. This elasticity is lower the lower is the degree of the speculators' risk aversion, the higher is the quality of the speculators' information and the higher is the response of producers' demand for precautionary inventories to favorable supply shock; and (v) the effect of real interest rate on the equilibrium real price of commodities is stronger, presumably, on those more "storable" commodities

The paper is organized as follows. After a brief review of the literature, Section II develops the model and obtains both the static and rational expectation solution for the path of commodity prices. Section III sets up the econometric specifications in consonance with the theoretical finding of the previous section. Section IV discusses the empirical results and Section V contains concluding remarks. The Appendix contains the derivation of key results as well as the description and sources of the variables used in the empirical section.

1. Literature review

The increasing volatility in commodity prices after the breakdown of the Bretton-Wood system and the importance of those prices as transmitter of shocks, particularly for developing countries, have spawned a number of empirical and theoretical papers on commodity price determination. Those studies sought to spell out the time-series property of the actual behavior of commodity prices and to build theoretical models capable of mimicking the empirical evidence.

Time-series studies were carried out with model-free techniques for individual and aggregated commodity prices. Chu and Morrison (1984) studied the behavior of nominal and real primary commodity prices for the period of 1957-83 and for the subperiods of 1957-71 and 1972-83. 1/ The most salient features the authors reported were the marked increase in nominal and real

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1/ Nominal (or dollar) commodity price indices refer to the IMF index of international market prices, in terms of U.S. dollar, for primary commodities excluding petroleum and gold. The all commodities index includes 35 price series chosen as representative of the 30 commodities exported by primary producing countries. The individual commodity price indices are weighted by average export earnings during 1968-1970 in 98 developing countries excluding major oil exporting countries. Real commodity price indices obtains by deflating the nominal indices by the United Nations price index of manufactured exports of developed countries.

commodity price instability after 1972, 1/ the rise in nominal prices by about 130 percent, on average, during the second subperiod, and the lack of a definite trend that real price series exhibited throughout 1957-83. Cuddington (1992) uses time series techniques to re-examine the Prebisch-Singer hypothesis of secular deterioration in primary commodity prices relative to manufacture good prices. He considers 26 individual commodities over the period 1900-1983 and concludes that the Prebisch-Singer hypothesis should certainly not be considered a universal phenomenon or "stylized fact."

Reinhart and Wickham (1994) discussed thoroughly the time series property of real commodity prices for the period 1957-1993. 2/ They report some descriptive statistics for the four groups of real prices they studied during the sampling periods of: 1957:I-1969:II, 1970:I-1979:IV and 1980:I-1993:II. The stylized facts include a lower mean and mode value for the most recent sample period, a sustained and sharp increase, since early 1970s, in real price volatility, 3/ positive skewness although closer to normality in the recent sample period, and kurtosis although large shocks became relatively infrequent during the recent sample period. As the appropriate policy response to external shocks channeled through real commodity prices depends on whether the shocks are perceived to be temporary or permanent, the authors were concerned whether the series exhibited stationarity or not during the whole sample period. They used most of the recently developed tests to assess stationarity with and without structural breaks. Here, as in previous studies, the results are ambiguous. When no structural breaks were assumed, they could not reject the unit root hypothesis (at standard confidence level) for any of the four price indices. However, with a one-time structural break, 4/ the tests indicated that the metal index was stationary around the broken trend, while the food and

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1/ They measured instability around a long-term trend as well as around a medium-term trend for nominal and real non-oil individual primary commodities and aggregate indices of all commodities, food, beverages, agricultural raw materials and metals. The long-term trend is estimated by the semi-log regression of the quarterly price on time, and the medium-term trend by the 19-quarter moving average of the actual price. The authors also reported two measures of instability, namely, (a) the average of the absolute values of percentage deviations of the quarterly price from the trend and (b) the standard error of estimate (in percent) of the semi-log regression of price on time.

2/ Their real commodity price indices refer to the IMF grouping of all non-fuel commodity prices, beverages, food and metals, and each of them deflated by the IMF index of manufacturing export unit values of industrial countries. Both indices, in the numerator and denominator are in U.S. dollars.

3/ Volatility is measured by the coefficient of variation which is based on fifteen-year moving average and fifteen-year standard deviation.

4/ The authors incorporate a one-time single structural break, which consist in a change in both the level and the slope of the deterministic component of the series. They allowed the data to indicate the date of the potential break: 1973:1 for all commodities and for food, 1976:I for beverages and 1974:III for metals.

beverages indices were not. For all commodities the results were inconclusive as some tests rejected the unit root hypothesis and others did not.

Reinhart and Wickham also posed the question whether the observed decreasing trend in real commodity prices, since the early 1980s, is cyclical or secular. They concluded it is mostly of a secular nature and singled out a few determining factors: (i) "the marked and secular slowdown in the growth of output in the industrial countries in the early 1970s, with 1973 constituting the end of the strong postwar expansion phase for most countries;" (ii) a surge in the commodities supply triggered by two distinct elements, namely, the expansion in export volume on the part of developing countries, after the mid-1980s, to service the debt; and permanent technological changes, information diffusion and factor productivity; and (iii) the failure during the 1980s and the 1990s of a number of international commodity price agreements. Furthermore, the authors noted that the secular price weakening was reinforced by some adverse recent cyclical factors such as the industrial countries' weak performance and the low demand for and rising supply of commodities in the former Soviet Union.

To the best of our knowledge, Ridler and Yandle (1972) were the first to analyze the effect of exchange rate changes on commodity prices. For a given commodity, the authors started from an equilibrium situation between the world demand for imports (which depends only on the world price of the commodity in importers' currency) and the world supply of exports (which depends only on the world price of the commodity in exporters' country). They then performed comparative static to obtain the percentage change in the dollar (numeraire) price of the commodity as a weighted average of the percentage change in exporters' and importers' nominal exchange rates in terms of the numeraire currency. 1/ The authors did not explicitly consider real exchange rates or other supply and demand variables.

Dornbusch (1985) studied the effects of real exchange rate and income effects in a supply and demand framework. He assumed that a given commodity is traded in an integrated world market with two consuming blocs, the United States and the rest of the world, and that the world demand for the commodity depends on the real price of the commodity in terms of GDP deflators in each of the two blocs and on real activity. Moreover, he assumed an entirely demand driven model, that the law of one price for the commodity holds between the two blocs and that the commodity real price in terms of the U.S. deflator moves to clear the market. In this framework, a real appreciation (depreciation) of the dollar with respect to the rest of

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1/ They derived the following formula:

$$\Delta P = \frac{\eta_s}{\eta_s - \eta_d} R + \frac{-\eta_d}{\eta_s - \eta_d} K$$

where ΔP is the percentage change in the commodity price, R and K are the weighted average percentage change in exporters' and importers's nominal exchange rates in terms of the numeraire currency, and η_s and η_d are price elasticity of the world supply of exports and the world demand for imports.

the world decreases (increases) the commodity world demand inducing the commodity real price in terms of U.S. deflator to fall (rise). 1/

Borensztein and Reinhart (1994) extended the Dornbusch (1985) model by incorporating in the exogenous commodity supply the volume of primary commodities imported by the industrial countries as a proxy for the supply shocks of the 1980s, and by taking a broader view of world demand. The world demand comprises two blocs, the United States and an aggregate of the rest of the industrial countries; the latter includes output developments in Eastern Europe and the former Soviet Union. Unlike Dornbusch (1985), their empirical estimations yielded the expected magnitude (between 0 and -1) for the elasticity of the real commodity price with respect to the real bilateral exchange rate between the two blocs considered. The authors reported that with their extensions to supply and demand, their econometric projections can better explain the decline in the real commodity prices since early 1980s and remedy much of the systematic overprediction of the demand driven model.

Sjaastad (1985) analyzed the effects of the bilateral real exchange rates among the major currencies on the real (dollar based) price of the commodity. He advanced the hypothesis that changes in the exchange rates among major currencies will cause commodity prices to fluctuate independently of the movements in the general price levels of the major countries. He points out "that fluctuations of the U.S. dollar strongly influence the (dollar) prices of internationally traded goods was particularly evident during the intense real appreciation of the dollar from early 1980 until early 1985. During that period the dollar appreciated by more than 90 percent against the Deutsche Mark (and by 45 percent in real terms), while the IMF dollar-based commodity price index fell by 30 percent."

Sjaastad considered an internationally-traded homogeneous commodity, the price of which obeys the law of one price. He assumed that worldwide there are N trading blocs, that the numeraire currency, the dollar, is the currency of bloc 1, and that each bloc's commodity excess demand depends on the commodity price deflated by the general price level and on other supply

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1/ Assume, momentarily, that the dollar price of the commodity and the GDP deflators in each bloc are given. A real appreciation of the dollar, ensuing from a nominal appreciation, would increase the nominal and real price of the commodity in terms of the rest of the world currency, which reduces the quantity demanded of the commodity in the rest of the world. The excess supply is resolved by a decline in the real price of the commodity in terms of U.S. deflator in a fraction of the real appreciation of the dollar. His explicit formula is:

$$\partial \ln(P_C/P)/\partial \ln(P/eP^*) = -\beta^*\eta^*/(\beta\eta + \beta^*\eta^*)$$

where η and η^* are the domestic and foreign price elasticity of commodity demand and β and β^* are the share of the home country and the rest of the world in total demand.

and demand variables. World market clearing condition closed the model, which yields the following reduced form equation: 1/

$$p_t = \sum_{j=2}^{N} \theta^j e_t^j + K_t \tag{1}$$

where p_t is the logarithm of the real (dollar based) commodity price, $e^j{}_t$ is the logarithm of the bilateral real exchange rate between blocs 1 and j, K_t groups together other supply and demand variables and θ^j is the elasticity of the real commodity price with respect to the bilateral real exchange rate between blocs 1 and j. Note that the θ^js are between zero and one.

Interestingly, θ^j reveals the "market power" of bloc j on commodity i. 2/ Its magnitude measures the relative market power possessed by a participant (bloc) in the world market for the commodity in question. 3/ Each θ^j depends on the share of country j in the world market of the commodity and on the domestic demand and supply elasticities. If bloc j is a price taker, because of either its relatively small market share or its extremely inelastic excess demand, θ^j will be zero. If bloc j is a price maker, because of either its relatively large market share or its extremely elastic excess demand, θ^j will be one. The empirical evidence indicates that the magnitude of θ^j lies between zero and one and that the blocs' relative market power are not uniform across commodities. 4/

A key feature of Sjaastad's model is that the country that has the most influence in determining the world price of a commodity is not always the country in whose currency the commodity price is denominated. One can gain insight into this with an example from the financial markets. The dollar-denominated price of a U.S. company heavily exporting to Japan would be affected by changes in the dollar-Yen exchange rate, whereas the dollar-

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1/ See the Appendix for a derivation. Sjaastad (1985) first presented this specific model; a similar approach was developed by Dornbusch (1987).

2/ The market power of bloc 1 is given by $\theta^1 = 1 - \sum_{j=2}^{N} \theta^j$.

3/ This also holds for the multi-commodity model. Sjaastad (1985) derives first the single-commodity model reduced form equation (1) to then obtain the multi-commodity reduced form equation, which result from multiplying (1) by $\Sigma_i \omega_i$, i=1,...,M, where the ω_is are the appropriate weights corresponding to each commodity. The multi-commodity reduced form equation can be expressed exactly like (1) where p_t would be now a weighted average of commodity prices, θ^j would be now the average market power of bloc j on all commodities, K_t would be now a weighted average magnitude and $e_t{}^j$ remains the same.

4/ Juan-Ramon (1986) applied this framework for some indices of commodity prices. Sjaastad and Scacciavillani (1993) applied it to the price of gold.

denominated price of a U.S. company which does not trade with Japan would be quite independent from movements in the dollar-Yen exchange rate.

Sjaastad and Scacciavillani (1993) applied the model developed by Sjaastad (1985) to analyze the gold market for the period 1982-90. They use a dynamic econometric specification to study the effect of fluctuations in the real exchange rate among the major currencies on fluctuations in the price of gold. The authors reported the following empirical findings:

(i) "The volatility of the exchange rates among the major currencies since the dissolution of the Bretton Woods international monetary system has been a major source of price instability in the gold market. Indeed, the instability of real exchange rates between major currencies is responsible for nearly half of the observed volatility in the spot price of gold during the 1982-90 period."

(ii) "With respect to the international gold market, the evidence strongly supports the 'efficient market' hypothesis in that systematic unexploited profit opportunities have been absent."

(iii) "While gold is usually denominated in U.S. dollars, the dollar bloc has but a small influence on the international price of gold."

(iv) "The major gold producers of the world (South Africa, the former U.S.S.R., and Australia) appear to have no significant influence on the world price of gold."

(v) "The world gold market is dominated by the European currency bloc which possesses approximately two-thirds of the 'market power' enjoyed by all participants in the market. Accordingly, real appreciations or depreciations of the European currencies have profound effects on the price of gold in all other currencies."

(vi) "Gold appears to be a store of value as it was found that 'world' inflation increases the desire to hold gold; it is estimated that the real price of gold rises just over 1 percent in response to a one point increase in the rate of world inflation."

The authors made clear that they do not claim their empirical findings for the gold case can be generalized to other commodities.

Deaton and Laroque (1992) used a standard rational expectations competitive storage model to mirror the actual time series properties of thirteen commodity prices. While their model does explicitly introduce the role of inventory and expectations in commodity prices determination, it does not incorporate the role of exchange rates. They assumed a deterministic consumption demand as an implicit function of the commodity price deflated by a general price level, a stochastically inelastic supply, and risk neutral inventory holders who can borrow or lend from a perfect capital market. A central feature of their model "is the explicit recognition of the fact that it is impossible for the markets as a whole to carry negative inventories, and this introduces an essential nonlinearity which carries through into nonlinearity of the predicted commodity price series."

Our paper contributes to the above literature by examining real commodity prices determination in a setting explicitly allowing for speculative as well as precautionary inventories on the part of speculators and producers, respectively. The dynamic econometric specification is based on the real commodity dynamic path solution derived from the theoretical model. Unlike Deaton and Laroque (1992), our model does not take into account the fact that aggregate inventories can not be negative.

II. The Model

We model the relation between movements in real exchange rates among the major currencies and in real commodity prices within a framework of producers, consumers and speculators. By explicitly considering a demand for inventories on the part of speculators and producers, the analysis stresses the role of expectations, flows and stocks in determining the real prices of commodities. However, first we use a standard supply-demand graphical analysis to gain insight on how changes in the nominal and real exchange rate and in other variables change the nominal and real prices of a commodity.

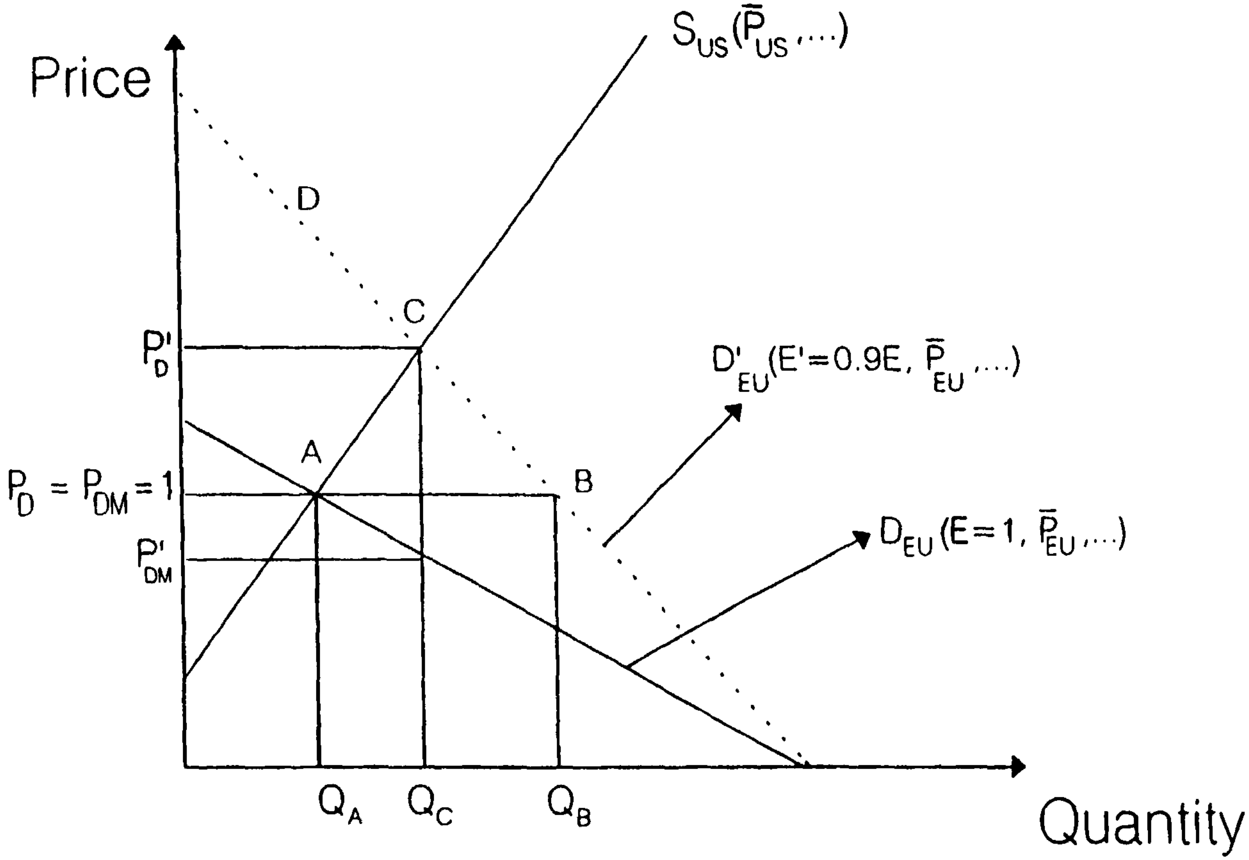
1. A graphical analysis

Consider two major commercial blocs (e.g., the United States and Europe) trading a given commodity, whose price is quoted in dollars. Europe has an excess demand for the commodity in question, D_{EU}, and the United States has an excess supply, S_{US} (shown in Figure 1). The quantity supplied and demanded respond to their relevant real (relative) prices, namely, the dollar price of the commodity deflated by the general price level in the U.S. and the Deutsche mark price of the commodity deflated by the general price level in Europe. Since the vertical axis of each figure represents the nominal price of the commodity in terms of both U.S. dollars, P_D, and Deutsche marks, P_{DM}, the supply shift parameters include the general price level in the United States, $\bar{P}_{US}$, a weather proxy variable (if we were dealing with an agricultural commodity), and technology. By the same token, the demand shift parameters include the general price level in Europe, $\bar{P}_{EU}$, and the price of the dollar in terms of Deutsche marks, E. The commodity under consideration is homogeneous and its price obey the law of one price, i.e., $P_D E = P_{DM}$. At the initial equilibrium (point A in Figure 1), E and P_D are normalized to unity, which, since the law of one price holds, implies that P_{DM} also equal unity.

Starting from an initial equilibrium, point A in Figure 1, consider a 10 percent nominal--and real, as both general price levels do not change--depreciation of the dollar vis-a-vis the Deutsche mark. For a given P_D, the dollar depreciation must produce a proportional reduction in P_{DM} for the law of one price to hold. This reduces the real price, $P_{DM}/\bar{P}_{EU}$, thus increasing the demand for the commodity, which is shown as a shift from point A to

Figure 1

US Dollar Depreciation (Deutsche Mark Appreciation) and its Effect on the US Dollar and Deutsche Mark Prices of a Given Commodity



point B. 1/ Although the law of one price holds at point B, it is not an equilibrium point since quantity demanded, Q_B, exceeds quantity supplied, Q_A; therefore, prices have to change to clear the market. The excess demand increases P_D (and the quantity supplied along S_{US}), which, in turn, implies that P_{DM} decreases but less than in proportion to the depreciation of the dollar for the law of one price to hold. The market clears at point C at a higher nominal (and real) U.S. dollar price, P'_D, and at a lower nominal (and real) Deutsche mark price, P'_{DM}. 2/

The market power possessed by each bloc can be measured as the relative change in real prices in response to a relative change in the real exchange rate. Thus, market power depends on the structure of the market, that is, on supply and demand price elasticities. Figure 1 portrays a case in which Europe has more market power (as price setter) than the United States. This follows since, as we can see in the graph, the percentage change in the dollar real price, $P'_D - 1$, divided by the percentage change in the real exchange rate, $P'_D - P'_{DM}$, is closer to unity. An opposite polar example would be a case in which the United States is a total price setter--ensuing from a totally elastic supply. In this case, the dollar real price would remain constant while the Deutsche mark real price would change in proportion to the change in the real exchange rate.

The graphical analysis can readily incorporate the role of expectations by treating E, $\bar{P}_{US}$ and $\bar{P}_{EU}$ as forward-looking variables, i.e., whose current values are determined by the expected current and future values of the relevant fundamentals. For example, starting from an initial equilibrium, point A in Figure 1, expectations of a future real depreciation of the dollar induces a real depreciation today (equal to a fraction of the expected real depreciation), which, in turn, affects equilibrium real prices (point C in Figure 1).

Summing up, the graphical analysis reveals the following: (i) a current or expected real depreciation (appreciation) of the dollar increases (decreases) the equilibrium dollar real price of the commodity regardless of which bloc has excess supply or demand; (ii) the market power (as price setter) possessed by each bloc can be measured by the elasticity of the dollar real price with respect to the real exchange rate, which lies between zero and one depending upon the market structure. The closer to one, the lesser is the market power of the United States relative to other blocs, and

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1/ The demand curve shifts around a pivot point on the quantity axis. This is so because, to keep the quantity demanded constant at any level, the real price, $E\,P_D/\bar{P}_{EU}$, must remain unaltered. Given that $\bar{P}_{EU}$ remains unchanged, the 10 percent fall in E must produce an opposite proportional change in P_D (measured by the vertical distance between points D and A in Figure 1).

2/ The relative increase in P_D, $\hat{P}_D = P'_D - 1$, is less, in absolute value, than the relative depreciation of the dollar, $\hat{E} = E' - 1$ (or equivalently, $\hat{E} = P'_{DM} - P'_D$). Since the relative change in the Deutsche mark price of the commodity is $\hat{P}_{DM} = P'_{DM} - 1$, we have $\hat{E} = \hat{P}_{DM} - \hat{P}_D$, which is the relative version of the law of one price. And the absolute magnitudes of $\hat{P}_{DM}$ and $\hat{P}_D$ depends on the supply and demand elasticities.

the closer to zero, the larger is the market power of the United States relative to other blocs; (iii) assuming, as in Figure 1, that the United States has an excess supply and Europe an excess demand for a given commodity, a real depreciation (appreciation) of the dollar leads to an increase (decrease) of the equilibrium quantity of the commodity; and (iv) assuming that the United States has excess demand and Europe has excess supply for a given commodity, a real depreciation (appreciation) of the dollar leads to a decrease (increase) of the equilibrium quantity of the commodity.

The graphical analysis does not lend itself to analyze movements in a commodity real prices caused by movements in the real exchange rate in a model with more than two trading blocs, stochastic shocks, inventory demand and intertemporal speculation. To include those features in the analysis, we setup a formal model with closed-form solution. As we will see, the theoretical model yields explicit formulation, which is useful for specifying the econometric model and for interpreting the expected sign of key estimated coefficients. In particular, the model makes explicit the possibility that a real dollar depreciation (appreciation) either increases or decreases the dollar real price of a commodity depending upon the value taken by parameters related to the inventory demands.

2. Setup of the formal model

The market for commodity i = 1,...,M in country j = 1,...,N is populated by producers, consumers and speculators, whose decisions to produce, consume and hold inventories of each commodity are guided by the following behavioral equations. 1/

$$D_t^j = d_0^j + d_1^j p_t^j + d_2^j q_t^j + d_3^j r_t^j + \epsilon_t^{d,j} \tag{2}$$

$$S_t^j = s_0^j + s_1^j p_t^j + s_2^j z_t^j + \epsilon_t^{s,j} \tag{3}$$

$$I_t^{1,j} = k_1^j (\tilde{p}_{t+1}^j - p_t^j - \tilde{r}_t^j) \tag{4}$$

$$I_t^{2,j} = h_0^j + h_1^j S_t^j \tag{5}$$

$$I_t^j = I_t^{1,j} + I_t^{2,j} \tag{6}$$

where superscript j denotes the country and subscript t the time. D_t^j is the quantity demanded for the commodity and S_t^j the quantity produced of the commodity, $I_t^{1,j}$ represents the amount of inventory that speculators want to carry forward to the next period and $I_t^{2,j}$ the amount of inventory that

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1/ The subscript i has been omitted for simplicity.

producers want to carry forward to the next period. p_t^j is the logarithm of the real commodity price, i.e., the commodity price in terms of country j's currency deflated by the country j's general price index, q_t^j stands for the logarithm of the real income and $\bar{r}_t^j$ is the expected real interest rate. z_t^j denotes a stochastic supply shock idiosyncratic to country j. z_t^j, which might be persistent, can take negative values for adverse shocks (droughts, strikes, wars, red tape, corruption), positive values for favorable shocks (weather bonanzas, trade liberalization, deregulation, government subsidy) and zero for no shocks. $\epsilon_t^{d,j}$ and $\epsilon_t^{s,j}$ are demand and supply innovations, that is, i.i.d. shocks with zero means, and $\bar{p}_t^j$ is the one step ahead forecast conditional on the available information at the beginning of the forecast period, i.e., $\bar{p}^j_{t+k} = E[p^j_{t+k} \mid G^j_{t+k-1}]$

In (2), the quantity demanded varies directly with real income ($d_2^j>0$), and inversely with the current relative price ($d_1^j<0$) and the expected real rate of interest ($d_3^j<0$). d_1^j reflects intratemporal substitution possibilities between the commodity in question and other goods and commodities, while d_3^j reflects intertemporal substitution possibilities between consuming the commodity this period or next. In (3), the quantity supplied varies directly with the current relative price ($s_1^j>0$) and with the stochastic supply shock ($s_2^j>0$). The parameters and the motivation for equations (4) and (5) (inventory demands) are analyzed below.

a. <u>Inventory demands</u>

We distinguish two types of inventory holders: speculators and producers. The amount of inventory hold by each depends on different variables as we assume they have distinct motives for carrying forward the commodity.

In (4), $I_t^{1,j}$ is the amount of inventory that speculators carry forward into t+1 to exploit expected profits. 1/ Thus, the speculators relevant relative price is the expected discounted future real commodity price relative to the current real commodity price. Rational speculators with Constant Absolute Risk Aversion (CARA) utility function and facing normally distributed returns would demand an amount of inventory given by the following expression:

$$I_t^1 = \frac{E[r_{t+1}^0 \mid G_t] - r_t}{\rho \, var(r_{t+1}^0 \mid G_t)}$$

where ρ is the risk aversion coefficient and r_t^0 is the return on the commodity, thus $E[r^0_{t+1} \mid G_t] - r_t \approx \bar{p}_{t+1} - p_t - r_t$. Furthermore, we assume that the speculators' information set, G_t, is the same across countries.

1/ The j index will be omitted in the rest of this section for simplicity.

If $\tilde{p}_{t+1} = E[p_{t+1} | G_t] + v_t$, then $var(r^0_{t+1} | G_t) = \sigma^2_v$ which is the forecast error variance. 1/ Hence the speculative inventory response to a change in the relevant relative price is given by $k_1 = 1/(\rho\ \sigma_v^2)$, which is an increasing function of the quality of the speculator's information and a decreasing function of the speculator's degree of risk aversion, ρ^j. Therefore, the inventory demand schedule on the part of the speculators is:

$$I^1_t = k_1 (\tilde{p}_{t+1} - p_t - r_t)$$

In (5), I_t^2 is the amount of inventory that producers carry forward into t+1 as a precaution to keep the level of contractually agreed deliveries when production is hit by adverse shocks. Thus, producers hold inventory in direct relation to the level of production ($0<h_1<1$); that is, they accumulate larger inventories when production is "larger" than expected as a safeguard for temporary or persistent unexpected adverse shocks (negative realizations of z_t) affecting production. 2/ Therefore, the possibility of adverse shocks to production, which might even be persistent, is what motivate producers to hold "precautionary" inventories. 3/

3. World market clearing

World-market clearing condition for a given commodity requires the world excess demand be zero. Defining the excess demand at time t for a given commodity in country j as Z_t^j, world-market clearing for that commodity require

$$\sum_{j=1}^{N} Z^j_t = \sum_{j=1}^{N} (D^j_t + I^j_t - I^j_{t-1} - S^j_t) = 0 \qquad (7)$$

Assuming that the law of one price and the uncovered interest rate parity hold, and choosing the dollar as the reference currency, we derive in the Appendix the equilibrium process for the real (dollar) price of the commodity in question, which is represented by equation (8).

1/ The smaller (larger) the forecast error variance, the finer (poorer) the quality of the speculator information.

2/ z_t^j represents shocks to country j, that is, they affect similarly to all producers in the country. If the shocks were idiosyncratic to each producers, there might be no need for them to hold precautionary inventories.

3/ In fact, here also the ultimate motive is profit. Producers formally or informally have committed themselves to deliver a certain minimum quantity and quality to domestic and/or international distributors. Faltering to this commitments, would lead to a loss of reliability, market share and ultimately to a loss of profit. Thus, the "precautionary" inventory allows the producer to comply with quantity-quality contracts when production declines unexpectedly.

$$\gamma_0+\gamma_1 p_{t-1}+\gamma_2 p_t+\gamma_5(\bar{p}_{t+1}-\bar{p}_t)+\gamma_4 r_t+\gamma_5 r_{t-1}+\sum_{j=1}^{N} X_t^j=0 \qquad (8)$$

where

$$X_t^j=\gamma_3^j q_t^j+\gamma_6^j z_t^j+\gamma_7^j z_{t-1}^j+(\gamma_5^j-\gamma_1^j)e_{t-1}^j+(\gamma_4^j-\gamma_2^j)e_t^j-(\gamma_4^j+\gamma_5^j)\bar{e}_{t+1}^j+\epsilon_t^j$$

$$\gamma_i=\sum_{j=1}^{N}\gamma_i^j, \quad i=0,\ldots,5$$

Equation (8) shows the equilibrium law of motion for the real commodity price (p) as a function of current and one-period lagged values of aggregate supply shocks (z), aggregate demand and supply innovations (ϵ), real rate of interest (r), and real exchange rate (e), as well as of current aggregate income (q) and of expected one-period forward values of both the real commodity price and the real exchange rate. Therefore, we have to specify the formation of expectations to completely characterize the solution to (8).

4. Static expectations solution

To solve for p_t in the reduced form equation (8), we impose the static expectations hypothesis, i.e., forcing the expectations on future prices to be equal to the current prices. 1/ This coincides with the rational expectation solution when p_t and e^j_t follow random walk processes. In this case, $\bar{p}_{t+1} = p_t$ and $\bar{e}^j_{t+1} = e^j_t$ yield (9)

$$p_t=-\frac{\gamma_0}{\gamma_2}-\frac{\gamma_1}{\gamma_2}p_{t-1}-\frac{\gamma_4}{\gamma_2}r_t-\frac{\gamma_5}{\gamma_2}r_{t-1}+\frac{1}{\gamma_2}\sum_{j=1}^{N}(\gamma_2^j+\gamma_5^j)e_t^j$$
$$+\frac{1}{\gamma_2}\sum_{j=1}^{N}(\gamma_1^j-\gamma_5^j)e_{t-1}^j-\frac{1}{\gamma_2}\sum_{j=1}^{N}\gamma_3^j q_t^j-\frac{1}{\gamma_2}\sum_{j=1}^{N}(\gamma_6^j z_t^j+\gamma_7^j z_{t-1}^j+\epsilon_t^j) \qquad (9)$$

where

$$\gamma_i=\sum_{j=1}^{N}\gamma_i^j, \quad i=0,\ldots,5$$

In the Appendix (derivation of equation (8)), we establish the expected signs for the gammas as follows: $\gamma_3{}^j > 0$, $\gamma_4{}^j < 0$, $\gamma_5{}^j > 0$, $\gamma_7{}^j < 0$, $\gamma_6{}^j < 0$ (if $0 < h_1 < 1$) and $\gamma_2{}^j < 0$ (if $0 < h_1 < \bar{h}$), while the signs for $\gamma_0{}^j$ and $\gamma_1{}^j$ are a priori unknown. We can now establish the sign, and in some cases the value, of the elasticity of the real commodity price with respect to the right-hand side variables in (9), $\eta(p_t,i)$, where i index those right-hand side variables.

1/ We do this to obtain the simplest equation possible. Long lags in exogenous variables appear only for rational expectations.

The sign of $\eta(p_t, p_{t-1})$ is a priori unknown. We can, however, single out the elements affecting its sign. A high quality of the speculator's information, a low degree of risk aversion on the part of speculators and a low elasticity of producer's inventory demand with respect to the level of production will most likely produce a positive value of the elasticity under consideration, and a negative value otherwise. The sign of $\eta(p_t, r_t)$ is most likely negative as expected. A higher expected real rate of interest at time t reduces both current consumption demand (equation (2)) and current speculative demand for the commodity (equation (4)), which, ceteris paribus, reduces the current real price of the commodity. The sign of $\eta(p_t, r_{t-1})$ or, equivalently, the sign of $\eta(p_{t+1}, r_t)$ is most likely positive as expected. As we just examine, a temporary higher expected real interest rate at t reduces the real price of a commodity at t. Since, at t, the expected real interest rate was temporarily higher, at t+1, the expected real rate of interest is lower, which by the same reasoning as before, it leads to a higher real price of the commodity at t+1.

The sign of $\eta(p_t, e^j{}_t)$ is most likely positive and its value lies between 0 and 1. 1/ That is, a real depreciation of the dollar with respect to the j's country's currency (an increase in $e^j{}_t$) increases, in some proportion, the real price of the commodity. And the larger (smaller) is the proportional increase in the real price, the larger (smaller) is the market power as a price setter of country j. This result corresponds exactly with the graphical analysis for cases that $0<h_1{}^j<1$. The sign of $\eta(p_t, e^j{}_{t-1})$ is most likely positive as expected. 2/ The sign of $\eta(p_t, q^j{}_t)$ is most likely positive as expected. This is an straightforward income effect. The sign of $\eta(p_t, z^j{}_t)$ is most likely negative as expected. A positive (favorable) realization of the supply stochastic shock at t increases the supply schedule thus reducing the current real price of a commodity, and the sign of $\eta(p_t, z^j{}_{t-1})$ is most likely negative as expected.

5. Rational expectations solution

To solve for p_t in the reduced form equation (8), we impose the rational expectations hypothesis, i.e., forcing the expectations on future prices to be consistent with the model conditional on available information.

1/ From (9) $\eta(p_t, e_t{}^j) = (\gamma_2{}^j + \gamma_5{}^j)/\gamma_2$, and replacing the gammas, obtains

$$0<\frac{d_1^j-(1-h_1^j)s_1^j}{\sum_{j=1}^{N} d_1^j-\sum_{j=1}^{N}(1-h_1^j)s_1^j-\sum_{j=1}^{N}k_1^j}<1, \qquad for\ 0<h_1^j<1$$

Note that there are combinations of "large" values of $h_1{}^j$ and $s_1{}^j$ that will render the sign of $\eta(p_t, e_t{}^j)$ negative rather than positive.

2/ In (9), $\eta(p_t, e^j{}_{t-1}) = (\gamma_1{}^j - \gamma_5{}^j)/\gamma_2 = - h_1{}^j s_1{}^j /\gamma_2 > 0$. Note that we implicitly assume that $\gamma_2 = \sum_j \gamma_2{}^j < 0$, which is the most plausible outcome.

Let p^*_{t+j} be the j+1 step ahead price forecast based on the available information at t-1, and let $\bar{p}_{t+j}$ be the one step ahead price expectation based on the available information at t+j-1.

$$p^*_{t+j} = E[p_{t+j} \mid G_{t-1}]$$
$$\bar{p}_{t+j} = E[p_{t+j} \mid G_{t+j-1}]$$

$p_{t-1} = p^*_{t-1}$, $\bar{p}_t = p^*_t$, $\bar{p}_{t+1} = p^*_{t+1} + v_t$ with $E[v_t \mid G_{t-1}] = 0$.

Taking expectations on (8) conditional on G_{t-1}, yields

$$p^*_{t+1} - \theta_1 p^*_t - \theta_2 p^*_{t-1} = \Omega_{t-1} \tag{10}$$

where

$$\theta_1 = 1 - \frac{\gamma_2}{\gamma_5} > 1, \qquad \theta_2 = -\frac{\gamma_1}{\gamma_5} > -1$$

$$\Omega_{t-1} = -\frac{1}{\gamma_5}\{\gamma_0 + E[\gamma_4 r_t + \gamma_5 r_{t-1} + \sum_{j=1}^{N} x_t^j \mid G_{t-1}]\}$$

Ω_{t-1} is the forcing process of the second order difference equation (9). The j-step ahead rational forecast is derived from equation (10).

III. Commodity Price Regression Functions

1. Regression function under static expectations

The regression function under condition of static expectations follows from taking first differences to equation (9). By differentiating once, we insure stationarity. 1/ All the variables, except the expected real rate of interest, are in logarithm.

$$\Delta p_t = \beta_1 \Delta p_{t-1} + \beta_{2,0} \Delta r_t + \beta_{2,1} \Delta r_{t-1} + \sum_{j=2}^{k_3} \beta^j_{3,0} \Delta e^j_t + \sum_{j=2}^{k_3} \beta^j_{3,1} \Delta e^j_{t-1} + \beta_4 q_t + u_t \tag{12}$$

1/ Other methods, as cointegration and error-correction representation will also be used to deal with the problem of nonstationarity while still using information contained in the levels of the variables.

Regression (12) differs from equation (9) in some aspects: (i) all variables in (12), except the real interest rate, are expressed as first difference of logarithm in order to impose stationarity in the series; (ii) the current and lagged real interest rate is ex-post rather than ex ante; (iii) the number of blocs under consideration, k_3, is smaller than N; (iv) q_t is the logarithm of an index of industrial production in industrial countries to avoid potential multicolinearity problem as industrial production growth might be correlated across countries; and (v) u_t is an stochastic error term including the current and lagged stochastic supply shocks, and a positive autocorrelated term at one lag, which includes supply and demand innovations. Therefore, u_t would, most likely, be an autoregressive process.

The results of running regression (12) for 65 commodities are presented in Tables 2 to 6 in the Appendix.

2. *Regression function under rational expectations*

Substituting for $\bar{p}_t$ and $\bar{p}_{t+1}$ in (8), yields

$$p_t = \beta_0 + \beta_1 p_{t-1} + \sum_{i=0}^{\infty} \beta_{2,i} r_{t-i} + \sum_{i=0}^{\infty} \sum_{j=2}^{N} \beta_{3,i} e^j_{t-i} + \sum_{i=0}^{\infty} \sum_{j=1}^{N} \beta^j_{4,i} q^j_{t-i} + \sum_{i=0}^{\infty} \sum_{j=1}^{N} \beta^j_{5,i} \pi^j_{t-i} + \epsilon_{t-i} \qquad (13)$$

ϵ_t is positively autocorrelated at one lag. Moreover, as prices and exchange rates are often considered to be non stationary process, (11) will be estimated using first differences.

$$\Delta p_t = \beta_1 \Delta p_{t-1} + \sum_{i=0}^{k_2} \beta_{2,i} \Delta r_{t-i} + \sum_{i=0}^{k_3} \sum_{j=2}^{N} \beta^j_{3,i} \Delta e^j_{t-i} + \sum_{i=0}^{k_4} \beta_{4,i} \Delta q_{t-i} + \sum_{i=1}^{k_5} \beta_{5,i} \Delta \pi_{t-i} + \delta_t \qquad (14)$$

where k_2, k_3, k_4 and k_5 denote the number of lags used in practice.

The lag structure depends on the form of the linear predictor representing the conditional expectation $E[X_{t+k} \mid G_{t-1}]$ and the roots of the difference equation defining p^*_t.

IV. Empirical Results

Using the model described above, we estimate the long term effect on individual real commodity prices 1/ of bilateral real exchange rates dollar-Deutsche mark and dollar-yen, as well as changes in international real interest rates and world industrial production. We use different econometric methods, including: (i) regressions on the log first differences of the variables to insure stationarity; (ii) regressions on the log first differences with long lags to study the long term responses; and (iii) error correction representation. Recall that, according to the model (see equation (9)), the elasticity of the commodity price with respect to the exchange rate is between zero and one.

We transformed all variables, except real interest rate, in first difference to induce stationarity. We tested, with the Augmented Dickey Fuller (ADF) test, the stationarity of the series in their levels and their first difference form. The ADF test allows for a constant term, a deterministic time drift, and five lagged differences of the dependent variable. The test shows that the level of the bilateral real exchange rates, the level of industrial production, ex-post real interest rate, and the level of real commodity prices are stationary (see Table 1). 2/

According to the ADF test, some variables are stationary in their levels. The hypotheses of a unit root is rejected, at a 2.5 percent significance, for interest rate, banana, coconut oil, copra, rice (long grain), sugar (U.S. import), and it is rejected, at a 5 percent significance level, for cotton (industrial), diammonium phosphate, fish, groundnut, groundnut meal, shrimp, soybean, and soybean meal (see Table 1). For these variables, the regressions on the first differences would imply over-differentiation and therefore losing information contain in the series and, also, the cointegration tests would have no meaning for these series as they are stationary in the first place. We still report the results of differences-based regressions, however, for lack of methods to estimate regression equations which includes stationary and non-stationary variables.

According to the ADF test, all time series are stationary in their first difference form, except for natural gas, for which, the hypotheses of a unit root is accepted at a 5 percent significance level.

First, on the basis of equation (12), we regress the difference of individual real commodity prices on its own lag, and on the difference of the real bilateral exchange rates, on the ex-post real interest rate and on the difference of world industrial production, together with their lags. We use Cochrane Orcutt procedure to control for the autocorrelation of

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1/ We use individual commodity prices rather than aggregate indices as the assumption of exogeneity becomes more difficult to defend for large aggregates. All variables, except the interest rate, are in logarithm.

2/ That is the levels of the variables are integrated of order one, or they have a unit root. Two caveats are in order, the ADF test has a low power and the test performed does not allow for structural breaks in the series.

residuals. The short-term response of the commodity price to a change in the Deutsche mark (resp. the yen) is just the sum of the coefficients of the Deutsche mark (resp. the yen) and its lag. The hypotheses that the sum of coefficients on the Deutsche mark and the Deutsche mark lagged (as well as for the yen and the yen lagged) was tested.

The results, shown in Table 2, includes: the Deutsche mark was significant at the 5 percent level for a few of the commodities studied; beef, butter (price quoted in London), cocoa, copper, gold, groundnut oil, lamb, phosphoric rock, sugar (European import price), tin, wheat, and zinc. The yen was significant at the same level for beef, butter (price quotes in New Zealand), gold, logs, maize, phosphoric acid, wheat. If the level of significance is lowered somewhat, other commodities could be included as aluminum, lead, phosphoric acid, soybean meal for the Deutsche mark, ammoniac, gasoline for the yen. 1/ For some commodities, the elasticities are significant but of the wrong sign (i.e., they are negative). Those commodities are groundnut oil, phosphoric acid, and wheat for the Deutsche mark, and beef, gasoline, maize for the yen. One necessary condition for the elasticity of the commodity price with respect to the contemporaneous exchange rate to be negative is that the supplier's inventory reacts so much to an increase in supply that the supply net of inventory would be a decreasing function of gross supply, which is hardly believable. The negative short term elasticities puzzle remains to be solved.

The regressions, reported in Table 2, estimate of the short-term response of individual real commodity price to changes in the bilateral real exchange rates. From these results, one could estimate of the long term response by dividing the short term response by one minus the coefficient on the lagged endogenous variable. Although this procedure provides an easy way to estimate long term response, it has several drawbacks. The long-term elasticity estimate itself is a function of estimated coefficients and, therefore, will compound estimation errors. This is particularly true of the coefficient for the endogenous variable, as what appears in the indirect estimate is the inverse of one minus this coefficient. Furthermore, the indirect estimation does not provide the standard error of the estimate.

As an alternative, we estimate the long term responses using distributed lags of the independent variables. 2/ This approach can be applied for "static" as well as "rational" expectations. One advantage of this method is that it leaves the data more freedom to determine the long term elasticities individually for each explanatory variable. In the preceding method, where long term responses were inferred from short-term responses, the coefficient on the endogenous lagged variable was influenced by all the exogenous variables taken as a group. The long lags approach seems more flexible, but one has to choose the number of lags on the

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1/ Lowering the level of significance means in this case that an estimated coefficient is considered significant if in the test of joint significance for the coefficients of the Deutsche mark (resp. yen) exchange rate and its lag, its F statistics is superior to 3.5.

2/ Rational expectations will naturally creates such lags.

regressors, which introduces arbitrariness in the estimation process. We used twelve lags for all commodities. 1/

The main results, shown in Table 6, are the following: the Deutsche mark had a significant influence in the real prices of aluminum, beef, butter (price quoted in London), copper, cotton (industrial), gold, groundnut, groundnut oil, iron ore, lamb, log, rubber, shrimp, silver, and wheat. The yen was significant for coconut oil, copra, iron ore, palm kernel oil, soybean, steel, sunflower oil, and wheat. Some commodities exhibit puzzling negative elasticities. Those are groundnut oil, and wheat for the Deutsche mark, and iron ore (which was not significant in the short term) for the yen. For the Deutsche mark, many of the commodities that were significantly affected by the exchange rate in the short term are also significantly affected in the long run. Those are aluminum, beef, butter (price quoted in London), copper, gold, groundnut oil, lamb and wheat. No such stability is observed for the yen. Only wheat is both significant in the short and long run.

Surprisingly, the elasticities of groundnut oil, and wheat with respect to Deutsche mark change signs when we switch from the short term to the long term. The estimates of the long run elasticities using the regression on the first differences and using the long lags vary considerably. Long lags estimates are typically larger, often greater than one, which contradicts the theory.

As a conclusion, significant short-term elasticity does not imply significant long-term elasticity, and viceversa. Also the estimates of the long-term response can vary a lot across the two methods. Also, the estimate may be inferior or superior to one. The exchange rates coefficients loose their interpretation of market power weights they had in Sjaastad (1985), and in Sjaastad and Scacciavilani (1993).

We cannot explain why the long term response estimates vary so much across estimation methods for some commodities nor can we account for the discrepancies between short term and long term elasticities. Economic theory does not imply that long term and short term elasticities must be equal.

An alternative approach to estimate the possible long-term relation between the real exchange rates and the commodity prices is to run an error correction model, provided that the given commodity price be cointegrated with the explanatory variables, real exchange rates, industrial production, and real interest rates. Table 3 displays the results of the cointregration tests. A simple Dickey-Fuller test shows that most of the commodities are cointegrated. The cointegration vector provides an estimate of the long-run relation between the variables. The error correction representation takes into account the long-term relation and the short-run dynamics. It provides

1/ Alternatively, one can use some procedures to determine the "optimal" number of lags in each case, such as the Akaike Information Criterion or the Schwarz Criterion.

also the speed of adjustment, that is, how fast the variables are reverting back to their long-run equilibrium.

The results of the error correction representation model: the estimated short- and long-terms elasticities, as well as the speed of adjustment are shown in Table 5. There, 'first diff. regression' refers to the regressions of the differences of the logarithms of each commodity price on the differences of the logarithm of the Deutsche mark and yen exchange rates, industrial production, and the difference of the interest rate, together with the differences of their lags (see equation (12)). In the same table, 'ECM' refers to the error correction model. In the short run section, the column "first diff." (resp. ECM) corresponds to the sum of the coefficients of each explanatory variable (Deutsche mark, yen, interest rate), and the coefficient of its lag. In the long run section, the column "first diff." (resp. ECM) correspond to the short-term elasticities divided by one minus the coefficient on the lagged endogenous variable. The column "cointegration regression" displays the estimated cointegration vector. Most of the commodities are cointegrated, the ones which are not are: coffee (the four types: columbia, arabica, robusta, and other milds), copra, phosphoric acid.

The cointegration regression does not yield an estimate of the standard deviation of the long-term response estimates. The cointegration test is global, it relates to the existence of a long-term relation among a set of variables. It cannot tell much about the 'significance' of a particular variable within the set. The same caveat holds for the estimates of the short-term responses in the ECM regressions. This makes it difficult to compare the long- and short-term responses estimates across different estimation methods. That is why, to judge the significance of the exchange rates coefficients we use long lags.

Another problem with the traditional cointegration tests is that they give an 'all or nothing' answer. Either the residual is stationary (and so the variables are cointegrated), or it is not (and the variables are not cointegrated). An alternative would be to use the methodology of 'fractional integration'. This method has been used in Sjaastad and Scacciavialani (1993), and Scacciavialani (1994). Due to the difficulty in implementing this approach, we did not use it in this paper.

V. Concluding Comments

This paper extends Sjaastad's (1985) model, incorporating inventory demands and expectations, and estimate the model on large data set (65 commodities), most of which had not been studied in the past. In most cases, we used twenty years of monthly data (between January 1972 and January 1992). From the outset, we adopted simple and identical regression methods across all commodities, so that, we did not give ourselves too much freedom to maximize the number of commodities for which the relation between exchange rates and commodity prices was significant. For example, we used the same time period for every commodity. To refine the results, one could introduce some dummy variables to account for exceptional circumstances, like adversary weather conditions. This would be particularly important for agricultural commodities, coffee for example.

The main conclusions are the following:

(i) The price of many commodities in real terms, seem to be influenced, in the short term, in the long run, or in both, by real exchange rates

(ii) The previous results can be used to measure the degree of market integration. For example, the U.S. import price of sugar is insensitive to fluctuations in either the dollar/Deutsche mark or dollar/Yen, whereas the European import price of sugar, denominated in dollar, is in fact dominated by the Deutsche mark, at least for short-term elasticities. The effect of state intervention on the sugar market is clearly perceived through looking at the exchange rate effect. This is more a confirmation than a discovery, the real finding is that the dollar price in the European market in not completely dominated by the Deutsche mark. This means that despite the European apparatus, the Deutsche mark (or ECU currency) sugar price in Europe is not isolated from the rest of the world. Moreover, the long-term elasticity estimate for the Deutsche mark is not significant at the five percent level.

(iii) The results also show that geographical proximity matters as illustrated by the examples of butter. New Zealand butter is dominated by the Yen whereas the price of butter quoted in London is dominated by the Deutsche mark. New Zealand butter is exported to Japan more than to Britain now that it has entered the Common market. Some weaker examples are logs and rice. In the short-term, the dollar price of logs is heavily influenced by the yen, which could be explained by the United States exports of logs to Japan. Likewise, Thai rice is somewhat influenced by the yen in the short term, whereas long grain rice is not. Japan imports some Thai rice, but, to the best of our knowledge, not much long-grain rice. Note that the elasticities loose their significance in the long run.

(iv) Real interest rate affects some commodity real prices--higher real interest rate reduces the equilibrium real price of some commodity, as expected, through reducing the demand for inventory. We conjecture that the effect of real interest rate is stronger on those commodities which are more "storable" than others.

(v) The results show that the relative elasticities of supply and demand can play an important role in determining the price of commodities in world market besides and above the mere size of the share in the world trade of the commodity. This is illustrated by comparing the estimated market powers with the share of each bloc or country in the world trade of each product. For example, although Japan is a large importer of agricultural raw materials and metallic commodities, it has some influence on the first but none on the second.

(vi) The blocs' relative market power are not uniform across commodities. The country or bloc that has the most influence in determining the world price of a commodity is not always the country or bloc in whose currency the commodity price is denominated, or the country or bloc with the largest market share in world trade, or the country or bloc producing the commodity in question. Relative elasticities can play an important role in determining the price of commodities in world markets.

(vii) The degree of market integration is perceived in the reaction of a commodity price to changes in the exchange rates. Market integration can arise because of geographic proximity or because of state intervention.

(viii) The magnitude of the response of a commodity price to fluctuations in exchange rates is affected by the presence of precautionary and speculative demand for inventories. This elasticity is lower the lower is the degree of the speculators' risk aversion, the higher is the quality of the speculators' information and the higher is the response of producers' demand for precautionary inventories in response to favorable supply shocks.

Table 1. Augmented Dickey-Fuller Test on the Levels and First Differences of Exogenous Variables and Commodity Prices, 1970:1 - 1993:6

The table shows the values of the t-statistics on α in the following regressions: $\Delta Y_t = \mu + \beta t + \alpha Y_{t-1} + \sum^{5}_{i=1} \delta i \; \Delta Y_{t-i} + \epsilon_t$

Series	Levels	Differences
Variables		
Deutsche mark/dollar		
Real exchange rate	-1.97	-7.30
Yen/dollar		
Real exchange rate	-2.60	-6.73
Industrial production	-1.27	-4.25
Interest rate	-4.69	-11.15
Commodities		
1. Aluminum	-2.75	-5.07
2. Ammoniac	-2.78	-6.53
3. Banana	-5.83	-9.65
4. Beef	-2.65	-6.84
5. Butter (London)	-2.45	-6.72
6. Butter (New Zealand)	-2.97	-8.82
7. Coal	-1.97	-6.57
8. Cocoa	-1.95	-6.08
9. Coconut oil	-3.86	-4.19
10. Coffee (Colombia)	-1.93	-6.16
11. Coffee (Arabica)	-2.18	-6.54
12. Coffee (other milds)	-2.15	-6.58
13. Coffee (Robusta)	-1.64	-6.52
14. Copper	-2.70	-6.49

Table 1. Augmented Dickey-Fuller Test on the Levels and First Differences of Exogenous Variables and Commodity Prices, 1970:1 - 1993:6 (Continued)

The table shows the values of the t-statistics on α in the following regressions: $\Delta Y_t = \mu + \beta t + \alpha Y_{t-1} + \sum^5_{i=1} \delta i \, \Delta Y_{t-i} + \epsilon_t$

Series	Levels	Differences
15. Copra	-3.70	-4.13
16. Cotton (industrial)	-3.69	-5.91
17. Cotton (long-staple)	-2.33	-5.52
18. Diammonium phosphate	-3.47	-4.44
19. Fish	-3.62	-5.00
20. Gasoline	-2.05	-5.52
21. Gold	-1.84	-7.33
22. Groundnuts	-3.48	-4.66
23. Groundnut meal	-3.51	-6.28
24. Groundnut oil	-3.09	-5.62
25. Hide	-2.85	-6.69
26. Iron ore	-2.14	-7.29
27. Lamb	-2.56	-7.29
28. Lead	-2.30	-6.29
29. Log	-3.36	-6.71
30. Linseed oil	-2.49	-5.68
31. Maize	-3.10	-6.44
32. Manganese	-0.97	-6.33
33. Natural gas	-1.39	-3.34

Table 1. Augmented Dickey-Fuller Test on the Levels and First Differences of Exogenous Variables and Commodity Prices, 1970:1 - 1993:6 (Continued)

The table shows the values of the t-statistics on α in the following regressions: $\Delta Y_t = \mu + \beta t + \alpha Y_{t-1} + \sum^5_{i=1} \delta i \; \Delta Y_{t-i} + \epsilon_t$

Series	Levels	Differences
34. Nickel	-2.28	-7.52
35. Oil (average)	-1.89	-8.00
36. Oil (Alaska)	-1.76	-7.75
37. Oil (Dubai)	-1.90	-8.08
38. Oil (U.K. Brent)	-2.096	-8.014
39. Oil (West Texas I)	-2.15	-5.70
40. Palm kernel oil	-3.78	-4.31
41. Phosphoric acid	-3.54	-6.01
42. Phosphate rock	-2.23	-4.96
43. Rapeseed oil	-2.17	-4.19
44. Rice (Thailand)	-2.82	-5.03
45. Rice (long grain)	-3.81	-5.73
46. Rubber	-3.08	-5.25
47. Shrimp	-3.68	-6.59
48. Silver	-1.99	-7.75
49. Soybean	-3.47	-7.04
50. Soybean meal	-3.68	-6.75
51. Soybeans oil	-3.07	-5.97
52. Sorghum	-2.83	-7.15
53. Steel	-2.68	-5.85

Table 1. Augmented Dickey-Fuller Test on the Levels and First Differences of Exogenous Variables and Commodity Prices, 1970:1 - 1993:6 (Concluded)

The table shows the values of the t-statistics on α in the following regressions: $\Delta Y_t = \mu + \beta t + \alpha Y_{t-1} + \sum^5_{i=1} \delta i \ \Delta Y_{t-i} + \epsilon_t$

Series	Levels	Differences
54. Sugar (U.S. import)	-4.10	-5.36
55. Sugar (E.U. import)	-2.39	-7.20
56. Sunflower oil	-2.87	-5.77
57. Tea	-3.07	-8.245
58. Tin	-1.89	-6.43
59. Tobacco	-3.10	-8.20
60. Triple super phosphates	-2.76	-4.11
61. Urea	-2.82	-4.52
62. Wheat	-3.05	-6.69
63. Wool (coarse)	-2.55	-5.26
64. Wool (fine)	-3.01	-4.92
65. Zinc	-3.15	-5.82

Table 2. Regression of the First Difference of the Logarithm of the Dollar Price of Commodities on the Set of Independent Variables

Dependent Variables	Independent Variable: Dep. Vbl. Lagged	DM	DM{-1}	Y	Y{-1}	Q	Q{-1}	R	R{-1}	Rho	Adjusted R square	F-test
1. Aluminum	0.32	0.07	0.24	-0.05	0.06	0.63	-0.43	-0.37	-0.38	-0.23	0.07	4.23
	(5.22)	(0.52)	(1.75)	(-0.35)	(0.38)	(1.45)	(-0.98)	(-0.62)	(-0.83)	(-1.89)		
2. Ammoniac	0.06	-0.01	-0.14	0.29	0.55	0.18	0.43	0.29	-2.16	0.24	0.07	1.11
	(0.69)	(-0.03)	(-0.55)	(1.03)	(1.99)	(0.23)	(0.53)	(0.22)	(-1.86)	(0.88)		
3. Banana	0.10	-0.15	0.86	-0.26	-0.12	1.05	-0.47	1.37	1.04	-0.16	0.03	1.94
	(1.50)	(-0.47)	(2.70)	(-0.74)	(-0.34)	(1.08)	(-0.48)	(1.03)	(0.99)	(-0.81)		
4. Beef	0.22	0.27	0.12	-0.29	-0.07	0.66	0.45	-1.38	-0.36	0.11	0.21	6.32
	(3.53)	(2.75)	(1.24)	(-2.70)	(-0.59)	(2.31)	(1.55)	(-3.61)	(-1.07)	(0.38)		
5. Butter (London)	0.18	0.46	-0.03	0.06	0.33	-0.61	0.56	1.14	0.57	-0.26	0.09	4.66
	(2.74)	(3.00)	(-0.18)	(0.35)	(1.89)	(-1.25)	(1.14)	(1.71)	(1.12)	(-1.86)		
6. Butter (New Zealand)	-0.12	-0.05	-0.01	0.64	0.28	-0.60	0.33	1.50	-1.99	-0.25	0.17	2.92
	(-1.77)	(-0.20)	(-0.03)	(2.19)	(0.95)	(-0.72)	(0.39)	(1.32)	(-2.23)	(-0.86)		
7. Coal	-0.05	-0.02	0.12	0.02	-0.09	-0.56	0.14	1.06	0.70	-0.29	0.10	0.88
	(-0.79)	(-0.12)	(0.89)	(0.14)	(-0.59)	(-1.31)	(0.32)	(1.84)	(1.58)	(-1.18)		
8. Cocoa	0.14	0.18	0.32	0.05	0.04	0.67	-0.17	0.87	0.71	0.18	0.14	2.96
	(2.16)	(1.15)	(2.02)	(0.29)	(0.25)	(1.48)	(-0.38)	(1.46)	(1.41)	(0.60)		
9. Coconut oil	0.48	-0.18	-0.21	0.24	0.13	-0.45	1.24	0.22	0.49	-0.15	0.12	8.57
	(8.17)	(-0.89)	(-0.99)	(1.04)	(0.58)	(-0.71)	(1.93)	(0.25)	(0.71)	(-1.38)		
10. Coffee (Colombia)	0.45	-0.05	0.01	-0.15	-0.07	-0.81	1.13	1.69	-0.18	-0.13	0.09	5.20
	(7.24)	(-0.27)	(0.07)	(-0.78)	(-0.33)	(-1.58)	(2.17)	(2.39)	(-0.33)	(-1.06)		
11. Coffee (Arabica)	0.42	0.00	0.03	-0.16	0.27	-0.52	0.60	1.09	-0.15	-0.26	0.02	5.70
	(7.05)	(0.01)	(0.16)	(-0.68)	(1.15)	(-0.78)	(0.89)	(1.21)	(-0.22)	(-2.43)		
12. Coffee (Other milds)	0.38	-0.08	0.10	-0.08	0.01	-0.04	0.82	0.75	0.15	-0.04	0.10	4.69
	(6.22)	(-0.45)	(0.56)	(-0.40)	(0.07)	(-0.08)	(1.55)	(1.05)	(0.25)	(-0.27)		
13. Coffee (Robusta)	0.26	0.00	0.17	-0.02	-0.12	-0.10	0.64	0.74	-0.06	0.11	0.10	2.24
	(4.05)	(0.02)	(1.02)	(-0.13)	(-0.65)	(-0.21)	(1.36)	(1.18)	(-0.11)	(0.30)		
14. Copper	0.16	0.43	0.44	0.06	0.07	0.47	0.71	-0.24	-0.65	0.20	0.23	5.44
	(2.51)	(3.09)	(3.12)	(0.41)	(0.45)	(1.17)	(1.78)	(-0.45)	(-1.46)	(1.05)		
15. Copra	0.51	-0.16	-0.05	0.18	-0.02	-0.54	1.20	0.09	0.98	-0.30	0.07	9.48
	(8.77)	(-0.71)	(-0.24)	(0.75)	(-0.09)	(-0.76)	(1.67)	(0.09)	(1.30)	(-3.24)		
16. Cotton (Industrial)	0.34	0.12	0.01	-0.10	0.02	0.08	-0.16	0.41	-0.20	0.32	0.33	3.91
	(5.30)	(1.17)	(0.11)	(-0.92)	(0.22)	(0.28)	(-0.55)	(1.14)	(-0.63)	(0.23)		
17. Cotton (Long-staple)	-0.29	0.13	0.03	-0.12	-0.00	0.33	0.11	0.63	1.52	0.41	0.08	5.79
	(-4.74)	(1.03)	(0.28)	(-0.88)	(-0.01)	(0.90)	(0.31)	(1.46)	(3.94)	(4.43)		
18. Diammonium phosphate	0.04	-0.06	0.20	-0.02	0.24	-0.03	-0.54	1.27	0.38	0.18	0.06	1.80
	(0.65)	(-0.38)	(1.16)	(-0.08)	(1.29)	(-0.06)	(-1.11)	(1.98)	(0.70)	(0.68)		
19. Fish	0.12	0.17	0.05	0.09	0.13	0.86	1.06	0.26	-0.27	0.11	0.09	2.54
	(1.83)	(0.96)	(0.30)	(0.45)	(0.69)	(1.68)	(2.05)	(0.38)	(-0.48)	(0.28)		

Table 2. Regression of the First Difference of the Logarithm of the Dollar Price of Commodities on the Set of Independent Variables (Continued)

Dependent Variables	Independent Variable										Adjusted R square	F-test
	Dep. Vbl. Lagged	DM	DM{-1}	Y	Y{-1}	Q	Q{-1}	R	R{-1}	Rho		
20. Gasoline	0.10	-0.06	-0.13	-0.25	-0.48	-1.24	1.14	-3.93	-0.61	0.06	0.17	4.27
	(1.25)	(-0.23)	(-0.51)	(-0.99)	(-1.84)	(-1.67)	(1.46)	(-3.11)	(-0.53)	(0.20)		
21. Gold	0.13	0.40	0.09	0.22	0.33	-0.85	-0.21	-0.12	-0.72	0.14	0.19	5.57
	(2.04)	(3.01)	(0.66)	(1.51)	(2.23)	(-2.19)	(-0.52)	(-0.23)	(-1.69)	(0.56)		
22. Groundnuts	0.29	0.22	-0.02	-0.21	0.62	-0.74	0.51	-1.20	-1.38	0.08	0.12	2.32
	(3.45)	(0.61)	(-0.06)	(-0.55)	(1.67)	(-0.70)	(0.47)	(-0.67)	(-0.88)	(0.27)		
23. Groundnut meal	0.02	0.11	0.28	0.08	-0.17	0.88	0.19	-0.44	-0.39	0.20	0.03	0.56
	(0.33)	(0.54)	(1.34)	(0.37)	(-0.77)	(1.54)	(0.32)	(-0.59)	(-0.61)	(0.64)		
24. Groundnut oil	0.24	-0.49	-0.02	0.18	0.01	0.31	0.04	-0.74	-0.24	0.04	0.09	3.20
	(3.74)	(-2.90)	(-0.09)	(0.96)	(0.06)	(0.62)	(0.08)	(-1.10)	(-0.43)	(0.14)		
25. Hide	0.07	-0.09	0.02	-0.11	0.00	1.63	0.37	-0.86	-1.00	-0.01	0.02	1.62
	(1.11)	(-0.39)	(0.07)	(-0.44)	(0.02)	(2.42)	(0.54)	(-0.94)	(-1.35)	(-0.02)		
26. Iron ore	-0.17	0.11	-0.01	-0.08	0.02	0.01	-0.38	-0.33	-0.22	0.16	-0.01	1.24
	(-2.59)	(1.25)	(-0.10)	(-0.86)	(0.16)	(0.06)	(-1.47)	(-0.97)	(-0.75)	(0.78)		
27. Lamb	0.13	0.27	0.20	0.01	0.16	-0.02	0.46	1.08	0.03	0.01	0.12	4.54
	(2.10)	(2.43)	(1.81)	(0.07)	(1.32)	(-0.07)	(1.39)	(2.43)	(0.07)	(0.05)		
28. Lead	0.22	0.29	0.15	-0.15	0.03	0.22	0.60	0.55	-0.54	-0.03	0.04	2.22
	(3.41)	(1.78)	(0.89)	(-0.83)	(0.15)	(0.44)	(1.19)	(0.82)	(-0.98)	(-0.12)		
29. Log	-0.19	0.03	-0.10	0.60	0.72	-0.25	-0.56	0.24	0.20	0.49	0.20	5.91
	(-3.12)	(0.21)	(-0.69)	(4.07)	(4.82)	(-0.61)	(-1.38)	(0.52)	(0.49)	(5.65)		
30. Linseed oil	0.15	-0.36	0.01	0.21	-0.17	0.18	-0.50	-1.00	0.74	0.18	0.10	1.86
	(2.30)	(-1.87)	(0.04)	(0.97)	(-0.78)	(0.32)	(-0.89)	(-1.37)	(1.19)	(0.28)		
31. Maize	0.09	0.04	-0.03	-0.28	-0.18	-0.26	0.09	-0.66	0.12	0.26	0.13	2.08
	(1.32)	(0.29)	(-0.21)	(-2.04)	(-1.36)	(-0.75)	(0.24)	(-1.49)	(0.30)	(0.91)		
32. Manganese	0.14	0.15	0.02	-0.04	-0.05	-0.37	0.53	0.91	0.04	0.18	0.08	1.63
	(2.16)	(1.50)	(0.16)	(-0.34)	(-0.41)	(-1.26)	(1.77)	(2.30)	(0.13)	(0.30)		
33. Natural gas	0.23	-0.33	-0.05	0.23	-0.23	1.56	-0.71	-0.78	0.04	-0.22	-0.06	0.87
	(1.99)	(-0.90)	(-0.15)	(0.56)	(-0.56)	(1.59)	(-0.65)	(-0.47)	(0.03)	(-0.78)		
34. Nickel	0.19	0.02	0.07	-0.10	0.14	0.60	0.15	0.56	0.30	0.19	0.12	1.76
	(2.91)	(0.15)	(0.45)	(-0.56)	(0.81)	(1.31)	(0.33)	(0.93)	(0.60)	(0.29)		
35. Oil (average)	0.17	0.16	-0.43	-0.42	0.51	-0.99	-0.47	-2.43	-1.90	-0.10	0.08	4.17
	(2.81)	(0.64)	(-1.70)	(-1.55)	(1.85)	(-1.32)	(-0.62)	(-2.36)	(-2.28)	(-0.52)		
36. Oil (Alaska)	0.17	0.14	-0.55	-0.42	0.61	-0.94	-0.60	-2.80	-1.94	-0.13	0.08	4.35
	(2.67)	(0.51)	(-1.97)	(-1.37)	(1.96)	(-1.10)	(-0.69)	(-2.40)	(-2.07)	(-0.68)		
37. Oil (Dubai)	0.18	0.17	-0.48	-0.46	0.50	-1.30	-0.43	-2.75	-2.26	-0.14	0.08	4.73
	(2.87)	(0.58)	(-1.66)	(-1.46)	(1.57)	(-1.50)	(-0.48)	(-2.31)	(-2.38)	(-0.77)		
38. Oil (U.K. Brent)	0.16	0.17	0.08	-0.36	-0.02	-0.71	0.14	-3.30	-1.35	0.16	0.16	3.19
	(1.95)	(0.68)	(0.30)	(-1.35)	(-0.08)	(-0.92)	(0.18)	(-2.58)	(-1.15)	(0.24)		

Table 2. Regression of the First Difference of the Logarithm of the Dollar Price of Commodities on the Set of Independent Variables (Continued)

Dependent Variables	Independent Variable: Dep. Vbl. Lagged	DM	DM{-1}	Y	Y{-1}	Q	Q{-1}	R	R{-1}	Rho	Adjusted R square	F-test
39. Oil (West Texas I)	0.28	0.24	-0.14	-0.46	0.09	-1.37	0.89	-6.26	-2.01	-0.04	0.37	...
	(2.61)	(0.84)	(-0.49)	(-1.38)	(0.28)	(-1.60)	(0.97)	(-4.71)	(-1.52)	(-0.13)		
40. Palm kernel oil	0.37	0.06	-0.42	0.12	0.36	-0.30	1.31	0.40	0.57	-0.05	0.11	5.28
	(6.10)	(0.28)	(-1.97)	(0.52)	(1.53)	(-0.48)	(2.03)	(0.45)	0.81)	-0.33)		
41. Phosphoric acid	0.37	-0.32	-0.01	0.25	0.11	-0.48	0.54	1.42	-0.42	-0.18	0.04	3.81
	(5.29)	(-2.37)	(-0.04)	(1.74)	(0.77)	(-1.19)	(1.29)	(2.10)	(-0.77)	(-1.32)		
42. Phosphate rock	0.09	0.02	-0.55	-0.20	0.68	-0.59	-1.30	-1.92	-1.00	-0.19	0.10	4.65
	(1.47)	(0.11)	(-2.72)	(-0.91)	(3.07)	(-0.96)	(-2.06)	(-2.27)	(-1.51)	(-1.07)		
43. Rapeseed oil	0.16	-0.15	0.02	-0.17	-0.03	0.16	0.47	-0.06	-0.53	0.15	0.05	0.88
	(1.90)	(-0.63)	(0.11)	(-0.69)	(-0.14)	(0.24)	(0.67)	(-0.05)	(-0.51)	(0.13)		
44. Rice (Thailand)	0.45	-0.06	-0.07	0.24	0.01	-0.18	-0.06	0.44	-0.25	-0.03	0.19	7.68
	(7.51)	(-0.59)	(-0.60)	(2.02)	(0.07)	(-0.55)	(-0.18)	(0.99)	(-0.69)	(-0.19)		
45. Rice (Long grain)	0.14	-0.03	-0.15	-0.09	0.08	0.23	0.24	0.18	-0.37	0.39	0.24	1.21
	(2.13)	(-0.23)	(-1.17)	(-0.66)	(0.53)	(0.59)	(0.64)	(0.39)	(-0.92)	(1.76)		
46. Rubber	0.24	0.02	0.31	0.10	0.02	0.47	0.44	0.00	-0.90	0.04	0.12	4.04
	(3.72)	(0.19)	(2.40)	(0.72)	(0.12)	(1.26)	(1.19)	(0.00)	(-2.17)	(0.19)		
47. Shrimp	0.40	0.08	0.15	0.00	0.02	0.68	-0.44	-0.61	-0.36	-0.07	0.11	5.97
	(6.69)	(0.69)	(1.23)	(0.00)	(0.17)	(1.84)	(-1.19)	(-1.21)	(-0.88)	(-0.54)		
48. Silver	0.18	0.07	0.30	0.41	-0.05	0.31	-0.86	-1.54	-0.78	0.11	0.08	2.92
	(2.75)	(0.29)	(1.34)	(1.62)	(-0.20)	(0.48)	(-1.31)	(-1.78)	(-1.07)	(0.28)		
49. Soybean	0.30	0.02	-0.29	-0.09	0.07	0.18	-0.23	-2.82	-0.46	0.09	0.20	6.20
	(4.87)	(0.15)	(-2.00)	(-0.60)	(0.45)	(0.44)	(-0.54)	(-5.00)	(-0.96)	(0.38)		
50. Soybean meal	0.15	0.37	0.21	-0.13	-0.16	0.34	0.35	0.51	0.47	0.24	0.11	1.37
	(2.16)	(1.91)	(1.05)	(-0.63)	(-0.75)	(0.61)	(0.62)	(0.69)	(0.75)	(0.58)		
51. Soybeans oil	0.03	-0.03	0.07	-0.07	-0.35	-0.29	-0.06	0.28	1.05	0.30	0.08	0.86
	(0.48)	(-0.15)	(0.43)	(-0.41)	(-1.96)	(-0.61)	(-0.14)	(0.47)	(2.03)	(1.52)		
52. Sorghum	0.13	-0.00	-0.09	-0.23	0.11	-0.31	0.30	-0.47	0.02	0.10	0.05	1.70
	(1.93)	(-0.02)	(-0.63)	(-1.50)	(0.72)	(-0.76)	(0.74)	(-0.88)	(0.04)	(0.10)		
53. Steel	0.43	0.10	-0.07	0.00	0.16	0.53	0.02	0.62	-0.23	-0.30	0.08	8.14
	(7.21)	(1.02)	(-0.68)	(0.01)	(1.43)	(1.62)	(0.05)	(1.38)	(-0.68)	(-3.00)		
54. Sugar (US import)	0.01	0.12	0.22	0.06	-0.19	-0.57	-0.27	-0.74	-1.21	0.24	0.07	1.24
	(0.20)	(0.65)	(1.24)	(0.29)	(-0.95)	(-1.11)	(-0.52)	(-1.11)	(-2.13)	(1.04)		
55. Sugar (EU import)	-0.24	0.53	0.15	-0.07	0.24	-0.57	-0.90	0.42	0.89	-0.13	0.18	5.00
	(-3.92)	(3.31)	(0.92)	(-0.37)	(1.36)	(-1.17)	(-1.82)	(0.63)	(1.67)	(-0.43)		
56. Sunflower oil	0.06	-0.27	0.11	0.20	-0.27	-0.01	-0.10	0.06	1.01	0.22	0.06	1.19
	(0.93)	(-1.64)	(0.64)	(1.08)	(-1.43)	(-0.01)	(-0.20)	(0.09)	(1.88)	(0.70)		
57. Tea	0.01	0.21	0.12	0.28	0.19	-0.19	0.27	0.27	0.01	0.23	0.07	1.46
	(0.14)	(1.09)	(0.61)	(1.32)	(0.92)	(-0.35)	(0.49)	(0.39)	(0.02)	(0.88)		

Table 2. Regression of the First Difference of the Logarithm of the Dollar Price of Commodities on the Set of Independent Variables (Concluded)

Dependent Variables	Independent Variable										Adjusted R square	F-test
	Dep. Vbl. Lagged	DM	DM{-1}	Y	Y{-1}	Q	Q{-1}	R	R{-1}	Rho		
58. Tin	-0.21	0.18	0.23	0.14	0.05	0.53	-1.07	0.03	0.16	0.49	0.13	1.68
	(-3.35)	(1.48)	(1.89)	(1.06)	(0.37)	(1.50)	(-2.98)	(0.07)	(0.43)	(5.61)		
59. Tobacco	0.05	0.02	-0.12	0.07	-0.02	0.43	-0.18	0.40	0.03	-0.07	0.11	3.96
	(0.71)	(0.29)	(-1.90)	(1.05)	(-0.31)	(2.34)	(-0.96)	(1.60)	(0.14)	(-0.23)		
60. Triple Super Phosphates	-0.05	0.00	0.09	0.01	0.31	-0.19	-0.49	1.52	0.51	0.37	0.13	2.74
	(-0.83)	(0.00)	(0.62)	(0.05)	(1.87)	(-0.44)	(-1.11)	(2.81)	(1.08)	(2.72)		
61. Urea	0.39	0.15	-0.11	-0.33	0.60	-0.53	-0.18	0.48	-1.18	-0.29	0.06	6.89
	(6.53)	(0.77)	(-0.59)	(-1.56)	(2.85)	(-0.87)	(-0.29)	(0.58)	(-1.85)	(-2.90)		
62. Wheat	0.07	-0.32	-0.18	0.25	0.21	0.02	0.44	-1.29	0.04	0.35	0.22	4.78
	(1.12)	(-2.67)	(-1.43)	(1.89)	(1.55)	(0.06)	(1.24)	(-2.98)	(0.09)	(1.76)		
63. Wool (Coarse)	-0.18	0.14	0.05	0.14	0.18	0.85	0.90	-0.52	-0.76	0.26	0.10	3.53
	(-2.85)	(1.20)	(0.42)	(1.14)	(1.44)	(2.57)	(2.69)	(-1.25)	(-2.08)	(1.86)		
64. Wool (Fine)	0.27	0.10	0.03	0.19	0.02	0.19	0.64	-1.12	-0.96	-0.18	0.04	4.12
	(4.35)	(0.63)	(0.17)	(1.13)	(0.12)	(0.38)	(1.31)	(-1.71)	(-1.83)	(-1.24)		
65. Zinc	0.31	0.28	0.20	-0.10	0.01	0.53	0.49	1.01	0.02	0.04	0.14	4.77
	(4.82)	(1.76)	(1.26)	(-0.56)	(0.07)	(1.15)	(1.05)	(1.63)	(0.04)	(0.20)		

Table 3. Regressions of the Level of the Logarithm of the Dollar Price of Commodities on the Set of Independent Variables

(Long-run equilibrium reduced form equation, or cointegration regressions)

Dependent Variables	Independent Variables					Adjusted R square	F-test	Cointegration Test (U = U(-1) +E) U (-1)
	Constant	DM	Y	Q	R			
1. Aluminum	4.19 (5.24)	0.61 (3.80)	0.19 (1.13)	0.05 (0.64)	-5.15 (-2.80)	0.29	25.60	-0.06 (-2.60)
2. Ammoniac	-5.78 (-4.69)	-0.11 (-0.52)	-1.13 (-4.40)	-0.51 (-1.09)	-4.84 (-1.59)	0.52	39.25	-0.14 (-3.38)
3. Banana	-3.00 (-4.68)	0.41 (3.20)	-0.14 (-1.02)	-0.14 (-2.04)	1.21 (0.82)	0.06	5.11	-0.34 (-6.94)
4. Beef	-1.43 (-2.46)	0.32 (2.78)	-0.34 (-2.74)	0.56 (9.01)	-3.50 (-2.62)	0.52	65.04	-0.05 (-2.51)
5. Butter (London)	-1.92 (-3.06)	1.09 (8.98)	-0.57 (-4.31)	-0.32 (-5.04)	0.03 (0.02)	0.33	29.40	-0.11 (-3.90)
6. Butter (New Zealand)	-4.09 (-5.75)	0.36 (2.54)	-0.78 (-5.14)	0.34 (4.50)	1.10 (0.67)	-0.31	27.60	-0.24 (-5.74)
7. Coal	-23.20 (-27.96)	1.32 (8.02)	-1.84 (-10.37)	-0.53 (-5.93)	-1.11 (-0.58)	0.31	27.30	-0.07 (-3.04)
8. Cocoa	-4.72 (-2.82)	1.11 (3.33)	-1.64 (-4.60)	0.13 (0.71)	-6.81 (-1.77)	0.16	12.38	-0.04 (-2.30)
9. Coconut oil	-2.87 (-1.75)	-0.13 (-0.39)	-0.87 (-2.48)	0.77 (4.38)	-12.30 (-3.28)	0.29	24.95	-0.06 (-2.84)
10. Coffee (Colombia)	-5.38 (-3.03)	0.60 (1.86)	-1.19 (-3.17)	0.17 (1.02)	-3.63 (-1.03)	0.10	6.87	-0.02 (-1.51)
11. Coffee (Arabica)	-6.66 (-3.95)	0.56 (1.68)	-1.42 (-3.95)	0.08 (0.42)	-3.90 (-1.01)	0.11	8.55	-0.03 (-1.64)
12. Coffee (Other milds)	-4.23 (-2.83)	0.40 (1.34)	-0.92 (-2.90)	0.12 (0.76)	-4.47 (-1.31)	0.08	6.01	-0.03 (-1.68)
13. Coffee (Robusta)	-7.22 (-4.06)	0.48 (1.36)	-1.47 (-3.87)	0.15 (0.80)	-6.98 (-1.71)	0.14	10.61	-0.27 (-1.70)
14. Copper	0.80 (1.05)	0.63 (4.19)	0.09 (0.55)	0.89 (11.02)	-3.44 (-1.98)	0.61	96.26	-0.06 (-2.73)
15. Copra	-2.84 (-1.70)	0.02 (0.07)	-0.81 (-2.28)	0.66 (3.72)	-13.05 (-3.41)	0.24	20.41	-0.09 (-1.70)
16. Cotton (Industrial)	-6.48 (-7.88)	0.98 (5.97)	-1.33 (-7.57)	0.42 (4.74)	-3.89 (-2.07)	0.48	55.94	-0.06 (-2.59)
17. Cotton (Long-staple)	2.47 (3.32)	0.53 (3.59)	0.27 (1.72)	0.36 (4.48)	-0.71 (-0.41)	0.36	34.51	-0.05 (-2.43)
18. Diammonium phosphate	-4.69 (-4.19)	0.78 (3.48)	-1.13 (-4.72)	0.54 (4.49)	-3.60 (-1.40)	0.33	30.85	-0.05 (-2.63)
19. Fish	1.23 (1.31)	0.36 (1.92)	-0.09 (-0.46)	1.04 (10.32)	-4.30 (-1.99)	0.52	66.35	-0.08 (-3.52)

Table 3. Regressions of the Level of the Logarithm of the Dollar Price of Commodities on the Set of Independent Variables (Continued)

(Long-run equilibrium reduced form equation, or cointegration regressions)

Dependent Variables	Independent Variables: Constant	DM	Y	Q	R	Adjusted R square	Cointegration Test (U = U{-1} +E): F-test	U {-1}
20. Gasoline	-14.09	1.38	-2.82	-0.39	-7.62	0.65	74.55	-0.15
	(-15.81)	(7.64)	(-14.99)	(-1.25)	(-2.67)			(-3.51)
21. Gold	1.54	0.55	-0.05	-1.39	-4.34	0.61	95.99	-0.06
	(1.90)	(3.40)	(-0.32)	(-15.99)	(-2.33)			(-2.82)
22. Groundnuts	2.35	0.92	-0.12	-2.30	-2.70	0.13	6.61	-0.09
	(1.41)	(3.28)	(-0.34)	(-3.62)	(-0.65)			(-2.49)
23. Groundnut meal	-4.24	0.72	-1.05	1.04	-5.50	0.57	78.20	-0.08
	(-4.08)	(3.46)	(-4.75)	(9.39)	(-2.31)			(-3.20)
24. Groundnut oil	-3.48	0.57	-1.14	0.76	-4.32	0.41	43.53	-0.05
	(-3.06)	(2.52)	(-4.73)	(6.26)	(-1.66)			(-2.44)
25. Hide	7.20	-0.33	1.51	0.51	-2.04	0.37	36.15	-0.10
	(7.81)	(-1.81)	(7.70)	(5.17)	(-0.97)			(-3.55)
26. Iron ore	-6.36	0.86	-1.10	-0.33	-0.15	0.38	37.77	-0.09
	(-15.03)	(10.24)	(-12.17)	(-7.35)	(-0.15)			(-3.27)
27. Lamb	-2.78	0.94	-0.68	0.22	-0.66	0.45	49.68	-0.07
	(-4.98)	(8.46)	(-5.69)	(3.62)	(-0.51)			(-2.94)
28. Lead	-4.43	2.15	-1.51	0.31	-5.38	0.57	80.31	-0.08
	(-4.61)	(11.25)	(-7.35)	(2.97)	(-2.44)			(-3.10)
29. Log	3.89	0.38	0.57	-0.50	-3.27	0.51	62.70	-0.09
	(6.22)	(3.06)	(4.27)	(-7.52)	(-2.28)			(-3.45)
30. Linseed oil	-5.55	0.90	-1.52	0.58	-4.98	0.30	26.42	-0.04
	(-3.80)	(3.10)	(-4.89)	(3.69)	(-1.49)			(-2.47)
31. Maize	-10.01	0.44	-1.30	0.63	-4.57	0.54	71.39	-0.07
	(-11.73)	(2.60)	(-7.14)	(6.90)	(-2.34)			(-3.18)
32. Manganese	-18.30	1.76	-1.23	-0.24	1.71	0.34	31.91	-0.03
	(-21.41)	(10.34)	(-6.73)	(-2.58)	(0.87)			(-1.74)
33. Natural gas	0.40	-0.83	0.19	-5.86	8.39	0.43	16.79	-0.10
	(0.16)	(-2.31)	(0.37)	(-3.09)	(1.83)			(-2.12)
34. Nickel	7.13	0.42	0.50	0.50	-2.02	0.28	24.63	-0.04
	(6.81)	(2.01)	(2.24)	(4.46)	(-0.84)			(-2.22)
35. Oil (average)	-13.39	1.61	-2.52	-2.26	-10.03	0.63	101.36	-0.15
	(-12.02)	(7.23)	(-10.61)	(-18.99)	(-3.93)			(-4.39)
36. Oil (Alaska)	-12.01	1.44	-2.23	-2.51	-10.22	0.69	134.51	-0.16
	(-11.11)	(6.69)	(-9.68)	(-21.71)	(-4.13)			(-4.60)
37. Oil (Dubai)	-14.68	1.75	-2.79	-2.42	-11.05	0.61	96.83	-0.15
	(-12.03)	(7.21)	(-10.70)	(-18.53)	(-3.95)			(-4.37)
38. Oil (U.K. Brent)	-13.54	1.65	-2.56	-1.96	-9.24	0.57	81.02	-0.14
	(-12.46)	(7.61)	(-11.06)	(-16.91)	(-3.71)			(-4.30)
39. Oil (West Texas I)	-7.13	0.32	-1.13	-2.90	-10.97	0.81	114.07	-0.25
	(-6.53)	(1.97)	(-4.96)	(-6.79)	(-5.26)			(-3.91)

Table 3. Regressions of the Level of the Logarithm of the Dollar Price of Commodities on the Set of Independent Variables (Continued)

(Long-run equilibrium reduced form equation, or cointegration regressions)

	Independent Variables					Adjusted	Cointegration Test (U = U{-1} +E)	
Dependent Variables	Constant	DM	Y	Q	R	R square	F-test	U {-1}
40. Palm kernel oil	-4.18 (-2.42)	0.32 (0.92)	-1.18 (-3.20)	0.67 (3.61)	-12.99 (-3.28)	0.27	23.17	-0.07 (-2.96)
41. Phosphoric acid	-2.59 (-2.78)	0.21 (1.11)	-0.73 (-3.68)	1.03 (6.74)	-1.09 (-0.40)	0.36	31.33	-0.03 (-1.84)
42. Phosphate rock	-9.00 (-7.16)	1.39 (5.54)	-1.75 (-6.54)	-0.31 (-2.28)	-4.85 (-1.68)	0.17	13.29	-0.06 (-2.75)
43. Rapeseed oil	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00	0.00	-0.07 (-2.99)
44. Rice (Thailand)	-4.43 (-3.57)	1.17 (4.75)	-1.23 (-4.66)	0.83 (6.23)	-3.20 (-1.13)	0.43	46.71	-0.03 (-2.25)
45. Rice (Long grain)	-4.67 (-4.07)	0.52 (2.28)	-1.23 (-5.02)	1.07 (8.72)	-2.58 (-0.98)	0.51	64.69	-0.04 (-2.47)
46. Rubber	-2.68 (-2.80)	0.66 (3.49)	-0.46 (-2.28)	0.16 (1.55)	-7.39 (-3.38)	0.21	16.79	-0.07 (-3.00)
47. Shrimp	-4.95 (-7.53)	0.30 (2.27)	-0.43 (-3.05)	-0.23 (-3.34)	-1.67 (-1.10)	0.04	3.53	-0.06 (-2.55)
48. Silver	-8.35 (-5.59)	1.45 (4.87)	-2.20 (-6.90)	-1.14 (-7.13)	-11.07 (-3.23)	0.22	17.79	-0.08 (-3.20)
49. Soybean	-2.35 (-2.89)	0.36 (2.21)	-0.69 (-3.98)	0.87 (10.00)	-6.90 (-3.70)	0.59	85.92	-0.09 (-3.62)
50. Soybean meal	-1.17 (-1.30)	0.39 (2.16)	-0.43 (-2.26)	0.98 (10.16)	-5.48 (-2.66)	0.55	73.18	-0.10 (-3.69)
51. Soybeans oil	-6.26 (-5.26)	0.73 (3.10)	-1.61 (-6.37)	0.71 (5.58)	-7.11 (-2.61)	0.47	53.43	-0.07 (-3.06)
52. Sorghum	-10.14 (-12.46)	0.63 (3.87)	-1.45 (-8.36)	0.58 (6.63)	-4.10 (-2.20)	0.56	78.79	-0.07 (-3.19)
53. Steel	2.78 (4.79)	0.42 (3.63)	0.21 (1.71)	0.41 (6.52)	-2.23 (-1.67)	0.46	51.59	-0.07 (-3.05)
54. Sugar (US import)	-4.23 (-3.97)	0.44 (2.09)	-0.58 (-2.57)	0.12 (1.07)	-3.35 (-1.37)	0.08	6.11	-0.05 (-2.44)
55. Sugar (EU import)	-3.88 (-9.21)	1.38 (16.43)	-0.64 (-7.18)	-0.43 (-9.61)	-0.04 (-0.04)	0.63	104.43	-0.25 (-5.82)
56. Sunflower oil	-7.70 (-6.57)	0.85 (3.63)	-1.92 (-7.69)	0.87 (6.96)	-5.64 (-2.10)	0.55	74.94	-0.06 (-3.01)
57. Tea	-4.26 (-4.67)	0.36 (1.96)	-1.01 (-5.19)	0.27 (2.73)	-2.80 (-1.34)	0.27	23.44	-0.08 (-3.15)
58. Tin	-9.39 (-6.76)	0.97 (3.51)	-2.23 (-7.52)	-0.23 (-1.54)	-6.61 (-2.08)	0.27	23.02	-0.05 (-2.45)
59. Tobacco	-1.21 (-6.53)	-0.09 (-2.48)	-0.32 (-8.00)	0.19 (9.74)	1.07 (2.52)	0.68	131.22	-0.19 (-4.99)

Table 3. Regressions of the Level of the Logarithm of the Dollar Price of Commodities on the Set of Independent Variables (Concluded)

(Long-run equilibrium reduced form equation, or cointegration regressions)

	Independent Variables						Cointegration Test (U = U{-1} +E)	
Dependent Variables	Constant	DM	Y	Q	R	Adjusted R square	F-test	U {-1}
60. Triple Super Phosphates	-4.21	0.80	-0.99	0.63	-3.97	0.30	26.66	-0.04
	(-3.30)	(3.16)	(-3.63)	(4.61)	(-1.36)			(-2.24)
61. Urea	-7.87	1.28	-1.77	0.29	-5.50	0.26	22.11	-0.05
	(-5.40)	(4.41)	(-5.70)	(1.83)	(-1.65)			(-2.66)
62. Wheat	-8.28	0.46	-1.04	0.64	-4.31	0.44	48.84	-0.05
	(-8.87)	(2.49)	(-5.21)	(6.36)	(-2.01)			(-2.91)
63. Wool (Coarse)	0.96	0.20	-0.09	0.93	-4.82	0.55	74.25	-0.05
	(1.22)	(1.28)	(-0.56)	(11.03)	(-2.67)			(-2.48)
64. Wool (Fine)	6.47	-0.39	0.94	0.93	-4.74	0.43	46.84	-0.07
	(7.49)	(-2.28)	(5.08)	(10.05)	(-2.39)			(-3.03)
65. Zinc	5.16	-0.06	0.56	0.85	-1.90	0.29	25.72	-0.04
	(4.81)	(-0.30)	(2.46)	(7.36)	(-0.77)			(-2.24)

Table 4. Estimates of the Error-Correction Reduced Form Equation of Commodity Price, 1972:1-1992:1

Dependent Variables	Independent Variables											Adjusted R square	F-test
	Constant	Dep. Vbl. Lagged	D DM	D DM{-1}	D Y	D Y{-1}	D Q	D Q{-1}	D R	D R{-1}	U{-1}		
1. Aluminum	-0.00	0.14	0.05	0.16	-0.03	0.02	0.53	-0.30	-0.32	-0.17	-0.05	0.03	1.76
	(-0.35)	(2.13)	(0.34)	(1.14)	(-0.23)	(0.12)	(1.28)	(-0.72)	(-0.57)	(-0.37)	(-2.61)		
2. Ammoniac	-0.01	0.33	-0.19	-0.32	0.29	0.58	-0.48	-0.27	0.24	-1.23	-0.13	0.14	3.25
	(-0.94)	(4.07)	(-0.77)	(-1.26)	(1.10)	(2.16)	(-0.63)	(-0.35)	(0.19)	(-1.06)	(-3.55)		
3. Banana *	0.01	0.14	-0.41	0.33	-0.30	-0.27	1.50	0.59	0.98	0.25	-0.41	0.21	7.53
	(0.90)	(2.15)	(-1.44)	(1.13)	(-0.95)	(-0.86)	(1.76)	(0.69)	(0.86)	(0.27)	(-7.55)		
4. Beef	0.00	0.33	0.25	0.08	-0.29	-0.04	0.61	0.33	-1.40	-0.15	-0.05	0.23	8.26
	(0.44)	(5.42)	(2.53)	(0.77)	(-2.74)	(-0.32)	(2.08)	(1.13)	(-3.58)	(-0.44)	(-2.74)		
5. Butter (London)	-0.00	-0.04	0.48	0.04	0.02	0.33	-0.57	0.53	0.96	0.45	-0.10	0.13	4.51
	(-0.54)	(-0.57)	(3.17)	(0.24)	(0.14)	(1.97)	(-1.27)	(1.15)	(1.58)	(0.90)	(-3.46)		
6. Butter (New Zealand)	-0.01	-0.27	-0.09	-0.08	0.52	0.40	-0.69	-0.19	1.68	-1.15	-0.13	0.20	6.83
	(-0.94)	(-4.16)	(-0.36)	(-0.30)	(1.79)	(1.36)	(-0.88)	(-0.24)	(1.60)	(-1.31)	(-3.12)		
7. Coal	-0.00	-0.31	0.01	0.09	0.01	-0.09	-0.44	-0.08	0.80	0.64	-0.03	0.09	3.49
	(-0.21)	(-4.87)	(0.05)	(0.67)	(0.04)	(-0.58)	(-1.09)	(-0.19)	(1.48)	(1.46)	(-1.48)		
8. Cocoa	-0.00	0.29	0.18	0.26	0.05	0.08	0.56	-0.31	0.88	0.74	-0.02	0.14	5.02
	(-0.24)	(4.70)	(1.13)	(1.65)	(0.28)	(0.46)	(1.19)	(-0.66)	(1.40)	(1.43)	(-2.11)		
9. Coconut oil *	0.00	0.37	-0.20	-0.24	0.20	0.07	-0.54	0.84	0.17	0.85	-0.03	0.13	4.57
	(0.09)	(5.93)	(-0.99)	(-1.15)	(0.87)	(0.32)	(-0.85)	(1.32)	(0.21)	(1.20)	(-2.12)		
10. Coffee (Colombia) **	-0.00	0.35	-0.02	0.00	-0.16	-0.06	-0.72	0.91	1.53	-0.02	-0.03	0.10	3.30
	(-0.37)	(5.13)	(-0.13)	(0.00)	(-0.77)	(-0.30)	(-1.32)	(1.66)	(2.11)	(-0.04)	(-1.92)		
11. Coffee (Arabica) **	-0.00	0.20	-0.04	-0.03	-0.12	0.27	-0.38	0.22	0.85	0.02	-0.03	0.02	1.49
	(-0.54)	(3.14)	(-0.18)	(-0.12)	(-0.53)	(1.15)	(-0.60)	(0.34)	(1.00)	(0.02)	(-2.03)		
12. Coffee (Other milds) **	0.00	0.36	-0.08	0.09	-0.06	0.03	0.01	0.82	0.67	0.16	-0.03	0.11	4.08
	(0.10)	(5.79)	(-0.48)	(0.49)	(-0.33)	(0.18)	(0.02)	(1.57)	(0.96)	(0.28)	(-2.23)		
13. Coffee (Robusta) **	-0.00	0.36	-0.00	0.13	-0.01	-0.05	-0.19	0.70	0.79	-0.05	-0.02	0.11	3.92
	(-0.28)	(5.79)	(-0.02)	(0.83)	(-0.06)	(-0.28)	(-0.39)	(1.44)	(1.22)	(-0.10)	(-1.74)		
14. Copper	-0.00	0.33	0.38	0.31	0.05	0.04	0.16	0.40	-0.05	-0.16	-0.06	0.25	8.83
	(-0.22)	(5.57)	(2.76)	(2.19)	(0.32)	(0.27)	(0.39)	(0.96)	(-0.10)	(-0.35)	(-2.90)		
15. Copra *	0.00	-0.26	-0.24	-0.33	-0.49	-0.47	-0.26	-0.34	0.36	0.51	0.10	0.08	3.02
	(0.15)	(-2.01)	(-0.56)	(-0.75)	(-1.01)	(-0.97)	(-0.20)	(-0.25)	(0.20)	(0.33)	(3.38)		
16. Cotton (Industrial) *	-0.00	0.59	0.09	-0.05	-0.12	0.08	-0.02	-0.19	0.29	-0.31	-0.05	0.35	14.15
	(-0.63)	(11.04)	(0.88)	(-0.48)	(-1.13)	(0.70)	(-0.07)	(-0.65)	(0.73)	(-0.94)	(-3.86)		
17. Cotton (Long-staple)	0.00	0.12	0.12	-0.03	-0.09	0.05	0.23	0.08	0.78	1.55	-0.05	0.09	3.29
	(0.27)	(1.91)	(0.96)	(-0.24)	(-0.65)	(0.38)	(0.60)	(0.22)	(1.56)	(3.76)	(-2.92)		
18. Diammonium phosphate *	-0.01	0.21	-0.07	0.13	-0.07	0.26	-0.57	-1.08	1.34	0.67	-0.07	0.11	3.89
	(-1.26)	(3.41)	(-0.45)	(0.81)	(-0.39)	(1.45)	(-1.13)	(-2.09)	(2.02)	(1.19)	(-3.71)		

Table 4. Estimates of the Error-Correction Reduced Form Equation of Commodity Price, 1972:1-1992:1 (Continued)

Dependent Variables	Independent Variables											Adjusted R square	F-test
	Constant	Dep. Vbl. Lagged	D DM	D DM{-1}	D Y	D Y{-1}	D Q	D Q{-1}	D R	D R{-1}	U{-1}		
19. Fish *	0.00	0.24	0.10	-0.09	0.12	0.19	0.64	0.87	0.39	0.11	-0.07	0.14	4.81
	(0.71)	(3.81)	(0.56)	(-0.50)	(0.61)	(1.00)	(1.24)	(1.67)	(0.56)	(0.18)	(-3.60)		
20. Gasoline	-0.00	0.17	-0.10	-0.36	-0.34	-0.22	-1.95	0.45	-3.87	0.70	-0.14	0.24	5.95
	(-0.64)	(2.22)	(-0.45)	(-1.49)	(-1.40)	(-0.87)	(-2.65)	(0.58)	(-3.17)	(0.61)	(-3.84)		
21. Gold	-0.00	0.26	0.37	-0.00	0.23	0.31	-1.06	-0.29	-0.15	-0.53	-0.05	0.21	7.42
	(-0.49)	(4.07)	(2.78)	(-0.03)	(1.54)	(2.17)	(-2.65)	(-0.72)	(-0.29)	(-1.21)	(-2.60)		
22. Groundnuts *	-0.00	0.41	0.00	-0.33	-0.12	0.71	-1.38	0.35	-0.61	-0.29	-0.13	0.20	4.61
	(-0.29)	(5.19)	(0.01)	(-0.96)	(-0.33)	(2.01)	(-1.38)	(0.34)	(-0.36)	(-0.19)	(-3.88)		
23. Groundnut meal *	-0.00	0.24	0.08	0.10	0.05	-0.08	0.59	-0.22	-0.41	0.02	-0.07	0.07	2.66
	(-0.28)	(3.66)	(0.39)	(0.46)	(0.22)	(-0.35)	(0.95)	(-0.34)	(-0.49)	(0.02)	(-3.30)		
24. Groundnut oil	-0.00	0.29	-0.46	-0.03	0.11	0.02	0.07	-0.20	-0.66	0.06	-0.05	0.12	4.26
	(-0.43)	(4.66)	(-2.77)	(-0.20)	(0.62)	(0.12)	(0.13)	(-0.39)	(-0.98)	(0.11)	(-2.73)		
25. Hide	0.01	0.10	-0.07	0.06	-0.09	-0.18	2.15	1.15	-1.01	-1.29	-0.13	0.11	3.83
	(1.62)	(1.53)	(-0.33)	(0.27)	(-0.36)	(-0.77)	(3.29)	(1.73)	(-1.16)	(-1.81)	(-4.77)		
26. Iron ore	-0.00	0.01	0.13	-0.07	-0.11	0.07	0.08	-0.29	-0.39	-0.27	-0.07	0.02	1.59
	(-0.14)	(0.22)	(1.51)	(-0.76)	(-1.17)	(0.67)	(0.30)	(-1.08)	(-1.11)	(-0.92)	(-3.28)		
27. Lamb	-0.00	0.17	0.25	0.13	-0.02	0.18	-0.18	0.30	1.10	0.14	-0.06	0.14	4.95
	(-0.32)	(2.67)	(2.32)	(1.11)	(-0.14)	(1.52)	(-0.56)	(0.91)	(2.51)	(0.40)	(-2.73)		
28. Lead	-0.00	0.21	0.33	0.10	-0.23	0.01	-0.03	0.38	0.59	-0.21	-0.04	0.06	2.44
	(-0.12)	(3.26)	(2.01)	(0.60)	(-1.23)	(0.05)	(-0.06)	(0.75)	(0.88)	(-0.38)	(-2.13)		
29. Log	0.00	0.30	0.06	-0.09	0.55	0.29	-0.27	0.05	0.07	-0.13	-0.09	0.21	7.14
	(-0.00)	(4.80)	(0.47)	(-0.68)	(3.64)	(1.87)	(-0.65)	(0.12)	(0.13)	(-0.28)	(-3.90)		
30. Linseed oil	-0.00	0.32	-0.33	0.02	0.12	-0.23	-0.30	-0.93	-0.92	1.28	-0.05	0.14	4.81
	(-0.71)	(5.24)	(-1.76)	(0.13)	(0.55)	(-1.07)	(-0.51)	(-1.58)	(-1.20)	(2.00)	(-3.36)		
31. Maize	-0.00	0.33	-0.00	-0.11	-0.30	-0.05	-0.45	-0.07	-0.72	0.40	-0.06	0.17	6.03
	(-0.39)	(5.45)	(-0.01)	(-0.91)	(-2.28)	(-0.41)	(-1.24)	(-0.20)	(-1.51)	(1.00)	(-4.00)		
32. Manganese	0.00	0.31	0.17	-0.02	-0.06	-0.01	-0.36	0.60	0.95	-0.04	-0.02	0.08	3.08
	(0.87)	(4.75)	(1.68)	(-0.15)	(-0.53)	(-0.13)	(-1.17)	(1.93)	(2.26)	(-0.12)	(-1.39)		
33. Natural gas	-0.01	0.01	-0.36	-0.10	0.37	0.05	1.58	0.45	-0.64	-1.51	-0.11	0.05	1.42
	(-0.72)	(0.10)	(-1.07)	(-0.28)	(0.95)	(0.13)	(1.73)	(0.44)	(-0.43)	(-1.09)	(-3.09)		
34. Nickel	0.00	0.36	-0.00	-0.00	-0.13	0.11	0.54	0.06	0.62	0.44	-0.06	0.15	5.29
	(0.28)	(5.90)	(-0.03)	(-0.00)	(-0.77)	(0.65)	(1.17)	(0.14)	(1.00)	(0.85)	(-3.51)		
35. Oil (average)	-0.00	0.13	0.21	-0.53	-0.57	0.64	-1.76	-1.20	-2.15	-0.85	-0.10	0.12	4.39
	(-0.57)	(1.99)	(0.80)	(-2.02)	(-1.99)	(2.21)	(-2.21)	(-1.51)	(-2.08)	(-0.96)	(-3.65)		
36. Oil (Alaska)	-0.00	0.11	0.19	-0.61	-0.57	0.70	-1.72	-1.34	-2.39	-0.74	-0.11	0.12	4.30
	(-0.49)	(1.72)	(0.71)	(-2.21)	(-1.89)	(2.29)	(-2.04)	(-1.60)	(-2.18)	(-0.78)	(-3.69)		
37. Oil (Dubai)	-0.01	0.10	0.21	-0.58	-0.61	0.63	-2.10	-1.40	-2.36	-0.97	-0.10	0.13	4.56
	(-0.66)	(1.59)	(0.76)	(-2.05)	(-1.98)	(2.02)	(-2.45)	(-1.63)	(-2.12)	(-1.01)	(-3.69)		
38. Oil (U.K. Brent)	-0.00	0.16	0.22	-0.41	-0.54	0.59	-1.48	-1.04	-1.88	-0.98	-0.10	0.12	4.18
	(-0.54)	(2.41)	(0.92)	(-1.66)	(-2.02)	(2.17)	(-1.97)	(-1.39)	(-1.94)	(-1.17)	(-3.63)		

Table 4. Estimates of the Error-Correction Reduced Form Equation of Commodity Price, 1972:1-1992:1 (Continued)

Dependent Variables	Independent Variables											Adjusted R square	F-test
	Constant	Dep. Vbl. Lagged	D DM	D DM{-1}	D Y	D Y{-1}	D Q	D Q{-1}	D R	D R{-1}	U{-1}		
39. Oil (West Texas I)	-0.00	0.32	0.18	-0.24	-0.40	0.35	-2.12	0.38	-5.65	0.08	-0.25	0.46	10.00
	(-0.07)	(3.20)	(0.72)	(-0.91)	(-1.29)	(1.09)	(-2.61)	(0.45)	(-4.62)	(0.06)	(-4.19)		
40. Palm kernel oil	0.00	0.34	0.05	-0.44	0.06	0.33	-0.50	1.06	0.38	0.93	-0.03	0.12	4.38
	(0.26)	(5.57)	(0.22)	(-2.06)	(0.27)	(1.39)	(-0.77)	(1.62)	(0.45)	(1.28)	(-2.09)		
41. Phosphoric acid **	-0.00	0.18	-0.33	-0.14	0.21	0.19	-0.78	0.02	1.43	0.02	-0.05	0.07	2.57
	(-1.30)	(2.49)	(-2.50)	(-1.04)	(1.45)	(1.31)	(-1.97)	(0.04)	(2.24)	(0.03)	(-2.73)		
42. Phosphate rock	-0.01	-0.06	0.04	-0.57	-0.30	0.68	-1.00	-1.99	-1.56	-0.35	-0.05	0.13	4.65
	(-1.13)	(-0.95)	(0.22)	(-2.88)	(-1.39)	(3.10)	(-1.68)	(-3.30)	(-1.99)	(-0.53)	(-3.13)		
43. Rapeseed oil	-0.00	0.30	-0.57	-0.27	1.55	-0.17	-1.14	-0.32	8.51	-1.49	-0.06	0.59	35.00
	(-0.54)	(4.94)	(-2.99)	(-1.38)	(7.29)	(-0.72)	(-1.93)	(-0.53)	(11.00)	(-1.82)	(-3.73)		
44. Rice (Thailand)	-0.00	0.41	-0.08	-0.15	0.21	0.05	-0.53	-0.44	0.56	0.14	-0.04	0.24	8.67
	(-1.09)	(7.11)	(-0.79)	(-1.38)	(1.76)	(0.45)	(-1.62)	(-1.34)	(1.32)	(0.39)	(-4.22)		
45. Rice (Long grain) *	-0.00	0.51	-0.07	-0.17	-0.11	0.17	-0.15	-0.38	0.39	0.05	-0.05	0.28	10.09
	(-0.59)	(8.86)	(-0.54)	(-1.32)	(-0.76)	(1.17)	(-0.39)	(-0.96)	(0.76)	(0.11)	(-4.21)		
46. Rubber	0.00	0.27	0.00	0.26	0.10	0.02	0.37	0.39	-0.00	-0.78	-0.03	0.13	4.45
	(0.23)	(4.36)	(0.02)	(2.05)	(0.69)	(0.18)	(0.96)	(1.02)	(-0.01)	(-1.82)	(-1.70)		
47. Shrimp *	0.00	0.37	0.04	0.07	-0.00	0.05	0.80	-0.16	-0.69	-0.48	-0.08	0.16	5.59
	(0.27)	(6.14)	(0.36)	(0.59)	(-0.03)	(0.41)	(2.21)	(-0.43)	(-1.43)	(-1.21)	(-3.74)		
48. Silver	-0.00	0.29	0.02	0.19	0.39	-0.01	0.07	-1.14	-1.69	-0.44	-0.04	0.10	3.58
	(-0.54)	(4.48)	(0.09)	(0.81)	(1.56)	(-0.03)	(0.10)	(-1.70)	(-1.90)	(-0.58)	(-2.46)		
49. Soybean *	-0.00	0.39	-0.01	-0.38	-0.15	0.12	-0.16	-0.68	-2.72	0.31	-0.10	0.28	10.17
	(-0.60)	(6.69)	(-0.05)	(-2.67)	(-0.95)	(0.77)	(-0.37)	(-1.59)	(-4.81)	(0.63)	(-5.17)		
50. Soybean meal *	-0.00	0.38	0.29	-0.06	-0.15	-0.02	0.05	0.13	0.52	0.81	-0.10	0.16	5.68
	(-0.08)	(6.03)	(1.56)	(-0.33)	(-0.71)	(-0.12)	(0.09)	(0.24)	(0.67)	(1.26)	(-4.51)		
51. Soybean oil	-0.00	0.29	-0.05	-0.08	-0.08	-0.14	-0.49	-0.51	-0.01	1.11	-0.06	0.11	3.89
	(-0.73)	(4.66)	(-0.33)	(-0.47)	(-0.43)	(-0.75)	(-0.96)	(-1.00)	(-0.02)	(1.95)	(-3.75)		
52. Sorghum	-0.00	0.23	-0.04	-0.18	-0.27	0.19	-0.59	0.01	-0.41	0.41	-0.08	0.11	3.88
	(-0.53)	(3.58)	(-0.33)	(-1.29)	(-1.84)	(1.23)	(-1.45)	(0.02)	(-0.75)	(0.90)	(-3.90)		
53. Steel	0.00	0.18	0.11	-0.09	-0.06	0.08	0.44	-0.12	0.59	0.17	-0.08	0.11	3.98
	(0.38)	(2.77)	(1.10)	(-0.86)	(-0.54)	(0.70)	(1.42)	(-0.38)	(1.46)	(0.51)	(-3.69)		
54. Sugar (U.S. import) *	-0.01	0.24	0.08	0.07	0.05	-0.06	-1.09	-0.69	-0.50	-0.50	-0.07	0.11	3.81
	(-1.03)	(3.73)	(0.44)	(0.41)	(0.28)	(-0.31)	(-2.01)	(-1.26)	(-0.70)	(-0.84)	(-3.67)		
55. Sugar (EU import)	-0.00	-0.26	0.58	0.07	-0.14	0.30	-0.62	-1.06	0.49	1.08	-0.17	0.23	8.06
	(-0.77)	(-4.21)	(3.73)	(0.46)	(-0.79)	(1.76)	(-1.32)	(-2.24)	(0.78)	(2.10)	(-4.15)		
56. Sunflower oil	-0.00	0.25	-0.27	0.06	0.12	-0.20	-0.35	-0.39	0.12	1.30	-0.05	0.08	3.00
	(-0.80)	(3.90)	(-1.66)	(0.35)	(0.65)	(-1.07)	(-0.69)	(-0.76)	(0.17)	(2.31)	(-2.97)		
57. Tea	-0.00	0.28	0.17	-0.03	0.23	0.21	-0.39	0.24	0.44	0.32	-0.07	0.11	3.85
	(-0.63)	(4.30)	(0.91)	(-0.18)	(1.12)	(1.02)	(-0.70)	(0.43)	(0.59)	(0.52)	(-3.27)		
58. Tin	-0.00	0.27	0.15	0.05	0.14	-0.04	0.67	-1.19	-0.29	-0.22	-0.01	0.11	3.84
	(-1.05)	(4.29)	(1.22)	(0.43)	(1.04)	(-0.32)	(1.79)	(-3.16)	(-0.58)	(-0.54)	(-0.91)		

Table 4. Estimates of the Error-Correction Reduced Form Equation of Commodity Price, 1972:1-1992:1 (Concluded)

Dependent Variables	Independent Variables											Adjusted R square	F-test
	Constant	Dep. Vbl. Lagged	D DM	D DM{-1}	D Y	D Y{-1}	D Q	D Q{-1}	D R	D R{-1}	U{-1}		
59. Tobacco	-0.00	0.05	0.03	-0.07	0.04	0.01	0.43	-0.18	0.34	-0.12	-0.17	0.18	6.27
	(-0.19)	(0.77)	(0.56)	(-1.25)	(0.62)	(0.08)	(2.46)	(-1.03)	(1.46)	(-0.59)	(-4.67)		
60. Triple Super Phosphates	-0.01	0.29	-0.02	0.04	-0.03	0.31	-0.73	-0.87	1.70	0.52	-0.05	0.17	5.81
	(-1.42)	(4.85)	(-0.13)	(0.30)	(-0.17)	(1.91)	(-1.59)	(-1.85)	(2.85)	(1.03)	(-3.60)		
61. Urea	-0.01	0.11	0.08	-0.13	-0.40	0.52	-1.20	-1.40	0.84	0.09	-0.06	0.11	3.81
	(-1.26)	(1.83)	(0.42)	(-0.70)	(-1.91)	(2.50)	(-2.06)	(-2.33)	(1.12)	(0.13)	(-3.89)		
62. Wheat	-0.00	0.40	-0.30	-0.02	0.17	0.05	-0.22	0.02	-1.30	0.75	-0.05	0.24	8.46
	(-0.16)	(6.76)	(-2.53)	(-0.17)	(1.26)	(0.36)	(-0.61)	(0.05)	(-2.70)	(1.82)	(-3.40)		
63. Wool (Coarse)	0.00	0.08	0.13	0.02	0.13	0.09	0.82	0.67	-0.63	-0.64	-0.02	0.10	3.56
	(0.28)	(1.28)	(1.14)	(0.20)	(1.02)	(0.75)	(2.36)	(1.90)	(-1.36)	(-1.65)	(-1.42)		
64. Wool (Fine)	0.00	0.12	0.04	0.06	0.21	-0.00	0.15	0.52	-1.15	-0.91	-0.06	0.07	2.77
	(0.17)	(1.92)	(0.24)	(0.40)	(1.24)	(-0.01)	(0.33)	(1.11)	(-1.86)	(-1.75)	(-2.91)		
65. Zinc	0.00	-0.02	0.16	0.26	0.01	0.05	0.92	1.00	0.85	-0.31	0.08	0.09	3.28
	(0.86)	(-0.26)	(1.01)	(1.58)	(0.04)	(0.29)	(1.89)	(2.04)	(1.32)	(-0.56)	(3.89)		

Note: * Stationary in levels.
** Not cointegrated.

Table 5. Speed of Adjustment and Short- and Long-Run Elasticities

Commodities	Short-run First Diff. Regression	Short-run ECM Regression	Speed of Adjustment	Long-run First Diff. Regression	Long-run Cointegration Regression
1. Aluminum			-0.06		
DM	0.07	0.05		0.47	0.61
Y	-0.05	-0.03		0.01	0.19
R	-0.37	-0.32		-1.11	-5.15
2. Ammoniac			-0.14		
DM	-0.01	-0.19		-0.16	-0.11
Y	0.29	0.29		0.89	-1.13
R	0.29	0.24		-1.99	-4.84
3. Banana *			-0.34		
DM	-0.15	-0.41		0.79	0.41
Y	-0.26	-0.30		-0.42	-0.14
R	1.37	0.98		2.67	1.21
4. Beef			-0.05		
DM	0.27	0.25		0.51	0.32
Y	-0.29	-0.29		-0.46	-0.34
R	-1.38	-1.40		-2.24	-3.50
5. Butter (London)			-0.11		
DM	0.46	0.48		0.53	1.09
Y	0.06	0.02		0.47	-0.57
R	1.14	0.96		2.09	0.03
6. Butter (New Zealand)			-0.24		
DM	-0.05	-0.09		-0.05	0.36
Y	0.64	0.52		0.83	-0.78
R	1.50	1.68		-0.43	1.10
7. Coal			-0.07		
DM	-0.02	0.01		0.10	1.32
Y	0.02	0.01		-0.06	-1.84
R	1.06	0.80		1.68	-1.11
8. Cocoa			-0.04		
DM	0.18	0.18		0.58	1.11
Y	0.05	0.05		0.11	-1.64
R	0.87	0.88		1.84	-6.81
9. Coconut oil *			-0.06		
DM	-0.18	-0.20		-0.75	-0.13
Y	0.24	0.20		0.71	-0.87
R	0.22	0.17		1.37	-12.30
10. Coffee (Colombia) **			-0.02		
DM	-0.05	-0.02		-0.06	0.60
Y	-0.15	-0.16		-0.39	-1.19
R	1.69	1.53		2.71	-3.63
11. Coffee (Arabica) **			-0.03		
DM	0.00	-0.04		0.06	0.56
Y	-0.16	-0.12		0.19	-1.42
R	1.09	0.85		1.63	-3.90
12. Coffee (Other milds) **			-0.03		
DM	-0.08	-0.08		0.03	0.40
Y	-0.08	-0.06		-0.10	-0.92
R	0.75	0.67		1.44	-4.47

Table 5. Speed of Adjustment and Short- and Long-Run Elasticities (Continued)

Commodities	Short-run First Diff. Regression	Short-run ECM Regression	Short-run Speed of Adjustment	Long-run First Diff. Regression	Long-run Cointegration Regression
13. Coffee (Robusta) **			-0.27		
DM	0.00	-0.00		0.23	0.48
Y	-0.02	-0.01		-0.19	-1.47
R	0.74	0.79		0.92	-6.98
14. Copper			-0.06		
DM	0.43	0.38		1.03	0.63
Y	0.06	0.05		0.16	0.09
R	-0.24	-0.05		-1.05	-3.44
15. Copra *			-0.09		
DM	-0.16	-0.24		-0.42	0.02
Y	0.18	-0.49		0.32	-0.81
R	0.09	0.36		2.16	-13.05
16. Cotton (Industrial) *			-0.06		
DM	0.12	0.09		0.19	0.98
Y	-0.10	-0.12		-0.12	-1.33
R	0.41	0.29		0.32	-3.89
17. Cotton (Long-staple)			-0.05		
DM	0.13	0.12		0.13	0.53
Y	-0.12	-0.09		-0.09	0.27
R	0.63	0.78		1.67	-0.71
18. Diammonium phosphate *			-0.05		
DM	-0.06	-0.07		0.14	0.78
Y	-0.02	-0.07		0.24	-1.13
R	1.27	1.34		1.72	-3.60
19. Fish *			-0.08		
DM	0.17	0.10		0.25	0.36
Y	0.09	0.12		0.25	-0.09
R	0.26	0.39		-0.01	-4.30
20. Gasoline			-0.15		
DM	-0.06	-0.10		-0.20	1.38
Y	-0.25	-0.34		-0.81	-2.82
R	-3.93	-3.87		-5.05	-7.62
21. Gold			-0.06		
DM	0.40	0.37		0.57	0.55
Y	0.22	0.23		0.63	-0.05
R	-0.12	-0.15		-0.97	-4.34
22. Groundnuts			-0.09		
DM	0.22	0.00		0.28	0.92
Y	-0.21	-0.12		0.58	-0.12
R	-1.20	-0.61		-3.62	-2.70
23. Groundnut meal			-0.08		
DM	0.11	0.08		0.39	0.72
Y	0.08	0.05		-0.09	-1.05
R	-0.44	-0.41		-0.85	-5.50
24. Groundnut oil			-0.05		
DM	-0.49	-0.46		-0.66	0.57
Y	0.18	0.11		0.25	-1.14
R	-0.74	-0.66		-1.28	-4.32

Table 5. Speed of Adjustment and Short- and Long-Run Elasticities (Continued)

Commodities	Short-run First Diff. Regression	Short-run ECM Regression	Short-run Speed of Adjustment	Long-run First Diff. Regression	Long-run Cointegration Regression
25. Hide			-0.10		
DM	-0.09	-0.07		-0.08	-0.33
Y	-0.11	-0.09		-0.11	1.51
R	-0.86	-1.01		-2.01	-2.04
26. Iron ore			-0.09		
DM	0.11	0.13		0.09	0.86
Y	-0.08	-0.11		-0.06	-1.10
R	-0.33	-0.39		-0.47	-0.15
27. Lamb			-0.07		
DM	0.27	0.25		0.54	0.94
Y	0.01	-0.02		0.20	-0.68
R	1.08	1.10		1.27	-0.66
28. Lead			-0.08		
DM	0.29	0.33		0.57	2.15
Y	-0.15	-0.23		-0.16	-1.51
R	0.55	0.59		0.02	-5.38
29. Log			-0.09		
DM	0.03	0.06		-0.06	0.38
Y	0.60	0.55		1.11	0.57
R	0.24	0.07		0.37	-3.27
30. Linseed oil			-0.04		
DM	-0.36	-0.33		-0.42	0.90
Y	0.21	0.12		0.05	-1.52
R	-1.00	-0.92		-0.30	-4.98
31. Maize			-0.07		
DM	0.04	-0.00		0.01	0.44
Y	-0.28	-0.30		-0.50	-1.30
R	-0.66	-0.72		-0.60	-4.57
32. Manganese			-0.03		
DM	0.15	0.17		0.20	1.76
Y	-0.04	-0.06		-0.10	-1.23
R	0.91	0.95		1.11	1.71
33. Natural gas			-0.10		
DM	-0.33	-0.36		-0.50	-0.83
Y	0.23	0.37		-0.00	0.19
R	-0.78	-0.64		-0.97	8.39
34. Nickel			-0.04		
DM	0.02	-0.00		0.12	0.42
Y	-0.10	-0.13		0.06	0.50
R	0.56	0.62		1.07	-2.02
35. Oil (average)			-0.15		
DM	0.16	0.21		-0.32	1.61
Y	-0.42	-0.57		0.11	-2.52
R	-2.43	-2.15		-5.25	-10.03
36. Oil (Alaska)			-0.16		
DM	0.14	0.19		-0.50	1.44
Y	-0.42	-0.57		0.23	-2.23
R	-2.80	-2.39		-5.74	-10.22

Table 5. Speed of Adjustment and Short- and Long-Run Elasticities (Continued)

	Short-run			Long-run	
Commodities	First Diff. Regression	ECM Regression	Speed of Adjustment	First Diff. Regression	Cointegration Regression
37. Oil (Dubai)			-0.15		
DM	0.17	0.21		-0.38	1.75
Y	-0.46	-0.61		0.05	-2.79
R	-2.75	-2.36		-6.15	-11.05
38. Oil (U.K. Brent)			-0.14		
DM	0.17	0.22		0.29	1.65-0.22
Y	-0.36	-0.54		-0.45	-2.56 0.05
R	-3.30	-1.88		-5.57	-9.24-3.39
39. Oil ((West Texas I)			-0.25		
DM	0.24	0.18		0.13	0.32-0.08
Y	-0.46	-0.40		-0.51	-1.13-0.07
R	-6.26	-5.65		-11.50	-10.97-8.20
40. Palm kernel oil			-0.07		
DM	0.06	0.05		-0.57	0.32-0.60
Y	0.12	0.06		0.77	-1.18 0.59
R	0.40	0.38		1.54	-12.99 2.00
41. Phosphoric acid **			-0.03		
DM	-0.32	-0.33		-0.52	0.21-0.58
Y	0.25	0.21		0.58	-0.73 0.49
R	1.42	1.43		1.58	-1.09 1.76
42. Phosphate rock			-0.06		
DM	0.02	0.04		-0.58	1.39-0.50
Y	-0.20	-0.30		0.53	-1.75 0.35
R	-1.92	-1.56		-3.22	-4.85-1.80
43. Rapeseed oil			-0.07		
DM	-0.15	-0.57		-0.15	0.00-1.21
Y	-0.17	1.55		-0.24	0.00 1.98
R	-0.06	8.51		-0.70	0.0010.06
44. Rice (Thailand)			-0.03		
DM	-0.06	-0.08		-0.23	1.17-0.40
Y	0.24	0.21		0.45	-1.23 0.44
R	0.44	0.56		0.34	-3.20 1.19
45. Rice (Long grain) *			-0.04		
DM	-0.03	-0.07		-0.21	0.52-0.49
Y	-0.09	-0.11		-0.02	-1.23 0.12
R	0.18	0.39		-0.23	-2.58 0.89
46. Rubber			-0.07		
DM	0.02	0.00		0.43	0.66 0.37
Y	0.10	0.10		0.15	-0.46 0.17
R	0.00	-0.00		-1.18	-7.39-1.07
47. Shrimp *			-0.06		
DM	0.08	0.04		0.40	0.30 0.18
Y	0.00	-0.00		0.04	-0.43 0.08
R	-0.61	-0.69		-1.62	-1.67-1.86
48. Silver			-0.08		
DM	0.07	0.02		0.45	1.45 0.29
Y	0.41	0.39		0.43	-2.20 0.53
R	-1.54	-1.69		-2.83	-11.07-2.98

Table 5. Speed of Adjustment and Short- and Long-Run Elasticities (Continued)

	Short-run			Long-run	
Commodities	First Diff. Regression	ECM Regression	Speed of Adjustment	First Diff. Regression	Cointegration Regression
49. Soybean *			-0.09		
DM	0.02	-0.01		-0.38	0.36-0.63
Y	-0.09	-0.15		-0.03	-0.69-0.04
R	-2.82	-2.72		-4.67	-6.90-3.94
50. Soybean meal *			-0.10		
DM	0.37	0.29		0.68	0.39
Y	-0.13	-0.15		-0.34	-0.43
R	0.51	0.52		1.15	-5.48
51. Soybeans oil			-0.07		
DM	-0.03	-0.05		0.05	0.73
Y	-0.07	-0.08		-0.44	-1.61
R	0.28	-0.01		1.38	-7.11
52. Sorghum			-0.07		
DM	-0.00	-0.04		-0.10	0.63
Y	-0.23	-0.27		-0.14	-1.45
R	-0.47	-0.41		-0.53	-4.10
53. Steel			-0.07		
DM	0.10	0.11		0.06	0.42
Y	0.00	-0.06		0.29	0.21
R	0.62	0.59		0.67	-2.23
54. Sugar (U.S. import) *			-0.05		
DM	0.12	0.08		0.34	0.44
Y	0.06	0.05		-0.13	-0.58
R	-0.74	-0.50		-1.98	-3.35
55. Sugar (EU import)			-0.25		
DM	0.53	0.58		0.55	1.38
Y	-0.07	-0.14		0.14	-0.64
R	0.42	0.49		1.06	-0.04
56. Sunflower oil			-0.06		
DM	-0.27	-0.27		-0.18	0.85
Y	0.20	0.12		-0.07	-1.92
R	0.06	0.12		1.14	-5.64
57. Tea			-0.08		
DM	0.21	0.17		0.33	0.36
Y	0.28	0.23		0.47	-1.01
R	0.27	0.44		0.29	-2.80
58. Tin			-0.05		
DM	0.18	0.15		0.34	0.97
Y	0.14	0.14		0.15	-2.23
R	0.03	-0.29		0.15	-6.61
59. Tobacco			-0.19		
DM	0.02	0.03		-0.10	-0.09
Y	0.07	0.04		0.05	-0.32
R	0.40	0.34		0.45	1.07
60. Triple Super Phosphates			-0.04		
DM	0.00	-0.02		0.09	0.80
Y	0.01	-0.03		0.30	-0.99
R	1.52	1.70		1.92	-3.97

Table 5. Speed of Adjustment and Short- and Long-Run Elasticities (Concluded)

Commodities	Short-run First Diff. Regression	Short-run ECM Regression	Speed of Adjustment	Long-run First Diff. Regression	Long-run Cointegration Regression
61. Urea			-0.05		
DM	0.15	0.08		0.06	1.28
Y	-0.33	-0.40		0.45	-1.77
R	0.48	0.84		-1.15	-5.50
62. Wheat			-0.05		
DM	-0.32	-0.30		-0.54	0.46
Y	0.25	0.17		0.50	-1.04
R	-1.29	-1.30		-1.35	-4.31
63. Wool (Coarse)			-0.05		
DM	0.14	0.13		0.16	0.20
Y	0.14	0.13		0.28	-0.09
R	-0.52	-0.63		-1.09	-4.82
64. Wool (Fine)			-0.07		
DM	0.10	0.04		0.17	-0.39
Y	0.19	0.21		0.30	0.94
R	-1.12	-1.15		-2.87	-4.74
65. Zinc			-0.04		
DM	0.28	0.16		0.69	-0.06
Y	-0.10	0.01		-0.12	0.56
R	1.01	0.85		1.48	-1.90

Note: * Stationary in levels.
** Not cointegrated.

Table 6. Long-Run Responses of Commodity Prices to Real Exchange Rates and Real Interest Rate Using Distributed Lags 1/

Commodities	Deutsche Mark	Yen	Interest Rate
1. Aluminum	1.22	-0.25	-14.72
	(2.29)	(-0.43)	(-1.60)
2. Ammoniac	-0.66	0.66	-31.38
	(-0.66)	(0.58)	(-1.63)
3. Banana	0.77	0.32	19.70
	(0.66)	(0.26)	(0.98)
4. Beef	0.73	-0.29	-10.56
	(1.91)	(-0.72)	(-1.60)
5. Butter (London)	1.24	-0.28	9.31
	(2.06)	(-0.44)	(0.91)
6. Butter (New Zealand)	-0.32	0.24	8.94
	(-0.29)	(0.20)	(0.46)
7. Coal	0.29	0.01	11.21
	(0.58)	(0.03)	(1.31)
8. Cocoa	-0.34	0.70	-20.24
	(-0.56)	(1.08)	(-1.93)
9. Coconut oil	-1.09	2.57	-14.39
	(-1.34)	(2.96)	(-1.03)
10. Coffee (Colombia)	0.74	-0.94	16.28
	(0.96)	(-1.17)	(1.30)
11. Coffee (Arabica)	0.85	-0.73	8.22
	(1.01)	(-0.81)	(0.57)
12. Coffee (other milds)	0.73	-0.86	8.90
	(1.07)	(-1.18)	(0.76)
13. Coffee (Robusta)	1.02	-0.71	3.99
	(1.58)	(-1.03)	(0.36)
14. Copper	1.36	-0.50	4.55
	(2.46)	(-0.84)	(0.48)

Table 6. Long-Run Responses of Commodity Prices to Real Exchange Rates and Real Interest Rate Using Distributed Lags 1/ (Continued)

Commodities	Deutsche Mark	Yen	Interest Rate
15. Copra	-0.74	2.27	-7.86
	(-0.88)	(2.51)	(-0.54)
16. Cotton (industrial)	0.87	-0.59	-22.12
	(1.91)	(-1.21)	(-2.81)
17. Cotton (long-staple)	0.22	0.45	2.74
	(0.47)	(0.89)	(0.34)
18. Diammonium phosphate	0.45	0.34	1.16
	(0.71)	(0.50)	(0.11)
19. Fish	0.93	-0.17	-19.01
	(1.46)	(-0.25)	(-1.72)
20. Gasoline	0.06	-1.21	-28.86
	(0.06)	(-1.25)	(-1.54)
21. Gold	1.75	-0.76	-4.82
	(3.49)	(-1.42)	(-0.56)
22. Groundnuts	2.49	-1.87	-11.61
	(2.00)	(-1.33)	(-0.48)
23. Groundnut meal	-0.52	0.87	-31.29
	(-0.64)	(0.99)	(-2.21)
24. Groundnut oil	-1.50	1.21	-11.10
	(-2.31)	(1.74)	(-0.99)
25. Hide	0.09	1.22	-13.28
	(0.10)	(1.31)	(-0.88)
26. Iron ore	0.69	-0.72	17.93
	(2.20)	(-2.17)	(3.32)
27. Lamb	0.82	0.23	-0.13
	(2.00)	(0.53)	(-0.02)

Table 6. Long-Run Responses of Commodity Prices to Real Exchange Rates and Real Interest Rate Using Distributed Lags 1/ (Continued)

Commodities	Deutsche Mark	Yen	Interest Rate
28. Lead	0.48	0.97	-1.67
	(0.77)	(1.45)	(-0.15)
29. Log	1.09	-0.29	3.51
	(2.04)	(-0.50)	(0.38)
30. Linseed oil	-1.33	1.30	-18.16
	(-1.72)	(1.57)	(-1.36)
31. Maize	-0.82	0.75	-16.17
	(-1.64)	(1.40)	(-1.88)
32. Manganese	0.70	-0.52	16.62
	(1.75)	(-1.22)	(2.39)
33. Natural gas	0.89	-1.49	9.73
	(0.62	(-0.76)	(0.23)
34. Nickel	0.09	0.70	-6.64
	(0.15)	(1.01)	(-0.59)
35. Oil (average)	1.20	-1.09	0.43
	(1.40)	(-1.19)	(0.03)
36. Oil (Alaska)	1.04	-0.92	4.89
	(1.16)	(-0.97)	(0.32)
37. Oil (Dubai)	1.31	-1.14	2.30
	(1.43)	(-1.17)	(0.15)
38. Oil (U.K. Brent)	1.33	-1.24	-3.60
	(1.56)	(-1.36)	(-0.24)
39. Oil (West Texas I)	0.82	-2.31	-47.90
	(0.74)	(-1.66)	(-2.46)
40. Palm kernel oil	-0.69	2.37	-11.35
	(-0.83)	(2.68)	(-0.80)
41. Phosphoric acid	-0.51	0.87	-5.99
	(-1.12)	(1.79)	(-0.71)

Table 6. Long-Run Responses of Commodity Prices to Real Exchange Rates and Real Interest Rate Using Distributed Lags 1/ (Continued)

Commodities	Deutsche Mark	Yen	Interest Rate
42. Phosphate rock	0.15	0.86	27.73
	(0.23)	(1.20)	(2.41)
43. Rapeseed oil	-0.18	-0.72	-13.15
	(-0.21)	(-0.77)	(-0.82)
44. Rice (Thailand)	0.19	0.67	6.11
	(0.41)	(1.38)	(0.78)
45. Rice (Long grain)	0.32	-0.22	3.45
	(0.56)	(-0.36)	(0.35)
46. Rubber	1.17	0.12	-10.14
	(2.38)	(0.23)	(-1.19)
47. Shrimp	1.49	-0.23	3.33
	(2.99)	(-0.43)	(0.39)
48. Silver	2.22	-1.60	-19.58
	(2.59)	(-1.75)	(-1.32)
49. Soybean	-0.98	1.21	-23.88
	(-1.69)	(1.97)	(-2.40)
50. Soybean meal	-0.43	1.01	-24.14
	(-0.56)	(1.24)	(-1.84)
51. Soybeans oil	-0.72	0.71	-12.53
	(-1.11)	(1.03)	(-1.12)
52. Sorghum	-0.68	0.59	-18.63
	(-1.24)	(1.01)	(-1.98)
53. Steel	-0.47	1.29	-11.75
	(-1.25)	(3.20)	(-1.81)
54. Sugar (U.S. import)	0.38	-0.36	-1.88
	(0.59)	(-0.52)	(-0.17)
55. Sugar (E.U. import)	0.90	-0.32	0.92
	(1.44	(-0.48)	(0.09)

Table 6. Long-Run Responses of Commodity Prices to Real Exchange Rates and Real Interest Rate Using Distributed Lags 1/ (Concluded)

Commodities	Deutsche Mark	Yen	Interest Rate
56. Sunflower oil	-1.04	1.51	-15.76
	(-1.62)	(2.20)	(-1.42)
57. Tea	0.57	0.37	7.79
	(0.75)	(0.47)	(0.60)
58. Tin	-0.52	0.31	5.05
	(-1.07)	(0.60)	(0.61)
59. Tobacco	-0.32	0.06	4.27
	(-1.48)	(0.24)	(1.13)
60. Triple super phosphates	0.51	0.48	-0.69
	(0.87)	(0.78)	(-0.07)
61. Urea	0.74	0.30	22.76
	(1.12)	(0.43)	(2.01)
62. Wheat	-1.12	1.46	-21.48
	(-2.28)	(2.78)	(-2.53)
63. Wool (coarse)	0.51	0.04	-6.63
	(1.14)	(0.08)	(-0.86)
64. Wool (fine)	0.08	0.39	-11.83
	(0.13)	(0.59)	(-1.11)
65. Zinc	0.62	0.93	14.14
	(1.01)	(1.41)	(1.33)

Note: t-ratios in parenthesis.

1/ Elasticities for the exchange rates and semi-elasticities for interest rates.

Table 7. Trade Share of Primary Commodities (Excluding Fuels) by Blocs

	1970	1975	1982	1984	1986	1988	1990	1992
			I. Exports					
World	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
United States - Canada	20.8	21.7	21.7	22.0	17.4	19.3	19.1	18.8
Europe	28.7	31.2	33.6	33.1	38.3	38.9	41.8	43.7
Japan	1.1	0.8	1.0	1.0	1.0	1.3	0.9	1.0
Other	49.4	46.3	43.7	43.9	43.3	40.5	38.2	36.5
			II. Imports					
World	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
United States - Canada	15.0	12.0	11.7	14.0	13.8	11.9	11.5	11.1
Europe	48.7	44.8	41.2	39.3	44.7	45.3	47.0	47.8
Japan	10.7	10.5	10.4	10.8	10.4	12.7	12.0	11.8
Other	25.6	32.7	36.7	35.9	31.1	30.1	29.5	29.3

Source: UNCTAD Commodity Yearbook, United Nations, various issues.

Table 8. Trade Share of Selected Commodities by Blocs

	U.S. - Canada		Europe		Japan	
	Exports	Imports	Exports	Imports	Exports	Imports
Beef (bovine meat)						
1972	2.9	27.2	30.6	61.7	--	2.5
1975	2.3	17.3	59.2	59.7	--	2.0
1980	3.9	19.5	52.4	51.7	--	5.0
1985	9.2	20.0	54.2	49.2	0.0	8.0
1990	13.0	15.8	55.0	48.8	0.0	13.0
1992	15.4	15.0	55.8	51.2	0.0	13.2
Copper (refined)						
1972	18.0	6.8	18.1	66.0	1.0	7.0
1975	18.4	5.5	17.4	66.0	0.9	6.2
1980	11.0	13.6	18.5	55.4	7.0	6.5
1985	10.1	11.1	15.1	50.0	1.7	10.3
1990	14.1	7.1	15.6	55.3	1.4	15.6
1992	14.6	7.3	14.1	51.7	2.7	8.9
Groundnuts						
1972	20.9	5.8	2.5	66.2	--	9.2
1975	31.2	7.0	2.0	64.7	--	7.0
1980	39.0	7.1	3.6	55.5	--	10.4
1985	39.2	7.8	3.8	54.7	--	9.5
1990	23.1	8.3	6.6	52.8	--	5.7
1992	30.7	7.9	11.6	56.7	--	5.4
Iron ore 1/						
1972	13.9	12.3	14.8	38.9	--	35.8
1975	13.9	17.5	11.8	36.2	--	32.1
1980	17.5	11.5	7.5	35.1	--	34.6
1985	15.6	9.0	6.5	34.0	--	33.8
1990	10.0	7.1	6.7	37.7	--	30.4
1992	11.0	5.4	7.5	36.7	--	29.8
Manganese ore						
1972	1.5	16.1	3.6	42.2	0.2	27.4
1975	3.2	15.4	2.1	42.5	0.2	30.1
1980	0.9	10.6	3.3	41.2	0.1	27.1
1985	1.1	7.5	4.4	42.7	0.1	23.4
1990	0.8	6.3	2.9	42.1	0.0	20.4
1992	0.4	4.6	5.3	46.7	0.0	19.1
Rice						
1972	31.2	1.2	7.4	11.0	2.3	0.0
1975	29.5	1.0	8.8	10.9	0.0	0.5
1980	25.5	0.8	10.3	12.4	4.8	0.0
1985	20.0	1.9	16.9	20.0	--	0.1
1990	19.4	3.1	19.6	23.0	--	0.1
1992	14.3	3.0	19.2	19.8	--	0.1
Rubber						
1972	1.5	20.8	1.1	31.7	--	9.2
1975	1.7	21.3	1.6	29.1	--	9.0
1980	0.9	19.1	0.6	27.8	--	13.4
1985	1.8	25.8	0.9	25.0	--	13.4
1990	1.6	21.6	1.6	24.0	--	14.7
1992	1.3	24.4	1.8	23.8	--	15.4

Table 8. Trade Share of Selected Commodities by Blocs (Concluded)

	U.S. - Canada		Europe		Japan	
	Exports	Imports	Exports	Imports	Exports	Imports
Soya beans						
1972	87.2	2.1	2.0	58.5	--	25.4
1975	77.3	2.0	0.7	62.1	--	22.4
1980	83.2	1.6	1.3	58.5	--	16.9
1985	68.9	0.8	0.4	51.7	--	19.7
1990	61.8	1.2	1.8	52.4	--	18.8
1992	70.1	0.5	1.8	49.5	--	16.7
Sugar (raw and refined)						
1972	0.1	26.6	15.7	23.2	0.0	11.5
1975	1.1	17.3	9.9	22.4	0.6	12.3
1980	2.4	15.4	18.9	10.4	0.1	7.7
1985	0.9	12.2	13.5	10.6	0.0	2.2
1990	1.5	8.4	24.2	14.1	0.0	3.4
1992	1.5	9.0	28.7	22.2	0.0	3.9
Tea						
1972	1.0	11.1	9.4	37.6	0.2	3.3
1975	0.9	10.3	10.0	35.3	0.1	2.6
1980	1.0	8.6	10.5	35.4	0.1	3.0
1985	1.3	9.2	11.2	26.7	0.1	3.2
1990	0.5	6.5	14.0	23.6	0.1	4.3
1992	0.7	8.1	17.7	27.7	0.2	6.2
Tin metal						
1972	0.4	33.8	12.7	30.5	0.2	18.2
1975	1.0	32.6	10.9	29.4	0.1	14.1
1980	0.3	28.7	9.7	30.8	0.0	17.5
1985	0.9	25.5	10.5	30.4	0.0	18.8
1990	0.6	24.0	9.1	32.4	0.1	18.6
1992	1.0	22.5	5.6	34.3	0.1	16.5
Wheat and wheat flour						
1972	54.4	0.0	19.1	24.3	0.0	7.9
1975	59.2	0.0	18.9	17.2	0.0	8.0
1980	53.5	0.0	22.9	14.9	0.0	5.9
1985	43.5	0.2	28.1	15.3	0.2	5.8
1990	39.6	0.5	38.7	18.9	0.4	5.3
1992	45.2	1.0	38.2	20.1	0.4	5.5

Source: UNCTAD Commodity Yearbook, United Nations, various issues.

1/ Basically U.S. import from Canada.

Table 9. Instability Indices and Trends in Monthly Market Prices for Selected Primary Commodities

Commodity	Weight [1]	Instability index [2]			Trend [3]					
					In current dollars			In constant dollars [4]		
	1983-1985	1980-91	1980-86	1986 91	1980-91	1980-86	1986-91	1980-91	1980-86	1986 91
	Per cent	Percentage variation			Annual average rate of change, per cent					
Total food	67.02	13.3	10.4	8.3	-2.8	-9.1	1.5	-6.3	-8.7	-2.4
Food and tropical beverages	60.01	14.4	11.4	8.3	-2.7	-9.6	1.4	-6.1	-9.1	-2.5
Tropical beverages	17.36	14.0	10.4	10.0	-5.5	1.2	-13.9	-8.9	1.7	-17.8
Coffee	11.42	16 6	11 8	16 8	-3 5	3 1	-16 4	-6 8	3 6	-21 1
Cocoa	2 73	15 0	11 1	9 1	-5 6	-0 8	-14 4	-9 0	-0 3	-19 1
Tea	1.77	16 4	19 3	9 9	-1 8	0 1	2 9	-5 1	0 5	-1 8
Food	42.65	20.9	12.6	10.7	-2.0	-13.1	5.9	-5.4	-12.7	2.0
Sugar	7 12	51 7	32 8	15 0	-4 2	-27 6	20 3	-7 6	-27 1	15 5
Soybean meal	1 86	13 0	10 2	11 8	-0 7	-7 1	2 1	-4 1	-6 7	-1 8
Rice	1 78	20.9	9 8	10 5	-2 6	-13 8	7 8	6 0	-13 3	3 9
Bananas	1 47	13 6	13 4	12 5	2 3	-0 4	7 2	-1 1	0 0	2 5
Maize	1 35	13.2	12 4	11 4	-1 9	-4 9	6 0	-5 4	-4 4	2 1
Wheat	*1 06*	*11.2*	*6 0*	*14 5*	*-2 5*	*-6 6*	*3 4*	*-5 9*	*-6 1*	*-0 5*
Beef	0 86	6 9	4 3	4 6	-0 2	-4 2	4 7	-3 6	-3 7	-0 0
Fishmeal	0 58	17.4	11 7	12 9	0 2	-8 3	5 8	-3 3	-7 8	1 9
Pepper	0 45	40 8	23 8	15 8	6 8	19 6	30 6	3 4	20 1	-35 2
Vegetable oilseeds and oils	7.01	16.4	20.9	11.5	-3.9	-6.2	3.4	-7.4	-5.7	-0.5
Palm oil	2.31	20.5	25 7	15 8	-6 0	-8 5	2 0	-9 4	-8 0	-1 9
Soybeans	1.22	11.7	10 0	11 6	-1 2	-4 9	2 8	-4 6	-4 5	-1 1
Soybean oil	0 80	17.2	21 0	8 5	-2 7	-3 6	6 3	-6 1	-3 2	2 4
Coconut oil	0 67	29 5	37 8	23 4	-4 8	-5 9	3 0	-8 2	-5 4	-0 9
Sunflower oil	0 44	16.5	19 0	8 8	-3 3	-5 1	6 4	-6 8	-4 6	2 5
Palm kernel oil	0.30	26 9	35 4	21 3	-5 4	-8 0	3 0	-8 8	-7 5	-0 9
Groundnuts	0 15	11.1	12 4	4 8	-6 2	-8 1	-1 8	-9 7	-7 7	-5 7
Groundnut oil	0.14	25.5	25 6	*12 7*	-0 5	-3 1	12 5	-3 9	-2 7	8 6
Copra	0.12	27.8	35 4	23 8	-4 6	-6 4	2 6	-8 0	-6 0	-1 3
Palm kernels	0 03	25 6	33 3	17 4	-5 3	-8 2	6 7	-8 7	-7 7	2 8
Agricultural raw materials	13.31	9.0	5.6	5.5	1.1	-4.1	4.5	-2.3	-3.6	0.6
Rubber	2 96	15 8	12 1	13 1	-2 2	-8 4	1 0	-5 6	-7 9	-3 7
Cotton(medium)	2 52	13 8	10.9	9 5	-2 0	-8 2	8 7	-5 4	-7 7	3 9
Tobacco	2.25	7 0	7 6	2 9	0 8	2 5	3 0	-2 6	3 0	-0 9
Tropical sawnwood	1.93	15 8	3 7	9 2	3 3	-4 3	14 5	-0 2	-3 8	10 6
Tropical logs	1 79	14.7	13 6	6 2	4 8	-2 8	7 5	1 4	-2 4	3 6
Plywood	1 49	12 6	9 0	9 7	4 8	-1 2	3 8	1 4	-0 7	-0 1
Hides and skins	0.45	16 9	12 8	21 3	0 4	-0 8	-1 2	-3 1	-0 3	-5 1
Wool	0.25	18 8	4 2	22 7	5 0	-4 3	13 3	1 7	-3 8	8 5
Jute	*0.14*	*23.2*	30 8	*11 6*	*0 9*	*2 1*	*9 0*	*-2 6*	*2 5*	*5 1*
Linseed oil	0 08	23 4	13 5	28 4	-1 3	-5 5	8 7	-4 8	-5 0	4 7
Sisal	0 06	7 6	4 5	4 2	-0 0	-3 3	3 6	-3 4	-2 8	-0 3
Minerals, ores and metals	19.67	15.3	4.9	15.3	2.1	-5.8	7.3	-1.3	-5.4	3.4
Copper	4 45	22 0	7 4	14 7	4 3	-6 7	18 1	0 9	-6 2	13 3
Aluminium	3 22	22 8	14 5	24 5	2 4	-4 3	0 8	-1 1	-3 8	-3 1
Iron ore	2 94	7 4	3 5	2 9	0 5	-2 9	5 5	-3 0	-2 4	1 6
Tin	1.38	13 5	14 4	12 7	-9 8	-11 3	1 0	-13 1	-10 9	-3 8
Phosphate rock	0.96	12 9	9 2	4 4	-0 7	-6 0	5 4	-4 1	-5 5	1 5
Nickel	0 91	31 7	7 4	40 4	6 2	-7 1	15 5	2 8	-6 7	11 5
Zinc	0 31	19 2	10 1	22 7	6 0	-1 0	13 0	2 5	-0 5	9 0
Lead	0 25	26 4	11 7	10 4	0 2	-13 5	15 1	-3 1	-13 1	10 3
Manganese ore	*0 19*	*28 2*	*5 2*	*14 9*	*7 7*	*-3 9*	*26 4*	*4 2*	*-3 4*	*22 5*
Tungsten	0 05	15 8	9 4	10 6	10 0	-18 3	2 0	-13 4	17 8	-1 9
All commodities:										
In current dollars	100 00	13 0	8 2	8 5	-1 1	-7 7	3 3	-4 5	7 3	-0 5
In terms of SDR's		8.6	7 0	8 7	-2 8	-5 3	0 8	-6 2	-4 9	3 0

Notes

1 Derived from values of developing country exports

2 The measure of instability is $1/n \sum_{t=1} [(|Y - Y_t|)/Y_t]$ where y_t is the observed magnitude of the variable, y_t is the magnitude estimated by fitting an exponential trend to the observed value and N is the number of observations The vertical bar indicates the absolute value (i e disregarding signs) Accordingly, instability is measured as the percentage deviation of the variables concerned from their exponential trend levels for a given period

3 The growth rate of each period has been calculated using the formula Log(p) = a + b(t) where p is the price index and t is time

4 Constant 1980 dollars (current dollars divided by the United Nations index of export unit value of manufactured goods exported by developed market-economy countries)

Source: UNCTAD Commodity Yearbook, 1992, page 404.

Derivation of the Text Equations and Description and Sources of Variables

Derivation of the Reduced Form Equation (1)

The law of one price for a given commodity can be expressed as $p_j = p_1 - e_j$, where p_1 is the logarithm of the commodity price in terms of country 1's currency deflated by the country 1's general price level; by the same token, p_j is the commodity real price prevailing in country j; and e_j is the logarithm of the bilateral real exchange rate between countries 1 and j, where the bilateral real exchange rate is defined as the price of one unit of j's currency in terms of 1's currency times the ratio of country j's general price level to that of country 1's.

Defining the country j excess demand for the commodity in question as $Z_j = Z_j\ (p_j\ ,\ K_j)$, where K_j is a set of all relevant variables other than the real price, and using the law of one price as stated above, the world market clearing condition is given by:

$$\sum_{j=1}^{N} Z_j(p_j,K_j) = \sum_{j=1}^{N} Z_j(p_1-e_j,K_j) = 0 \tag{A1}$$

Totally differentiating the world market clearing condition and solving for dp_1, obtains:

$$dp_1 = \sum_{j=2}^{N} \theta_j de_j - \sum_{j=1}^{N} \lambda_j dK_j \tag{A2}$$

where

$$Z_{j,k}=\frac{\partial Z_j}{\partial K_j},\quad Z_{j,p}=\frac{\partial Z_j}{\partial p_j},\quad Z_p=\sum_{j=1}^{N} Z_{j,p},\quad \theta_j=\frac{Z_{j,p}}{Z_p},\quad \lambda_j=\frac{Z_{j,k}}{Z_p}$$

Note that $\theta_j \geq 0$, $j = 1, \ldots, N$ and $\sum_{j=1}^{N}\theta_j=1$.

Integrating dp_1 and defining $K_t=\sum_{j=1}^{N}\lambda_j K_j$, yields equation (1).

Derivation of the World Market Clearing Equation (8)

Let Z_t^j be the excess demand for a given commodity in country j.

$$Z_t^j = D_t^j + I_t^j - I_{t-1}^j - S_t^j \tag{A3}$$

Substituting (2)-(6) into (A3), obtains

$$z_t^j = \gamma_0^j + \gamma_1^j p_{t-1}^j + \gamma_2^j p_t^j + \gamma_3^j q_t^j + \gamma_4^j r_t^j + \gamma_5^j r_{t-1}^j + \gamma_5^j (\bar{p}_{t+1}^j - \bar{p}_t^j) + \gamma_6 z_t^j + \gamma_7 z_{t-1}^j + \epsilon_t^j \tag{A4}$$

where

$$\gamma_0^j = d_0^j - s_0^j$$

$$\gamma_1^j = k_1^j - h_1^j s_1^j$$

$$\gamma_2^j = d_1^j - (1 - h_1^j) s_1^j - k_1^j$$

$$\gamma_3^j = d_2^j$$

$$\gamma_4^j = d_3^j - k_1^j$$

$$\gamma_5^j = k_1^j$$

$$\gamma_6^j = -(1 - h_1) s_2$$

$$\gamma_7 = -h_1 s_2$$

$$\epsilon_t^j = \epsilon_t^{d,j} - (1 - h_1^j) \epsilon_t^{s,j} - h_1^j \epsilon_{t-1}^{s,j}$$

The expected signs are $\gamma_3{}^j > 0$, $\gamma_4{}^j < 0$, $\gamma_5{}^j > 0$, $\gamma_7{}^j < 0$, $\gamma_6{}^j < 0$ (if $0 < h_1 < 1$) and $\gamma_2{}^j < 0$ (if $0 < h_1 < \bar{h}$). The signs for $\gamma_0{}^j$ and $\gamma_1{}^j$ are unknown. The error term $\epsilon_t{}^j$ is positively autocorrelated at one lag, being the autocorrelation coefficient $h_1{}^j$.

The currency of country 1 is taken as the reference currency, the one in which the commodity is traded. To simplify notations, superscript 1 is omitted when dealing with country 1. A commodity excess demand equation for country j can be expressed in terms of p_t, $\bar{p}$, r_t, z_t, the bilateral real exchange rate between countries j and 1, and their lags and expected forward values. Let $e_t{}^j$ be the logarithm of the bilateral real exchange rate between j and 1 --defined as the price of one unit of j's currency in terms of the reference currency times the ratio of country j's general price level to country 1's general price level-- and let $\bar{e}_t{}^j$ be the one step ahead forecast of $e_t{}^j$, i.e., $\bar{e}_{t+k}^j = E[e_{t+k}^j \mid G_{t+k-1}]$.

We assume the law of one price and the uncovered interest rate parity hold:

$$p_t^j = p_t - e_t^j \tag{A5}$$

$$\bar{p}_t^j = \bar{p}_t - \bar{e}_t^j \tag{A6}$$

$$r_t^j = r_t + e_t^j - \bar{e}_{t+1}^j \tag{A7}$$

Equation (A5) portrays the law of one price applied to the real commodity price rather than to the nominal commodity price. It makes clear that the real price of a given commodity in country j would differ from the real price of that commodity in country 1 because of deviations from the PPP between those countries. Equation (A6) obtains by taking expectations at equation (A5). Equation (A7) depicts the uncovered interest rate parity applied to the real interest rate rather than to the nominal interest rate. It makes clear that real interest rate in country j would differ from that in country 1 as long as economic agents expect a change in the bilateral real exchange rate between those countries.

Substituting (A5)-(A7) into (A4), yields

$$z_t^j = \gamma_0^j + \gamma_1^j p_{t-1} + \gamma_2^j p_t + \gamma_4^j r_t + \gamma_5^j r_{t-1} + \gamma_5^j (\bar{p}_{t+1} - \bar{p}_t) + X_t^j \tag{A8}$$

where

$$X_t^j = \gamma_3^j q_t^j + \gamma_6^j z_t^j + \gamma_7^j z_{t-1}^j + (\gamma_5^j - \gamma_1^j) e_{t-1}^j + (\gamma_4^j - \gamma_2^j) e_t^j - (\gamma_4^j + \gamma_5^j) \bar{e}_{t+1}^j + \epsilon_t^j$$

World market clearing condition requires

$$\sum_{j=1}^{N} z_t^j = 0 \tag{A9}$$

Substituting (A8) into (A9) obtains equation (8).

Derivation of the Rational Expectation Solution Equation (10)

To gain insight about the structure of equation (9), one has to determine the roots of its characteristic equation. Using lag operators (L) and assuming $\lambda_1 \neq \lambda_2$, $\lambda_1 \neq 1$, one can alternatively write (9) as:

$$(1-\lambda_1 L)(1-\lambda_2 L) P_{t+1}^* = \Omega_{t-1} \tag{A10}$$

Therefore, λ_1 and λ_2 are the root of the following characteristic equation

$$(1-\lambda_1 L)(1-\lambda_2 L) = 1 - \theta_1 L - \theta_2 L^2$$

hence

$$\lambda_1 = \frac{\theta_1 + \sqrt{\theta_1^2 + 4\theta_2}}{2}, \quad \lambda_2 = \frac{\theta_1 - \sqrt{\theta_1^2 + 4\theta_2}}{2}$$

moreover

$$\theta_2 = \frac{\sum h_1^j s_1^j}{\sum k_1^j} - 1$$

Note that θ_2 is an increasing function of the speculators' forecast error variance and risk aversion (recall that $k_1{}^j = 1/\rho^j \sigma_v{}^2$). For $\theta_2 > \underline{\theta}$, $\lambda_1 > 1$, i.e., one root is unstable, and (9) must be integrated forward. This causes the expectation of the future price to depend on the forecast of the values of all the exogenous variables in the infinite future. If the other root is stable, p_t^* will also directly depend on past realizations of the exogenous variables. As θ_2 increases (because of speculators become more risk adverse or because of the speculators' quality of information become noisier), both roots become unstable (in that case $\lambda_2 < -1$).

If $|\lambda_2| < 1$, the solution to (9) is:

$$p_t^* = -\sum_{i=0}^{\infty} \sum_{j=0}^{\infty} \lambda_2^i \lambda_1^{-(j+1)} \Omega_{t-i+j-1} \tag{A11}$$

If $|\lambda_2| > 1$, the solution to (9) is:

$$p_t^* = -\sum_{i=0}^{\infty} \sum_{j=0}^{\infty} \lambda_2^{-(i+1)} \lambda_1^{-(j+1)} \Omega_{t+i+j} \tag{A12}$$

Let's introduce some notations

$$x_t^j = [q_t^j \, e_{t-1}^j \, e_t^j \, e_{t+1}^j]$$

$$X_t = [r_{t-1} \, r_t \, x_t^1 \ldots x_t^N]$$

$$\Omega_{t+k} = \theta' E[X_{t+k} | G_{t-1}] \, , \; k \geq 0$$

$$\Omega_{t-k} = \theta' X_{t-k} \, , \; k \geq 1$$

$E[X_{t+k} \mid G_{t-1}]$ is supposed to be linear in the exogenous variables and other variables observable at time t, for example, the inflation rate, the money supply in the different countries, the levels of external and public deficits, stock price indices and so on.
In the regression equations, π is a vector of possible instruments used to forecast the values of the exogenous variables.

Hence, p_t^* can be expressed as a sum of lagged exogenous variables; that is, equation (10).

$$p_t^* = \delta_0 + \sum_{i=0}^{\infty} \delta_{1,i} r_{t-1-i} + \sum_{i=0}^{\infty} \sum_{j=2}^{N} \delta_{2,i}^j e_{t-1-i}^j$$
$$+ \sum_{i=0}^{\infty} \sum_{j=1}^{N} \delta_{2,i}^j q_{t-1-i}^j + \sum_{i=0}^{\infty} \sum_{j=1}^{N} \delta_{3,i}^j \pi_{t-1-i}^j$$

$\tilde{p}_t = p_t^*$ and $\tilde{p}_{t+1} = p_{t+1}^*$, which can be obtained by forwarding (10) one period.

The regression equation would be

$$\Delta p_t = \beta_1 \Delta p_{t-1} + \beta_{2,0} \Delta r_t + \beta_{2,1} \Delta r_{t-1} + \sum_{j=2}^{N} \beta_{3,0}^j \Delta e_t^j$$
$$+ \sum_{j=2}^{N} \beta_{3,1} \Delta e_{t-1}^j + \beta_{4,0} \Delta q_t + \beta_{4,1} \Delta q_{t-1} + \delta_t \qquad (15)$$

This regression would be obtained among other things for high risk aversion or low information quality on the speculators' side.

If $|\lambda_2| < 1$, p_t^* will depend on lagged values of the exogenous variables and the regression equation will display long lags. Regression (13), which is also the static expectations solution in first difference, is the most economical in terms of lags.

Description and Sources of the Variables

Variables	Description and sources
dm	First difference of the logarithm of the Deutsche mark/dollar real exchange rate, defined as (D/DM) * GDPDG/GDPDUS), where D/DM is the price of the Deutsche mark in terms of dollars (end of period observation), and GDPDUS and GDPDG are GDP deflators in US and Germany, respectively. Source: IMF, International Financial Statistics.
dml	dm lagged one period.
y	First difference of the logarithm of the Yen/dollar real exchange rate defined as (D/Y) * GDPDJ/GDPDUS, where D/Y is the price of the Yen in terms of dollars (end of period observation) and GDPDJ is the GDP deflator in Japan. Source: IMF, International Monetary Statistics.
yl	y lagged one period.
q	First difference of the logarithm of an index of aggregate real industrial production in industrialized countries. The index industrial activities in mining, quarrying, manufacturing, electricity, gas and water. The IFS calculates the aggregate index using a weighted average geometric mean of country indices. The individual country production series are weighted by the value-added in industry, as derived from each country's national account. Finally the aggregate index includes adjusted production data. Source: IMF, International Financial Statistics.
ql	q lagged one period.
r	Real rate of interest (ex-post) defined as LIBOR minus GDP deflator in the United States.
rl	r lagged one period.

Commodities

Commodities are denoted by their complete names First difference of the logarithm of a given commodity price (as defined in the IMF, IFS). Source: IMF, International Financial Statistics.

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