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2 IDE Paper III

The Pricing Mechanism of Primary Commodities since the 1970s

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I. Introduction

One of the characteristics of developing economies is that they are highly dependent on exports of primary commodities for their foreign exchange earnings. The major issues of international commodity policy have been price instability and declines in real price and producer export earnings (see chapter 1 in Finlayson and Zacher (1988)).

However, when we analyze these problems we cannot solve them without understanding how prices of primary commodities are determined. It is a common perception among economists and traders involved in the international trade of primary commodities that some fundamental changes have occurred in the pricing mechanism of these commodities since the early 1970s. Therefore, it seems essential for both producing and consuming countries of primary commodities, as well as for those who consider the relevance of the existing international commodity agreements, to have a clear understanding of the pricing mechanism now in effect. Nevertheless, so far no conclusive answer has been given to this question. G.L. Rees and D.W. Colenutt (1977), and D.J.S. Rutledge (1977 – 78) studied the grain market and presented analyses suggesting that the instability of the grain price may be attributed to the futures markets. However, an OECD report (1979) which analysed this theme stated that any definitive conclusion on the point made by Rees et al. had yet to be reached. Thus, the object of this paper is to attempt to clarify the pricing mechanism for primary commodities since the 1970s through an analysis of price movements of primary commodities over the subsequent period.

The pricing mechanism has basically changed since the 1970s. The three characteristics of the changes are as follows.

"Volatility": The cyclical periods of commodity prices have become shorter, and the amplitudes of the cycles have widened.

"Linkage": A linkage of primary commodity markets with the financial markets (stocks, bonds, and currencies) has been formed, though the relationships have time differentials (leads or lags). The price of crude oil is leading other commodity markets, including the financial markets.

"Cycles": The prices of crude oil, gold, T-bills, and stocks exhibit the same periods of cycles.

The background underlying the changes in the pricing mechanism is the following seven factors.

(1) Gold: President Nixon proclaimed the end of the convertibility of the dollar to gold in 1971.

(2) Currencies: In February 1973, major currencies shifted to a floating exchange rate system from a fixed exchange rate system.

(3) Crude oil: Petroleum changed from being a cartel commodity to a market-sensitive commodity. The price of crude oil in the New York Mercantile Exchange tends to lead other commodity prices.

(4) Interest Rates: In 1979, the Federal Reserve Bank of the United States adopted a policy whereby the money supply would remain stable, which brought about more volatile markets in interest rates (T-bonds, T-bills).

(5) New financial instruments: Futures markets and option markets of interest rates, currencies, and stock indexes opened. In the course of these developments, commodities necessary for portfolio investment, such as bonds, stock indexes, currencies, gold, crude oil, and traditional commodities have started to be traded in the futures and/or option markets. This situation was supported by the following two facts:

(6) Information revolution: Program trading and a round-the-clock trading system became active due to the development of computers.

(7) The money glut in major advanced countries: The portfolio investment of funds by institutional investors, such as investment trust banks and insurance firms, expanded.

Section 2 quantitatively analyses the three characteristics of the pricing mechanism: "volatility," "linkage," and "cycles," which are tested by coefficients of variations, time lag correlations, and spectral analyses, respectively. Section 3 outlines in detail the background of the changes in the pricing mechanism since the 1970s. Section 4 explains why futures markets in open exchanges make commodity prices more volatile. The final section presents our conclusions and policy implications.

II. Evidence of Changes in Price Movements

The structural change in the pricing mechanism can be demonstrated by showing the new development that emerged in the relationship among petroleum, non-oil primary commodities, and financial commodities.

(1) The coefficients of variations increased in the period after 1970 compared

Table 1. PRICE MOVEMENT OF INTERNATIONAL COMMODITIES: COMPARISON OF COEFFICIENTS OF VARIATIONS ACCORDING TO MONTHLY DATA*†

Item	1957–69	1970–86	Durbin-Watson Ratio between 1970–86
Coffee	14.1	49.8	0.17
Tea	16.6	51.9	0.13
Sugar	11.3	45.0	0.13
Lumber	N.A.	46.5	0.21
Rubber	21.2	39.2	0.13
Palm oil	(a)	21.6	0.21
Tin	23.1	46.8	0.11
Copper	16.6	20.4	0.17
Jute	N.A.	27.8	0.12
Oil	2.8	52.2	0.04
Gold	(b)	42.8	0.12
Stocks (USA)	18.8	24.4	0.13
T-bills (USA)	No trading	33.7	0.25

Source: Estimated according to the data of 1962–1985 Commodity Year Book (Commodity Research Bureau, Jersey City). See the data source of Table 1 in an appendix. With regard to tea, estimated according to data of 1966–1985 Tea Statistics (J. Thomas & Company Pvt. Ltd., Calcutta), (North Indian Tea — London).

Notes: (a)Expansion of world production began from the end of the 1960s.
(b)Gold-dollar standard system with $35 to 1 ounce of gold.

* Trend removed by the functions of polynomials of degree three.

† If the Durbin-Watson ratio is smaller than 1.48 when the number of samples is 100, there is a serial correlation of the first degree, with the level of significance being 1%.

with those of the earlier period (Table 1).

(2) Each of the observed primary commodities fluctuates cyclically around the trend line. As the Durbin-Watson ratios in Table 1 indicate, other commodities besides timber, palm oil, and T-bills (United States Treasury bills) take values of approximately 0.1, suggesting the existence of positive linear serial correlations.

(3) Table 2 shows that prices of primary commodities have experienced similar periods of cycles since 1970. Except for jute, coffee, and timber, price movements of other commodities, including petroleum and gold, present basically similar periods of cycles of 23 and 35 months.

(4) The prices of petroleum, gold, T-bills, and the stock price index (Dow 30) show the same cyclical periods ranging from 2.5, 8, and 23 months.

(5) Since 1970, the period of cycles for individual commodities has begun to be similar, and at the same time cyclical changes in general have become faster (compare Table 2 and Table 3). In fact, monthly data between 1957 and 1969 given in Table 3 indicate the presence of few similar cycles, except perhaps for the long-term ones of 39 and 52 months.

(6) The following equations show time lag correlations between the price of crude oil and other parameters.

Table 2. SPECTRAL ANALYSIS
(According to Monthly Data for 1970 and after)

	Less than 10 months		11 – 20 months		21 – 29 months	30 – 59 months	
Yen rate	2.5	8					
NY stock price	2.4				23	35	
T-bills (3 month)	2.7	9			23		
Tokyo stock price	2.4	7			23		
U.S. WPI	2.5	8			23	35	
Petroleum	2.5	8					
Gold	2.4	7				35	
Tea			11	16	25	36	
Rubber			12	16	25	30	
Sugar			14	18	23	39	
Tin			13	15	23	36	
Jute					24	33	
Palm oil			12	16	25		
Copper			13	17		34	
Coffee		9					45
Lumber			11	19			

Source: The same as Table 1.

$$TB3 = 1.7107 + 0.2771\,OiL(-1) \quad (1)$$
$$(2.21) \quad (10.4)$$
$$R^2 = 0.511,\ F = 108,\ DW = 0.30$$

$$TB3 = 3.723 + 0.01447\,GOD(-2) \quad (2)$$
$$(7.43) \quad (10.5)$$
$$R^2 = 0.451,\ F = 111,\ DW = 0.12$$

$$WPI = 763.2 + 0.7949\,GOD(-15) \quad (3)$$
$$(36.1) \quad (13.6)$$
$$R^2 = 0.606,\ F = 187,\ DW = 0.07$$

$$GOD = 1.208 - 3.4394\,YEN(-22) \quad (4)$$
$$(21.7) \quad (-15.2)$$
$$R^2 = 0.670,\ F = 227,\ DW = 0.30$$

$$GOD = 199.8 + 7.151\,OiL(-3) \quad (5)$$
$$(5.74) \quad (6.00)$$
$$R^2 = 0.257,\ F = 36,\ DW = 0.17$$

$$Oil = 49.60 + 0.01938\,DU3(-6) \quad (6)$$
$$(35.2) \quad (15.4)$$
$$R^2 = 0.711,\ F = 239,\ DW = 0.26$$

$$Oil = 52.89 - 0.002887\,NiK(-15) \quad (7)$$
$$(43.0) \quad (-20.7)$$
$$R^2 = 0.828,\ F = 430,\ DW = 0.35$$

$$OiL = 78.30 - 0.04844\,WPI(-25) \quad (8)$$
$$(16.0) \quad (-10.5)$$
$$R^2 = 0.580,\ F = 110,\ DW = 0.11$$

Table 3. SPECTRAL ANALYSIS
(According to Monthly Data between 1957 and 1969)

	Less than 10 Months	11 – 20 Months	21 – 29 Months	30 – 59 Months	More than 60 Months
Rubber		10 12 17		39	
Cocoa		17		30 51	
Tin		10 13		31 51	
Coffee		16	23	52	
Sugar		20		39 52	
Copper				39 52	78

Source: The same as Table 1.

*TB*3 denotes United States Treasury bills (3 months), Oil is the price of crude oil (U.S. dollars), *GOD* is the price of gold (U.S. dollars), *WPI* is the United States wholesale price index, *YEN* is the currency rate of the Japanese Yen, *DU*3 is the New York Stock Exchange Dow 30, and *Nik* is the Nikkei average stock index 225. The sample period extends from November 1978 to May 1987.

Equation (1) indicates that the price of United States Treasury bills correlates with the price of crude oil with a one-month time lag (minus one in the parenthesis). It is noted that the roles of crude oil and gold are of great importance in the linkages of traditional commodities with financial instruments.

The above findings confirm, first, that the prices of petroleum, gold, United States stocks, T-bills, and other primary commodities began to show similar cyclical periods after 1970, even though these cycles have time differentials, and second, that cyclical changes in their price movements became faster and the amplitude of fluctuations widened.

Two salient points must be noted pertaining to the preceding analysis. First, one of the major factors determining the periods of cycles in price movements is mass psychology or market sentiment. In detecting periods of cycles the original time-series data were detrended by polynomials of degree three (the results were almost the same by either polynomials of degree two, four, or more), and spectral analyses were carried out for the detrended data. Sometimes sellers and buyers in the markets may not take into account long-term trends. In fact, the flow of funds into and out of the markets becomes much faster, and traders may enter markets in such an instance looking two or three months ahead. In an extreme case, so-called paper-tradings or dealings may indicate that the same account is being traded a few times in a day. The production cost of a primary commodity does not change over such a short period as a single day, nor does the production cost of petroleum or gold move in exact parallel to the price movements of bonds and stocks, so that mass psychology among traders in the markets is an important determinant of the short-term periods of price cycles. Against the fundamental factor of supply and demand for a commodity, this factor is called a "technical factor."

Regarding the correlation of the period of price cycles with price movements of such primary commodities that present a weaker correlation with the crude oil price, the following explanation must be given. That is, correlations pertaining to these commodities are not always strong when speculative money flows at the same time into the commodity markets in anticipation of an inflationary situation in the months ahead (e.g. the oil crisis), or conversely, speculative money flows at the same time out of the commodity markets due to a reaction against the prior rush into the markets or in psychological anticipation of future deflation (e.g. the depressed price situation for primary commodities in 1986), and prices of all the primary commodities move likewise. Furthermore, either commodity prices sensitive to the business cycle (e.g. non-ferrous metals) or prices of commodities which consume a large quantity of fuel oil (including electricity) are correlated with the crude oil price. On the other hand, in the case of farm products and other commodities, which are largely dependent on weather conditions (frost damage to coffee, for example), price movements occur for a dominant period of time which is different from the price movement of crude oil. Accordingly, the correlation coefficients between prices of these commodities and the crude oil price are smaller.

III. Factors Responsible for the Increase in Price Instability

There are two basic factors accounting for the increasing instability of primary commodity prices (petroleum and non-oil primary commodities): the so-called Nixon shock and the two oil crises, which have completely changed the markets for gold, petroleum, and currencies. A brief explanation is presented.

First, President Nixon proclaimed in 1971 the end of the convertibility of the dollar to gold, causing the collapse of the gold-dollar standard system that had linked a value of US$35 to an ounce of gold. As a result, gold, as a commodity providing a hedge against inflation, began to be subject to speculation in the commodity exchanges.

Second, petroleum (crude oil) became a market-sensitive commodity, from a cartel commodity, in the 1980s after having been controlled by the international oil majors and OPEC (the Organization of Petroleum Exporting Countries) for a long time [see Hamauzu (1986)]. Even though OPEC was formed in 1960, it had no command over the market until the 1970s. It was the fourth Middle East conflict of October 1973 and the Iranian Revolution of Februay 1979 that provided OPEC with the opportunity to directly challenge the oil majors [see Prast and Lax (1983)]. Then petroleum became a market-sensitive commodity in the 1980s. As Table 1 shows, the price of petroleum became highly volatile.

Third, as for currency, a floating exchange rate system was adopted in 1973, from the previous fixed exchange rate system. With this change in the system, exchange rates of major currencies started fluctuating, and consequently, speculative money was given an opportunity to play its role in the markets.

These three factors combined have brought about volatile price fluctuations in

the markets and have resulted in the introduction and development of futures markets in many commodities, including financial instruments, which were designed to assume functions to hedge against such drastic price fluctuations (see Table 4).

In the course of these developments, commodities necessary for portfolio investment, such as bonds, stocks, gold, petroleum, and other primary commodities, appeared in the futures markets. In this connection, the theory of portfolio selection had been present since as early as the 1950s, but the theory could not be put into practice in actual operations until the 1970s, when a full-fledged futures markets appeared and volume data began to be processed by computers. Thus, in the 1970s the role of "futures markets" and "financial instruments" became important in portfolio investment. These commodities are listed in Table 5. As a result of these developments, prices of commodities traded on commodity exchanges reflected in the 1970s in a lesser degree the actual supply and demand situations for those products. This argument is evidenced by the primary commodity models jointly developed by the Institute of Developing Economies and the University of Pennsylvania (1985). In the econometric models, (i) tin, (ii) copper, (iii) coffee, and (iv) sugar are taken into account. In principle, the models include demand functions, supply functions, and price equations. The demand function is determined by incomes levels, prices of primary commodities, and prices of goods that are substituted for these primary commodities. For the incomes level, the indices of industrial production or per capita GNPs of the United States, Japan, and the EC (or alternatively the OECD) were used. For the models a comparison was made between a case where the incomes level would have been 10% higher than the actual level throughout the 1970s and the actual case. The results obtained from this simulation are given in Table 6. The results show changes in the world prices of the four commodities in relation to the corresponding changes in production. The simulation indicates that even if the growth in GNP for the world economy had been 10% higher than the actual growth, the world price of each commodity under review would have remained unchanged, with the exception of copper.

Specifically, the price of tin would have changed by less than 1% over the 1974 – 80 period under the 10% higher GNP growth scenario. By the same token, the sugar price would have remained almost unchanged. The coffee price rose by 10% in 1977 and 8% in 1978, but it remained almost unchanged in other years under the assumed scenario. Finally, in the simulation copper showed significant price changes: in 1974 its price fell markedly, while in both 1976 and 1977 its price rose by approximately 20%. These simulated price movements can be better explained in light of the actual price movement of tin, sugar, coffee, and copper in the 1970s. Over the 1970s the tin price rose about 5.2 times, from 170 cents to 900 cents per unit, and the coffee price increased about 5.1 times, from 43 cents to 220 cents, while the copper price only rose 2.6 times over the corresponding period, from 50 cents to 130 cents. The slower price increase of copper may be partly attributed to the excess supply in the actual copper market during the 1970s due to the considerable production growth from 1960 through the early 1970s.

Table 4. A HISTORY OF THE OPENING OF THE TRADE OF NEW COMMODITIES

1972:	"currencies" (International Monetary Market, IMM) (May)
1974:	"crude oil" (New Orleans Commodity Exchange) (Sept.)
1974:	"gold" (Commodity Exchange, Inc. COMEX) (Dec.)
	(NY Mercantile Exchange, NYMEX) (Dec.)
	(Chicago Board of Trade, CBOT) (Dec.)
	(Chicago Mercantile Exchange, CME) (Dec.)
1975:	"GNMA" (Government National Mortgage Association Exchange)
1976:	"Treasury bonds" and others (See Table 5)
1981:	London International Petroleum Exchange (April)
1982:	"gold," etc. (Tokyo Metal Exchange) (March)
1982:	The London International Financial Futures Exchange (LIFFE) (April)
1984:	"gold, Deutsche Mark, Pound Sterling, U.S. Treasury Bonds, Nikkei Average Stock Price, etc." (Singapore International Monetary Exchange, SIMEX)
1986:	"U.S. T-bills, Eurodollar, gold" (Sidney Futures Exchange, SFE)
1986:	The Big Bang (deregulation by London Stock Exchange)
1986:	Tokyo Offshore Market (as a result the three major international financial centers—NY, London, and Tokyo—each now has an offshore market)

Accordingly, the copper price was formed in a market where the actual supply and demand situation overweighed speculative moves. Thus, a tight copper market would have resulted in a corresponding rise in the price, as the simulation indicates. In short, the results from the simulation suggest that price levels of the four, as well as other primary commodities were such that they did not reflect the actual demand and supply conditions in the markets. In other words, prices of primary commodities were partly dominated by speculation during the decade.

Therefore, the causes of the second oil crisis involved some different aspects from those of the first oil crisis. Namely, the second oil crisis took place in an environment where the role of speculation in the futures markets had become significant. The speculation on the rise was exemplified by the case of the Hunt Brothers with silver, and the situation was almost the same with regard to copper and other primary commodities. Here we can use as an illustration the case of the New York sugar No. 11 futures market. The average contract volumes were 4,181, 2,939, and 3,196 units in 1973, 1974, and 1975, respectively. Those volumes in 1979, 1980, and 1981 increased substantially, to 7,147, 14,287 and 9,842 units, respectively. Moreover, the highest volume unsettled by counter trade in the first oil crisis remained as low as 39,435 units, but in the second oil crisis it was 106,771 units [See Shukan Shohin Data (1982)]. Throughout the 1970s, trading widened the amplitude of the price movements of primary commodities. Since brokers took the same actions on similar computer programs, prices deviated in the same direction.

In the 1980s, this tendency further increased because of one or more of the following developments.

Table 5. MAJOR FUTURES TRANSACTIONS IN THE U.S. IN THE LATE 1970S

Grains	wheat, corn, oats, barley, grain sorghums
Oilseeds and products	soybean, rapeseed, flaxseed, soybean meal, soybean oil, coconut oil, palm oil
Livestock and products	cattle, feeder cattle, hogs, broilers, turkeys, skinned hams, boneless beef, eggs
Foods	potatoes, orange juice, sugar, coffee, cocoa
Fibers	cotton, wool
Forest products	plywood, lumber
Metals	gold, silver, platinum, palladium, copper, U.S. silver coins
Petroleum	propane, crude oil, industrial fuel oil, heating oil
Currency	British pound, Canadian dollar, Deutche mark, Japanese yen, Mexican peso, Swiss franc, French franc, Dutch guilder
Other financial commodities	federal guaranteed mortgages (GNMA), 90-day T-bills, 1-year T-bills, 30-day commercial paper, 90-day commercial paper, T-bonds, T-notes (4 year term)

Source: Thomas, A.H., *Economics of Futures Trading*, Commodity Research Bureau, Inc., Jersey City, 1980 (p.18). Peters M. and D. Vogel, *Inside the Financial Futures Markets*, John Wiley & Sons, New York.

(1) The rapid progress in high technology and development of new materials (such as optical fiber cable) has facilitated a kind of revolution of information. As a result, every entrant in the markets can share the same information in real time and at a low cost throughout the world.

(2) New futures markets have emerged and a variety of new commodities are offered in the markts (See Table 4).

(3) In the course of these developmens, a "round-the-clock trading system" for futures markets of gold, petroleum, currencies, stocks, and international commodities, in which the New York, Tokyo, and London markets assume the major role, has been established. In the past, such a new commodity would have been separately developed and offered to individual markets. Now, however, a newly developed commodity has begun to be offered to plural markets through tie-ups, for example, between the Sydney and Chicago markets, Chicago and New York, or London and Singapore, so that virtually all of the key commodities are shortly being covered by round-the-clock operation in the markets worldwide. Table 7 shows the volumes of contracts in various futures markets in the United States. It must be noted that all the T-bonds, stocks, currencies, and primary commodities have been chosen as portfolio assets. Another noteworthy aspect is that in terms of the number of contracts, the top three commodities were in the financial category, and by adding gold in the fourth rank, they accounted for 45.3% of the total contracts in 1985. The position of these financial commodities in 1985 presented a sharp contrast with that in 1983, when soybean and corn still accounted for 9.7% and 8.5% of the total contracts, respectively.

Table 6. THE RATE OF PRICE DEVIATION WHEN WORLD ECONOMIC GROWTH RATES WERE ASSUMED TO BE 10% HIGHER THAN THE ACTUAL RATE

(in %)

	Tin	Copper	Sugar	Coffee
1974	0	−15.9	0	+2.8
1975	−1.0	−2.5	−0.9	+2.3
1976	0	+20.6	0	+5.2
1977	−1.8	+18.4	+7.5	+10.5
1978	0	+9.2	0	+8.7
1979	+0.5	+10.5	0	+0.3
1980	−0.8	+7.7	0	−0.3

Source: the author's estimation.

Table 7. NUMBER OF CONTRACTS IN THE ALL FUTURES MARKETS IN THE U.S. IN THE 1980S

(Unit: 10,000)

Futures Commodities			1985		1984		1983		1982	
Kind	Commodities	Exchange	No. of Con-tracts	Share	No. of Con-tracts	Share	No. of Con-tracts	Share	No. of Con-tracts	Share
Bonds	T-bills	CBOT	4,044	25.4	2,996	20.1	1,955	13.9	1,673	14.9
Stocks	S&P500	CME	1,505	9.4	1,236	8.2	810	5.7	293	2.6
Currency	Eurodollar	CME	890	5.6	419	2.8	89	0.6	32	0.2
PC*	Gold	COMEX	777	4.9	911	6.1	1,038	7.4	1,228	10.9
PC	Soybeans	CBOT	739	4.6	1,136	7.6	1,368	9.7	916	8.1
Currency	Deutche mark	CME	644	4.0	550	3.6	242	1.7	179	1.6
PC	Corn	CBOT	639	4.0	910	6.1	1,192	8.5	794	7.0
PC	Silver	CBOT	482	3.0	674	4.5	264	1.8	77	0.7
Currency	Swiss franc	CME	475	3.0	412	2.7	372	2.6	265	2.3
PC	Live cattle	CME	443	2.8	355	2.3	424	3.0	444	3.9
PC	Crude oil	NYMEX	398	2.5	164	1.2	32	0.2	—	—
PC	Soybean oil	CBOT	364	2.3	400	2.6	385	2.7	304	2.7
PC	Soybean meal	CBOT	333	2.1	382	2.5	387	2.7	278	2.4
PC	Sugar	CS&C	301	1.9	244	1.6	320	2.2	203	1.8
Bonds	T-bills	CBOT	286	1.8	166	1.1	81	0.5	88	0.7
Stocks	NYSE composite index	CME	283	1.7	345	2.3	350	2.5	143	1.2
Currency	British pound	CME	279	1.7	144	1.0	161	1.1	132	1.1
PC	Copper	COMEX	244	1.5	250	1.6	318	2.2	236	2.1
Currency	Japanese yen	CME	241	1.5	233	1.5	344	2.4	176	1.5
Bonds	T-bills	CBOT	241	1.5	329	2.2	378	2.7	659	5.8
PC	(90-day term) No. 2 heating oil	NYMEX	220	1.3	290	1.4	186	1.3	174	1.5
Total			15,869	100.0	14,937	100.0	13,992	100.0	11,240	100.0

Source: Futures Industry Association.

* PC stands for primary commodity.

Under these circumstances, movements of interest rates, currencies, and petroleum prices significantly affect the prices of primary commodities. In particular, movements of the petroleum price determine to a substantial extent the price levels of the other primary commodities. Regarding the petroleum price, the futures price of crude oil in the New York Mercantile Exchange has recently been frequently regarded as the leading price. The price of crude oil formed in this market largely influences the spot price, the crude oil prices in other markets, and the prices of other commodities. The futures price of crude oil in the New York Mercantile Exchange has assumed a greater role as the reference price for other markets, because the volume of contracts has increased sharply. Although the United States produces only about 9 million B/D (barrels per day) against a world production of crude oil amounting to 45 million B/D, the volume of contracts of futures of crude oil in the New York market has amounted to 30 to 50 million B/D, and in October 1986 the average volume of contracts reached 42 million B/D or more. In this connection, the next section analyses the mechanism of price formation in the futures markets which induces price fluctuations on which is related to institutional factors of the futures markets.

IV. Institutional Aspects of Futures Markets and the Role of Volatile Price Movements in Futures Markets

(1) Participants in the futures market include the "speculator" and the "hedger." Hedge-selling refers to such practices as, for example, a farmer who grows a farm product that can be cropped in the next 12 months selling 10 tons of the product at ¥100,000 per ton in the futures market 12 months ahead, and then delivering the 10 tons of the harvested product on a specified date 12 months later. By this practice the farmer can ensure his income, which will amount to ¥1 million (¥100,000 × 10[t]), 12 months before the actual delivery, so that he can circumvent any possible risk associated with spot dealing. On the other hand, hedge-buying also applies to such practices as when a processor of a farm product who requires 5 tons of the product in the coming 6th months, buys 5 tons of the product at ¥80,000 per ton in the futures market 6 months ahead, and thus can be certain beforehand that the sum of ¥400,000 will be expended 6 months later.

Demand (buying) and supply (selling) in the futures market correspond to the sum of demands from both hedgers and speculators, and the sum of supplies from them, respectively. Regarding the selling or buying transactions of the hedger, as a supplier (hedge-selling) he may pursue a maximization of profit, and as a purchaser he may pursue a maximization of utilities (except derived demand), as economic textbooks show, so that a demand curve and supply curve could be obtained from such a behavior. But, in reality, investors who neither produce nor consume, but behave solely based on their expectations of short-term price changes did very well in the futures market (e.g. so-called Locals in Chicago). These expectations may change in taking into account such factors, in the case of rubber futures, as indicators for U.S. business (in particular the sale volume of automobiles), state-

ments of managers in the International Rubber Agreement, practices of major speculators, price movements of other commodities, inventory levels, weather forecasts, and interest rates. This means that both the demand and supply curves inferred from the behavior of speculators do not have specific grounds, and speculators themselves may instantly change from purchaser to supplier, and vice versa.

(2) In addition, institutional factors pertaining to the futures market such as (i) cash guarantee deposit, (ii) additional cover, and (iii) settlement date, affect to a greater extent the psychology of speculators. The effects of these institutional factors are exemplified by the case of transactions of rubber futures in Japan (as of September 1982).

(a) *Cash guarantee deposit*

The minimum trading unit of rubber is 5,000 kg (called 'mai'). When the standard price stands at less than ¥250 (per kg), an investor is allowed to buy a unit by depositing ¥70,000 as the cash guarantee. For example, he can buy a unit of rubber futures of ¥1 million (¥200 [standard price] × 5,000 kg) for ¥70,000 in cash, that is, he can purchase an amount of rubber 14.28 times (¥1 million/¥70,000) that he might buy in the spot market. Accordingly, the trading volume in the futures market can be much larger than the volume of actual transactions.

(b) *Additional cover*

The investor has to deposit an additional cash guarantee when his account has run into the red based on market evaluation. For example, when the standard price has declined to ¥180 per kg against his purchase at ¥200, a loss of ¥20 per kg accrues and his account of the unit (5,000 kg) generates an evaluation loss of ¥100,000 (this is not an actual loss unless he sells the account). Upon the accrual of the evaluation loss, he must deposit an additional amount of money, which is defined as the evaluation loss minus half of the original deposit [¥100,000 − ¥70,000/2 (= ¥35,000) = ¥65,000]. It must be pointed out that as stated in paragraph (a), in the rubber futures market he can buy an amount of rubber approximately 14 times that in the spot market, and likewise the amount of additional cover on his account must be 14 times the actual loss in the spot market. When the money invested in rubber futures is ¥1 million, he has to deposit ¥910,000 (¥65,000 × 14) because of a price decline from ¥200 to ¥180. If he fails to pay for the additional cover, he will be penalized. Thus, when the price of a commodity falls heavily, those investors who can not pay the additional cover decide to dump in order to encourage further collapse of the commodity price.

(c) *Settlement date*

The purchaser of rubber futures who does not settle the account by counter-selling has to take back the purchased rubber. If he is a speculator who does not use natural rubber, he will have to sell his account by the settlement date. An individual who buys a certain number of units of gold in the spot market, can hoard the gold, without being hindered by any price decline in an intermediate period, until his initial investment yields virtually any profit margin. In contrast, when he purchases the same commodity in the futures market three months ahead, his

investment can not yield a profit margin unless its price rises within the three months, and when this does not occur, he has to sell his account at a loss. The psychological effects of daily fluctuations of prices on the investor in the spot market and in the futures market vary to a greater extent. Those investors who are not affected by any time constraint will not be required to respond so sensitively to price fluctuations unlike the investors in the futures market. Therefore, buyers in the futures market respond sensitively to price fluctuations, further contributing to the widening of amplitude of the price fluctuations.

(3) Price fluctuations in the futures market are apt to be intensified by the reasons outlined below. The indigenous role of speculators in the futures market is to help mitigate price fluctuations. Their counter-selling in a bullish market serves to restrict a lopsided rise in prices, and likewise their counter-buying has a counter-effect in a bearish market to stop a lopsided fall in prices. In actual operations in the futures market, a rise in price sometimes takes place along with the increase in buying by speculators. When a rise in the rubber price is anticipated because of some favorable factors, speculators' incentive to buy more is encouraged and hence the rubber price increases. When the price rise reaches a certain level, profit-taking sales by investors who had bought at lower prices and counter-selling by speculators take place, so that the rubber price plummets. However, when there is a strong anticipation of a rise, the slight price decline may induce a substantial amount of buying by speculators, resulting in a rebound of the rubber price. Sometimes this process virtually results in the rubber price soaring in the futures market. In the last stage of a sharp price increase, speculators' purchasing of contracts without commensurate counter-selling, or their outstanding purchasing contracts which remain unsettled, has been expanding. If buyers who begin to feel uncertain about the higher price level commit themselves at once to counter-selling for settlement, the price of the commodity will collapse. This behavior underlines the fluctuations in prices of commodities. Further, these phenomena are fundamentally attributed to the psychology of investors and entrants in the market. In the light of their psychology, during a soft market there is a large number of potential sellers outnumbering potential buyers who are reluctant to buy in the market. When the market becomes tight for any reason, the price starts to rise and potential sellers begin to refrain from selling, which further promotes a tighter supply, resulting in another price rise. At the last stage of this price increase process, the price rises sharply. When most of the potential buyers have completed their purchases, there remain only potential sellers, which results in a price decline. This price decline spurs potential sellers' uncertainty about the higher price level, so that they begin to sell accounts they have so far reserved. This triggers a price collapse.

V. Conclusions and Policy Implications

First, the world economic environment considerably changed during the period between the end of the Second World War and the 1970s. In the 1970s, reflecting these changes in addition to the Nixon shock and the first oil crisis as a starting

point, the prices of gold and petroleum and currency exchange rates began to fluctuate from fixed prices. In the process of searching anchor levels for their prices, the fluctuations of prices, including those of primary commodities, temporarily intensified. In the futures markets, more emphasis was often placed on the "sentiment" of the market, and the prices of primary commodities were often formed in ignoring the costs. Accordingly, prices greatly fluctuated in the short run.

Second, since the latter part of the 1970s, along with the money glut in the major advanced countries, caused by an expanded tertiary industry and an increase in pension funds due to the aging population, the investment of funds by institutional investors (corporate bodies) became very active. Thus, "the financial instruments," such as bonds, currencies, and stocks, which are necessary for a portfolio selection, all appeared. The prices of bonds, stocks, primary commodities, and currencies reinforced their linkage with the same cycles with some time lag.

Third, with the development of advanced technologies, referred to as the Kondratieff wave, which occurs once every 50 years, "the use of computers" has developed under the so-called information revolution. This fact is manifested in the following three points. First, the speed of information processing accelerated and the cost decreased. Therefore, the portfolio selection, which used to exist only in theory, as it requires a large amount of data processing, has become applicable in actual tradings. Second, program trading began to be performed. After developing several indices and sending signals for selling and buying by integrating these indices, trading can be performed automatically. Recently the development of artificial intelligence (AI) has been accelerating this trend. In this way, the quality of the programs becomes competitive. However, when there are many similar programs the price moves simultaneously in one direction, accelerating the price fluctuations. Third, a round-the-clock trading system is well organized for gold, petroleum, bonds, stocks, and other primary commodities. This is partly because information has become available in real time at a low cost. Institutional investors try to get a margin by revolving the funds in a very short term, called dealings or paper trading. This is also a major factor for volatile price movements in the short run.

We showed the three characteristics of "volatility," "linkage," and "cycles" since the 1970s. Theoretically, the pricing mechanism can be explained by "the Catastrophe Expectation Formation Hypothesis" [see Kuchiki (1989)]. We will now discuss the policy implications based on the characteristics that can be explained by both our empirical study and theoretical model.

First, we can use the futures markets in order to mitigate the "volatility" in the short run. One of the merits of such a policy is that this intervention into the futures markets is effective in the same degree when prices are both declining and rising. In contrast, most of the International Commodity Agreements recently failed when prices were rising drastically due to the lack of buffer stocks. It is noticed that we should have enough funding to carry out the policy, and that illegal trading, like insider trading, should be abolished, and that we should study the indices

to give signals for intervention in the markets. We should discuss the possibility of making use of futures markets.

Second, the conference of the G7 should reflect the opinions of developing countries, due to the "linkage" in prices of traditional commodities and financial commodities. Changes in interest rates and exchange rates will affect the economies of producing countries, especially those who have debt problems. The inflationary pressures caused by the price hikes of primary commodities will increase discount rates for consuming countries. Thus the producing countries should take part in the continuing discussions on "the commodity price indicator" proposed during the G7 conference.

Third, the "cycles" are automatically mechanized in open exchanges, and they cannot be completely excluded from the price movements without fixing them by regulation. This fact can be explained by the "catastrophe expectation formation hypothesis." Each country must make use of the cycles as follows: it must save funds when prices are high, and compensatory financing in the form of loans will be effective when the prices are low.

Finally we refer to the effectiveness of the International Commodity Agreements (ICAs). They are not effective in the long run, but they are effective in the short run. An ICA can affect price movement in the short run. However since it cannot change the trend of the price movement at all, intervention may facilitate operations in order to mitigate drastic price changes. Also, due to linkages the commodity cannot be independent of other commodities, including financial instruments. Thus, in the long run, an ICA will become ineffective. Intervention into the markets by ICAs can only be effective in the short run.

NOTES

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APPENDIX

Forecast for Oil and Gold Prices and an Exchange Rate

Under the circumstances mentioned in IDE paper 2, the prices of petroleum and gold came to play "leading" roles for the overall prices of primary commodities. This was because the price rise of petroleum is one of the signs of inflation as well as a sign of business boom. This will further become a factor for causing inflation through the rise of prices of raw materials, fuels, and substitutable materials. Since gold is an important hedge, there is a high possibility that the price of gold will follow or lead that of petroleum. Therefore we show the forecast for prices of crude petroleum and gold.

Appendix Table 1. FORECAST STATISTICS

	Crude Petroleum (NYMEX, WTI) U.S. Dollars per Barrel	Gold (New York) U.S. Dollars per Ounce	Exchange Rate (Yen) Yen per Dollar
1990	21.08	415	134.2
1991	22.99	460	125.0
1992	24.62	501	118.0
1993	26.33	544	111.4
1994	28.16	592	105.2
1995	30.10	643	99.4

Source: the author's estimation by the ARIMA models.

Appendix Table 2.
(Data source of Table 1.)

Commodities	Terms	
Copper	Jan. 1957 – Dec. 1969	Average spot electrolytic copper prices, N.Y.
Cocoa	Jan. 1957 – Dec. 1969	Spot cocoa bean prices (ACCRA), N.Y.
Tin	Jan. 1957 – Dec. 1969	Average price of Straits tin (Prompt), N.Y.
Coffee	Jan. 1957 – Dec. 1969	Average price of "Manizales" coffee, N.Y.
Rubber	Jan. 1957 – Dec. 1969	Average spot crude rubber prices (smoked sheets), N.Y.
Sugar	Jan. 1957 – Dec. 1969	Average raw cane sugar (90°) prices, duty paid, N.Y.
Tin	Jan. 1970 – Feb. 1985	Average price of Straits tin (Alloyer price), N.Y.
Sugar	Jan. 1972 – Feb. 1985	Raw sugar N.Y. spot price (C.I.F., duty/free paid, No. 12)
Rubber	Jan. 1970 – Jan. 1985	Average spot crude rubber prices (smoked sheets), N.Y.
Petroleum	Jan. 1973 – Nov. 1978	Average price of crude petroleum at wells
	Dec. 1978 – Feb. 1985	Arabian Light spot price
	Mar. 1985 – Sept. 1986	North Sea Brent
Palm oil	Jan. 1974 – Aug. 1984	Average wholesale palm oil prices, C.I.F., bulk, U.S. ports
Lumber	Jan. 1974 – Feb. 1985	Average index pice of Ponderosa pine softwood, No. 2
Copper	Jan. 1971 – Dec. 1984	Producer prices of electrolytic (wirebar) copper
Jute	Jan. 1971 – Feb. 1985	Average wholesale price of burlap (40 inch—10 oz.), N.Y.
Coffee	Jan. 1970 – Dec. 1984	Average spot price of coffee (Santos No. 4), N.Y.
Cocoa	Jan. 1975 – Dec. 1984	Spot cocoa bean prices (ACCRA), N.Y.
Gold	Jan. 1976 – June 1983	Monthly average price (unfabricated) Engelhard Industries
	Jul. 1983 – Sept. 1986	London spot price
T-bills	Jan. 1976 – Dec. 1985	
U.S. stock	Jan. 1970 – Jul. 1985	S&P 500