AN INVESTIGATION INTO THE POSSIBILITIES OF EFFECTIVE SUPPLY MANAGEMENT OF PRIMARY COMMODITIES WITH SPECIAL REFERENCE TO TRADE IN COPPER AND WHEAT

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ABSTRACT

The success of a producer grouping (OPEC) in a major primary commodity, petroleum, has generated a great deal of controversy. This thesis investigates the possibilities of other primary product producing countries (both developed and less developed) forming similar "producer alliances." The thesis develops a methodology for examining producer supply management-largely through the examination of "excess demand" functions faced by producers' groups. Demand and supply functions are estimated econometrically. Other factors relevant to supply management, including structure of production and consumption, existence of reserves and nature of markets, are also taken into account. Two commodities, copper (produced largely by less developed countries) and wheat (produced largely by developed countries) are investigated in detail. Our analysis indicates that in the case of both commodities active supply management would be beneficial to producers. The analysis includes derivation of price levels which would maximise total profits or total revenues of various producer groupings.

RESUME

Le succès de l'OPEP, le groupe des producteurs de pétrole, a suscité de nombreuses controverses. Cette thèse analyse les possibilités pour d'autres producteurs de matières premières (à la fois de pays développés et de pays moins développés) de former des alliances de producteurs similaires. La thèse développe une méthodologie d'analyse de la gestion de l'offre des producteurs, principalement au moyen de l'analyse des fonctions de demande excédentaire auxquelles font face les groupes de producteurs. On estime économétriquement les fonctions d'offre et de demande. On tient compte également d'autres facteurs concernant la gestion de l'offre parmi lesquels la structure de la production et de la consommation, l'existence des réserves et la nature des marchés. La thèse analyse en détail le cas de deux marchandises, le cuivre (produit principalement dans les pays moins développés) et le blé (produit principalement dans les pays développés). Cette analyse montre que dans les deux cas, une politique de gestion active de l'offre serait bénéficiaire aux producteurs. L'analyse inclut le calcul des niveaux de prix qui maximisent les bénéfices totaux et les revenus totaux des différents groupes de producteurs pour les deux marchandises.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Concluded)

PREFACE

I am indebted to my supervisors, Professors Irving Brecher, John Iton and John Kurien for their guidance in every aspect of the research carried on in this thesis.

The thesis was written whilst I was a staff member of the International Bank for Reconstruction and Development (Washington, D.C.). I am grateful to my colleagues at this institution, and particularly Messrs. Mahbubul Haq, Shahid Javed Burki, Irfan ul Haque, Kenji Takeuchi, Bension Varon, Karsten Larsen and Sikander Rahim for their many helpful comments as the thesis was developed.

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SUMMARY

The success of a producer grouping (OPEC) in a major primary commodity, petroleum, has generated a great deal of controversy. This thesis investigates the possibilities of other primary product producing countries (both developed and less developed) forming similar "producer alliances."

The general price experience of individual commodities during the fifties and sixties indicates that the products of less-developed countries experienced greater instability and lower increases in price than products of developed countries. Consequently, less-developed countries have taken a more active interest in seeking high, stable commodity prices for their products, an interest which has become acute in the wake of recent price increases experienced in petroleum and food (particularly wheat). The less-developed countries have now embodied this interest in a call for a "New International Economic Order" having as its focal point an international commodity price maintenance and stabilization scheme. However, recent experience (including the lack of any positive outcome from the recent UNCTAD conference held in Manila in spring 1979) indicates that the lack of a community of interests between consuming and producing countries will result in a failure to reach agreement on any comprehensive international commodity scheme. It is therefore possible that primary product producing countries (both developed and less-developed) will resort to "supply management" on their own to influence international prices.

Commodity producer groupings have a long history. In fact, the greater part of the world's essential minerals and several important agricultural commodities were subjected to international "supply management" between the two world wars. The post-war experience initially saw the domination of multinational corporations over production and marketing. More recently, national interests of producer countries have begun to exert themselves.

Current literature on the prospects of producer alliances for primary commodities is limited. However, Takeuchi, Haque, Varon, Bergsten and Burrows (among others) have examined prospects for such groupings taking place on the basis of both economic and political factors. Some authors (e.g., Stern and Tims) have analyzed the "relative bargaining strengths of the developing countries". Others, like Connelly and Perlman, have focused on the increasingly independent position being taken by two resource-rich developed countries--Canada and Australia.

This thesis develops a methodology for examining producer supply management-largely through the examination of an "excess demand" function facing any producers group. Demand and supply functions are estimated econometrically. Other factors relevant to supply management, including structure of production and consumption, existence of reserves and nature of markets, are also taken into account.

Two commodities, copper (produced largely by less developed countries) and wheat (produced largely by developed countries) are investigated in detail. Our analysis indicates that in the case of both commodities active supply management would be beneficial to producers.

Specifically, copper is capable (within limits) of being subject to an effective supply management program conducted by existing members of the Conseil Intergouvernemental des Pays Exportateurs de Cuivre (comprising Australia, Chile, Indonesia, Mauritania, Papua New Guinea, Zambia and Zaire) if the political will to do so is forthcoming. Given the particular demand and supply elasticities faced by a group of copper producers like CIPEC an appropriate objective would be to maximize profits rather than total revenues. Such a profit-maximizing strategy would enable CIPEC producers to effectively establish a "floor" price for copper ranging between 96-100 cents per pound (constant 1974 prices) rather than the level of 50-65 cents per pound, (constant 1974 prices) being charged currently.

With regard to wheat, the thesis reaches the conclusion that a producer grouping comprising the United States, Canada and Australia, should, in order to achieve profit maximization, aim at prices of about $135 metric ton (constant 1976 prices). This level of prices, incidentally has generally prevailed in the post-1972 period, which indicates that, either by accident or design, major wheat producers are pursuing production policies which bring maximum benefit to them.

CHAPTER I

INTRODUCTION

This thesis seeks to examine the prospects of, and potential producer benefits (if any) for, major primary commodity producing countries forming successful producers' alliances for managing the supply of important primary commodities (with major producers acting in coordination with a limited number of other producers). The purpose of such supply management would be to increase either total revenues or total profits by setting a price for the commodity in international markets, as has been accomplished by OPEC--the Organization of Petroleum Exporting Countries. As a brief examination of the historical experience of primary commodity exports indicates, the gains which accrued due to the actions of the "oil producers group" were much greater than those achieved by "normal" market developments of the past two decades. It is, therefore, likely that producers will increasingly try to emulate the experience of the oil producing countries. An important incentive to form such alliances is not only the prospect of achieving higher export prices, but also the possibility of stabilizing prices (and hence export earnings) in what have been until now very unstable markets.

This chapter is divided into four sections. Section A reviews the trade and commodity price experience of the two decades before the oil price increases of 1973. Section B reviews the post 1973 trade and commodity price experience. Section C describes proposals

to support primary commodity prices including the call for a "New International Economic Order." Section D draws some preliminary conclusions regarding primary commodity price agreements and the role of commodity supply management.

Chapter II reviews the existence of commodity "cartels" or "producer groupings" in historical perspective and examines the status of earlier and current scholarship on the subject of supply management of primary commodities. Chapter III develops a methodology for examining the prospects and potential benefits (if any) to and of producer groupings for primary commodities. Basic commodities which are (i) of substantial importance in world trade, and (ii) may meet the initial conditions for forming a successful producers' alliance are identified; and of these, two (one produced by less-developed countries and the other by developed countries, and one a mineral and the other an agricultural product) are selected for detailed further investigation. Chapters IV and V examine the two commodities in detail to evaluate the possibilities of such action. Chapter VI sums up the conclusions of our analysis regarding the potential gains accruing to producers which form commodity groupings.

A. Commodity Trade and Price Movements--The Historical Experience 1950-73

Trade Volume. The size of world trade expanded from about $61 billion in 1950 to $128 billion in 1960, and to about $312 billion in 1970, i.e., by about 7.7 percent per annum in the fifties and by

about 9.2 percent per annum in the sixties.[1/] However, trade of the developed market economies increased from about $37 billion in 1950 to about $85 billion in 1960 and approximately $225 billion in 1970, i.e., by 8.7 percent per annum in the fifties and 10.2 percent per annum in the sixties. Trade of the less developed countries (LDC's), on the other hand, increased much less rapidly from about $19 billion in 1950 to about $27 billion in 1960 and $55 billion in 1970, i.e., by 3.7 percent in the fifties and 7.0 percent in the sixties.

Data on commodity composition of world trade are not available for 1950. However, data for 1960 (Table I.1) and 1970 (Table I.2) indicate that the less developed countries continued to be exporters of mainly primary products. The products comprised about 85 percent of LDC exports in 1960 and about 77 percent of LDC exports in 1970.

Commodity Price Movements. These are best investigated in a longer time frame in order to survey trends. For this purpose, we shall use Table I.3 which presents data prepared for the Sixth Special Session of the United Nations General Assembly (April 1974) surveying the evolution of basic commodity prices in relation to the unit value of exports of manufactures.

During the 1950's prices of almost all primary commodities declined in these terms. The only major commodities which improved

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1/ The 1950 figures are from United Nations, Handbook of International Trade and Development Statistics (New York: 1972), pp. 2-3; remaining figures from Tables I.1 and I.2, which indicate their respective sources.

TABLE I.1

VALUE OF EXPORTS AND IMPORTS OF DEVELOPED MARKET ECONOMIES, CENTRALLY PLANNED ECONOMIES AND DEVELOPING MARKET ECONOMIES, 1960.
(US$ Billion f.o.b.)

	Exports	Imports
Developed Countries[a]		
(i) Primary Products[d]	26.5	39.9
(of which petroleum)	(3.4)	(8.3)
(ii) Manufactures	58.6	41.4
Total	85.1	81.3
Centrally Planned Economies[b]		
(i) Primary Products[d]	6.4	6.0
(of which petroleum)	(1.6)	(1.1)
(ii) Manufactures	8.6	9.0
Total	15.0	15.0
Less Developed Countries[c]		
(i) Primary Products[d]	23.4	9.7
(of which petroleum)	(7.7)	(2.9)
(ii) Manufactures	4.0	18.7
Total	27.4	28.4
TOTAL		
(i) Primary Products[d]	56.3	55.6
(of which petroleum)	(12.7)	(12.3)
(ii) Manufacturers	71.2	69.1
	127.5	124.7

a/ "Developed Countries" include North America, Western Europe, Japan, Australia, New Zealand and South Africa.

b/ "Centrally Planned Economies" include trade of all such countries excluding intertrade of the centrally planned economies of Asia.

c/ Sum of regions other than "Developed Countries" and "Centrally Planned Economies."

d/ "Primary Products" include SITC Categories 0, 1, 2, 3, 4.

SOURCE: United Nations, Monthly Bulletin of Statistics XIX (March 1965): xvi-xvii.

TABLE I.2

VALUE OF EXPORTS AND IMPORTS OF DEVELOPED MARKET ECONOMIES, CENTRALLY PLANNED ECONOMIES AND DEVELOPING MARKET ECONOMIES, 1970
(US$ Billion f.o.b.)

	Exports	Imports
Developed Countries[a]		
(i) Primary Products[d]	59.1	87.3
(of which petroleum)	(7.6)	(21.7)
(of which cereals)	(5.2)	(3.7)
(ii) Manufactures	165.1	133.7
Total	224.2	221.0
Centrally Planned Economies[b]		
(i) Primary Products[d]	11.3	10.2
(of which petroleum)	(3.0)	(1.8)
(of which cereals)	(0.7)	(0.9)
(ii) Manufactures	21.6	21.2
Total	32.9	31.4
Less Developed Countries[c]		
(i) Primary Products[d]	44.5	16.5
(of which petroleum)	(17.9)	(4.4)
(of which cereals)	(1.1)	(2.3)
(ii) Manufactures	10.7	41.6
Total	55.2	58.1
OPEC		
(i) Primary Products[d]	17.1	1.8
(of which petroleum)	(15.0)	(0.2)
(of which cereals)	(..)	(0.3)
(ii) Manufactures	0.7)	7.7
Total	17.8	9.5
TOTAL		
(i) Primary Products[d]	114.9	114.0
(of which petroleum	(28.4)	(28.4)
(of which cereals)	(7.0)	(7.0)
(ii) Manufactures	197.4	196.5
	312.3	310.5

a/ "Developed Countries" include North America, Western Europe, Japan, Australia, New Zealand and South Africa.

b/ "Centrally Planned Economies" include trade of all such countries excluding intertrade of the centrally planned economies of Asia.

c/ "Less Developed Countries" exclude Southern Rhodesia but include OPEC.

d/ "Primary Products" include SITC Categories 0, 1, 2, 3, 4 and 68 (Non-ferrous Metals).

SOURCE: United Nations, Monthly Bulletin of Statistics XXIV (August 1976): xxvii-xlv.

TABLE I.3

EVOLUTION OF BASIC COMMODITY PRICES SINCE 1960, MEASURED IN RELATION TO UNIT VALUE OF EXPORTS OF MANUFACTURES, FOR SELECTED BASIC COMMODITIES
(ARRANGED ACCORDING TO MAGNITUDE OF AVERAGE ANNUAL CHANGE SINCE 1950)

(PERCENT CHANGE OVER SELECTED PERIODS)

	1960 TO 1973-4Q	1950 TO 1960	1960 TO 1970	1970 TO 1973-4Q
Beef	262.7	84.6	19.2	64.9
Zinc Ore	119.0	-32.8	0.4	224.9
Copper Ore	107.8	14.1	79.0	1.8
Sisal	77.2	14.0	-50.9	216.7
Fish	91.2	0.4	39.0	37.0
Copper	89.4	11.3	73.1	-1.7
Linseeds	72.3	-5.4	-15.4	115.4
Oilseed Cake and Meal	80.9	-10.1	7.8	86.6
Zinc	80.3	-34.9	0.8	174.8
Nickel	70.3	39.5	47.0	-17.0
Poultry	35.7	0.0	-4.0	41.3
Mutton and Lamb	54.0	27.6	6.4	13.5
Lumber	53.2	9.9	-6.7	49.4
Nickel Ore	42.4	14.8	46.1	-15.2
Pork	45.7	2.3	21.0	17.7
Groundnuts	40.4	-5.5	1.3	46.6
Olive Oil	39.6	-9.9	-0.5	55.8
Coal	36.4	-9.5	28.4	17.4
Tin Ore	36.1	-12.3	40.6	10.4
Palm Kernel Oil	29.1	-1.0	-9.6	44.2
Cottonseed Oil	27.7	-29.3	9.9	64.2
Rice	33.0	-26.6	-5.9	92.6
Tin	29.1	-13.4	40.6	6.0
Crude Petroleum	28.5	-16.7	-17.9	87.6
Wheat	28.3	-28.9	-19.8	125.1
Cocoa	18.3	-17.6	-0.6	44.4
Linseed Oil	14.7	-40.1	-38.4	211.0
Bacon	11.9	-12.2	-4.4	33.2
Animal Fats and Oils	11.0	-33.6	5.3	58.8
Soybean Oil	8.3	-38.5	18.7	48.5

TABLE I.3 (Concluded)

(PERCENT CHANGE OVER SELECTED PERIODS)

	1960 TO 1973-4Q	1950 TO 1960	1960 TO 1970	1970 TO 1973-4Q
Cheese	8.3	-8.4	13.8	3.9
Wine	7.7	-6.7	7.6	7.3
Woodpulp	5.4	-6.1	-2.9	15.6
Bauxite	4.6	-12.4	59.5	-25.2
Milk	4.1	-20.3	7.6	21.5
Furskins	0.6	0.0	-18.6	23.7
Iron Ore	-1.6	42.5	-21.1	-12.5
Soybeans	-3.6	-37.8	9.0	42.0
Eggs	-6.8	-22.0	-33.0	78.4
Barley	-7.2	-28.0	-5.1	35.7
Flax	-7.8	-11.4	-1.2	5.3
Lead Ore	-8.3	-41.1	24.9	24.6
Copra	-9.0	-27.4	-13.3	44.5
Aluminium	-10.1	40.1	-7.5	-29.8
Groundnut Oil	-10.5	-19.8	4.3	7.5
Tobacco	-10.6	4.0	-2.7	-11.5
Coconut Oil	-11.3	-33.1	-2.8	37.5
Maize	-12.0	-35.3	0.1	36.8
Palm Kernels	-15.4	-12.5	-13.8	16.6
Sugar	-17.1	-40.1	-0.4	41.6
Lead	-17.1	-43.0	27.1	14.3
Chrome Ore	-19.3	6.3	-0.4	-23.8
Crude Fertilizer	-25.4	-4.0	-3.7	-19.4
Cotton	-28.6	-49.1	-14.6	64.2
Coffee	-29.7	-37.9	22.1	-7.2
Palm Oil	-32.3	-31.9	-3.8	3.3
Wool	-36.3	-48.2	-37.9	98.2
Butter	-37.2	-19.3	-13.3	-10.2
Fruit	-32.6	-5.1	-28.6	-0.5
Hides	-40.5	-42.2	28.4	43.9
Jute	-41.1	7.9	-22.1	-30.0
Rubber	-52.2	-17.8	-57.6	37.1
Manganese Ore	-45.8	-16.4	-45.3	18.6
Tea	-63.3	-18.4	33.0	-32.9

SOURCE: United Nations, General Assembly, Study of the Problems of Raw Materials and Development, Document A/9544 (New York: April 2, 1974), pp. 6-7, Table 4.

their terms of trade against manufactured goods were beef (+85%), iron ore (+43%), aluminium (+40%), nickel (+40%), copper (+11%), lumber (+10%), jute (+8%), tobacco (+4%), pork (+2%) and fish (+0.5%). Although most of the above commodities (with the notable exception of jute and sisal) were produced by developed countries, it is significant to note that important commodities produced by developed countries also experienced price declines viz-a-viz manufactured goods e.g., wheat (-29%), wool (-48%), soya bean oil (-39%), barley (-28%), etc. However, most major commodities produced by the LDC's, viz. petroleum (-17%), coffee (-38%), sugar (-40%), cotton (-50%), rubber (-18%), cocoa (-18%), tin (-13%), tea (-18%), bauxite (-12%), etc. experienced substantial deterioration in their terms of trade (against manufactures).

The experience of the 1960's was perhaps more marked. Commodities which maintained or improved their position (again vis-a-vis manufactures) were copper ore (+79%), copper (+73%), bauxite (+60%), nickel (+47%), nickel ore (+45%), tin ore (+41%), tin (+41%), fish (+39%), lead ore (+25%), coal (+28%), coffee (+22%), pork (+21%), soyabean oil (+19%), cottonseed oil (+10%), cheese (+14%), wine (+8%), milk (+8%), oilseed cake and meal (+8%), mutton and lamb (+6%), animal oil and fats (+5%). Except for bauxite, tin and coffee, these commodities were in large part the products of developed countries. However, wheat, a major product of the developed world, still remained depressed (-20%). On the other hand, the position of

a large portion of the major primary commodities produced by LDC's deteriorated still further (against our index of unit value of exports of manufactures)--petroleum (-18%), cotton (-15%), rubber (-58%), tea (-33%).

The years 1970-73 (4Q) showed a remarkable recovery in commodity prices. In this period (for the major commodities), the largest increases, again relative to manufactuers (excluding the major crude petroleum price increase of January 1, 1974), were experienced by zinc ore (+225%), sisal (+217%), zinc (+175%), wheat (+125%), wool (+98%), rice (+93%), crude petroleum (+88%), oilseed cake and meal (+87%), cotton (+64%), soyabean oil (+49%), hides (+44%) and sugar (+42%). In fact, all commodities prices showed improvement except tea (-33%), jute (-30%), aluminum (-30%), bauxite (-25%), nickel (-17%), nickel ore (-15%), iron ore (-13%) and tobacco (-12%).

The record of the past 23 years 1950-73 (4Q), therefore, encompassed a wide magnitude of changes in the fortunes of primary commodities (and their producers). Cereals (particularly wheat and rice) which had fallen in the fifties and sixties, stood about 30% higher in relation to the unit value of manufactures (for the entire period). Beef, fish, mutton and lamb and pork rose by about 50 to 260% between 1950-73 (4Q). Petroleum (without incorporating the threefold price increase of January 1, 1974) improved its position by about 28% over the same period. On the other hand, a substantial number (nearly half of all major commodities) declined in price in

relation to the unit value of manufactures (for the period as a whole): tea (-63%), rubber (-52%), jute (-41%), coffee (-30%), cotton (-29%), lead (-17%), sugar (-14%), etc.

Terms of Trade. The effects of these commodity price changes are summarized in terms of trade indices. A finding of a secular deterioration in terms of trade for primary products was initially published in a United Nations document in 1949. The UN study claimed that "from the latter part of the nineteenth century to the eve of the second world war ... there was a secular downward trend in the price of primary goods relative to the price of manufactured goods. On an average, a given quantity of primary exports would pay, at the end of this period, for only 60 percent of the quantity of manufactured goods which it could buy at the beginning of the period.2/"

The 1950's and early 1960's saw both vigorous affirmation on the thesis of deterioration in the LDC's commodity terms of trade and its denial. Landmarks in the arguments supporting the thesis were works by H.W. Singer, W.A. Lewis and Raul Prebisch.3/ The agreement was questioned on both theoretical and empirical grounds by (among

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2/ United Nations, Department of Economic Affairs, Relative Prices of Exports and Imports in Underdeveloped Countries (New York: 1949), p. 72.

3/ H.W. Singer, "The Distribution of Gains Between Investing and Borrowing Countries," American Economic Review," Papers and Proceedings, May 1950, pp. 477-479; W.A. Lewis, "World Production, Price and Trade, 1870-1960," Manchester School of Economic and Social Studies, May 1952; Raul Prebisch, "Commercial Policy in Under-developed Countries," American Economic Review, Papers and Proceedings, May 1959, pp. 261-264.

others) R.E. Baldwin, Gottfried Haberler and M. June Flanders.4/ The controversy still has not been satisfactorily resolved.

Gains or losses incurred by the less developed countries due to changes in their terms of trade have been estimated for the period 1956-72 based on 1955 average prices.5/ Although there is an element of arbitrariness in the choice of any base year, the choice of the year 1955 is fairly defensible in that the effects of the Korean War had disappeared from international commodity markets. Table 1.4 sums up the results. These indicate fairly substantial losses (ranging between US$3-5 billion per annum) in most years from 1956 to 1972.

It would be only proper to mention here that there has been a substantial net flow of financial resources from developed countries to less developed countries as official aid, grants by private voluntary agencies and loan credits and investments at market terms. An often referred to indicator of "aid" is the Official Development Assistance (ODA) by 17 of the 24 members of the OECD who are members of the Development Assistance Committee (DAC). ODA consists of

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4/ R.E. Baldwin, "Secular Movements in the Terms of Trade," American Economic Review, Papers and Proceedings, May 1955, pp. 267-268; Gottfield Haberler, "Terms of Trade and Economic Development," in Howard S. Ellis, ed., Economic Development for Latin America (New York: St. Martin's Press, 1961), pp. 275-297; M. June Flanders, "Prebisch on Protectionism: An Evaluation," Economic Journal, June 1964, pp. 309-316.

5/ Estimation of gains and losses due to change in developing countries' terms of trade are based on the methodology developed by UNCTAD (see UNCTAD, Review of International Trade and Development (New York: 1967), TD/5/Rev. 1, p. 24).

TABLE I.4: DEVELOPING COUNTRIES: GAINS OR LOSSES ON ACCOUNT OF CHANGES IN TERMS OF TRADE

Year	Export unit value 1955=100 (1)	Change in export unit value from base year (2)=(1)-100	Value of exports (3)	Gains (+) or Losses (-) (4)=(2)x(3)	Import unit value 1955=100 (5)	Change in import unit value from base year (6)=(5)-100	Value of imports (7)	Gains (+) or Losses (-) (8)=(6)x(7)	Net Gains (+) or Losses (-) (9)=(4)+(8)
	Per cent		$ U.S. Million		Per cent		$ U.S. Million		
1956	99.1	-0.9	24,900	-224	101.0	+1.0	26,300	-263	-487
1957	99.1	-0.9	25,400	-229	104.0	+4.0	29,800	-1,192	-1,421
1958	94.6	-5.4	24,800	-1,339	100.0	.	27,800	.	-1,339
1959	92.8	-7.2	25,800	-1,858	97.0	-3.0	27,400	+822	-1,036
1960	92.8	-7.2	27,300	-1,966	98.0	-2.0	30,200	+604	-1,362
1961	90.1	-9.9	27,800	-2,752	98.0	-2.0	31,100	+662	-2,090
1962	87.4	-12.6	29,000	-3,654	99.0	-1.0	31,500	+315	-3,339
1963	90.1	-9.9	31,500	-3,119	99.0	-1.0	32,900	+329	-2,790
1964	92.8	-7.2	34,600	-2,491	101.0	+1.0	36,200	-362	-2,853
1965	91.9	-8.1	36,000	-2,916	102.0	+2.0	37,000	-740	-3,656
1966	92.7	-6.3	38,600	-2,432	102.0	+2.0	40,200	-804	-3,236
1967	92.8	-7.2	39,200	-2,824	102.0	+2.0	41,200	-824	-3,648
1968	92.8	-7.2	42,800	-3,082	101.0	+1.0	44,600	-446	-3,528
1969	95.5	-4.5	47,800	-2,151	104.0	+4.0	48,900	-1,956	-4,107
1970	98.2	-1.8	53,500	-963	107.9	+7.9	54,800	-4,329	-5,292
1971	103.6	+3.6	59,400	+2,138	111.9	+11.9	61,400	-7,307	-5,169
1972	108.1	+8.1	69,200	+5,605	114.9	+14.9	69,300	-10,326	-4,721

Source: Derived from United Nations Handbook of International Trade and Statistics (New York: 1972), pp. 2,3,10,11,38,39; United Nations Monthly Bulletin of Statistics (New York: October 1963) pp. xviii-xx, November 1973, pp. 110,111.

grants and loans at concessional terms extended by the public sector. Table 1.5 indicates the substantial sums (averaging about US$7 billion per annum) transferred to LDC's as development assistance.

B. Commodity Trade and Price Movements - The Post 1973 Experience

Trade Volume. The size of world trade increased from about $312 billion in 1970 (Table I-2) to $830 billion in 1974 (Table I.6) and $1124 billion in 1977 (Table I.7). The most significant changes occurred in the value of trade of two commodity groups, viz. petroleum (which increased eight-fold in value terms to $221 billion in 1977) and cereals (which tripled in value to $20 billion in 1977). The petroleum price increase caused severe adjustment problems in both developed and less-developed countries, while the cereal (largely wheat) price increase caused problems largely in less-developed countries. There were subsequently wide-ranging commodity price adjustments.

Commodity Price Movements. As Table I.8 indicates, commodity price movements in the post-1973 period have also been unstable. Energy related products (petroleum, coal) increased their prices substantially in real terms. Metals generally held firm, except for copper and iron ore - both of which experienced substantial declines. Only four agricultural products - coffee, cocoa, tea and pepper showed substantial real gains. All other agricultural product prices declined in real terms. This was also true of wheat prices, which,

TABLE I.5

NEW FLOW[1/] OF OFFICIAL DEVELOPMENT ASSISTANCE
FROM DAC COUNTRIES, 1962-1977
(US $ Million)

Year	(a) Bilateral Grants and Grant Like Flows	(b) Bilateral Loans at Concessional Terms	(c) Contributions to Multilateral Inst.	(a)+(b)+(c) TOTAL ODA (current prices)	TOTAL ODA (Constant Prices) 2/
1962	4020	907	511	5438	6316
1963	3940	1465	367	5772	6485
1964	3806	1740	405	5952	6881
1965	3714	1833	348	5895	6471
1966	3701	1947	336	5984	6999
1967	3578	2227	736	6541	7056
1968	3344	2283	683	6310	6691
1969	3251	2320	1050	6621	6883
1970	3323	2384	1124	6832	6832
1971	3634	2786	1339	7759	7453
1972	4370	2396	1904	8670	7652
1973	4482	2684	2249	9415	6764
1974	5336	2921	3047	11304	6673
1975	621	3547	3770	13585	7120
1976	6542	2963	4160	13665	7139
1977	7203	2881	4612	14696	7381

1/ Gross disbursements minus amortization receipts on earlier lending.
2/ GNP deflator (1970=100) from OECD, Development Cooperation (Paris, 1973), p. 197; 1977, p. 169; and 1978, p. 196.

Source: For 1961-62 data, OECD, Flow of Resources to Developing Countries (Paris, October 1973) p 431. For 1963-1973 data, OECD, Development Assistance (Paris, 1973) and Recent Trends, Press/A(74)25 (Paris, July 1974) p. 14. For 1974-1977 data, OECD, Development Cooperation Paris, 1977) p. 188 and 1978 p. 202.

TABLE I.6

ESTIMATED VALUE OF EXPORTS AND IMPORTS OF DEVELOPED MARKET ECONOMIES, CENTRALLY PLANNED ECONOMIES AND DEVELOPING MARKET ECONOMIES, 1974
(US$ Billion f.o.b.)

	Exports	Imports
Developed Countries[a]		
(i) Primary Products[d]	146.4	275.6
(of which petroleum)	(26.5)	(134.5)
(of which cereals)	(18.0)	(10.3)
(ii) Manufactures	395.8	311.7
Total	542.2	587.3
Centrally Planned Economies[b]		
(i) Primary Products[d]	27.4	21.9
(of which petroleum)	(9.9)	(4.0)
(of which cereals)	(1.3)	(.28)
(ii) Manufactures	43.7	48.8
Total	71.1	70.7
Less Developed Countries[c]		
(i) Primary Products[d]	190.0	63.2
(of which petroleum)	(133.7)	(28.9)
(of which cereals)	(3.2)	(9.0)
(ii) Manufactures	32.2	108.8
Total	222.2	172.0
OPEC		
(i) Primary Products[d]	120.6	11.3
(of which petroleum)	(116.4)	(0.7)
(of which cereals)	(..)	(2.0)
(ii) Manufactures	1.7)	24.8
Total	122.3	36.1
TOTAL		
(i) Primary Products[d]	363.8	360.7
(of which petroleum	(170.1)	(170.1)
(of which cereals)	(22.5)	(22.5)
(ii) Manufactures	471.7	469.3
	835.5	830.0

a/ "Developed Countries" include North America, Western Europe, Japan, Australia, New Zealand and South Africa.

b/ "Centrally Planned Economies" include trade of all such countries excluding intertrade of the centrally planned economies of Asia.

c/ "Less Developed Countries" exclude Southern Rhodesia but include OPEC.

d/ "Primary Products" include SITC Categories 0, 1, 2, 3, 4 and 68 (Non-ferrous Metals).

SOURCE: United Nations, Monthly Bulletin of Statistics (New York: August 1976): XXVIII-XIV.

TABLE I.7

VALUE OF EXPORTS AND IMPORTS OF DEVELOPED MARKET ECONOMIES, CENTRALLY PLANNED ECONOMIES AND DEVELOPING MARKET ECONOMIES, 1977
(US$ Billion f.o.b.)

	Exports	Imports
Developed Countries[a]		
(i) Primary Products[d]	177.4	331.8
(of which petroleum)	(36.2)	(166.0)
(of which cereals)	(15.7)	(9.7)
(ii) Manufactures	550.4	419.3
Total	727.8	751.1
Centrally Planned Economies[b]		
(i) Primary Products[d]	41.5	35.2
(of which petroleum)	(20.5)	(10.5)
(of which cereals)	(1.1)	(3.3)
(ii) Manufactures	66.0	68.9
Total	107.5	104.1
Less Developed Countries[c]		
(i) Primary Products[d]	238.0	81.3
(of which petroleum)	(164.5)	(39.1)
(of which cereals)	(3.3)	(6.8)
(ii) Manufactures	50.3	177.2
Total	288.3	258.5
OPEC		
(i) Primary Products[d]	148.5	13.3
(of which petroleum)	(142.7)	(1.8)
(of which cereals)	(..)	(2.3)
(ii) Manufactures	2.2	69.0
Total	150.7	82.3
TOTAL		
(i) Primary Products[d]	456.9	448.3
(of which petroleum	(221.2)	(215.6)
(of which cereals)	(20.1)	(19.8)
(ii) Manufactures	666.7	665.4
	1123.6	1113.7

a/ "Developed Countries" include North America, Western Europe, Japan, Australia, New Zealand and South Africa.

b/ "Centrally Planned Economies" include trade of all such countries excluding intertrade of the centrally planned economies of Asia.

c/ "Less Developed Countries" exclude Southern Rhodesia but include OPEC.

d/ "Primary Products" include SITC Categories 0, 1, 2, 3, 4 and 68 (Non-ferrous Metals).

SOURCE: United Nations, Monthly Bulletin of Statistics XXXIII (August 1976): xxxii-lvi.

TABLE I.8

EVOLUTION OF BASIC COMMODITY PRICES 1974-77 MEASURED IN RELATION TO UNIT VALUE OF EXPORTS OF MANUFACTURES
(ARRANGED ACCORDING TO MAGNITUDE OF CHANGE)
(PERCENTAGE CHANGE OVER SELECTED PERIOD)

	1973 to 1977
Petroleum	+187
Coffee	+142
Cocoa	+86
Coal	+63
Bauxite	+54
Tea	+56
Tin	+47
Phosphate Rock	+39
Potassium Chloride	+33
Aluminium	+28
Palm Oil	+27
Manganese	+23
Pepper	+23
Lead	+18
Steel	+8
Zinc	+4
Tobacco	+1
Nickel	-4
Bananas	-10
Groundnut Oil	-14
Iron Ore	-27
Logs	-34
Lamb	-34
Rubber	-36
Cotton	-37
Sisal	-38
Coconut Oil	-41
Copper	-43
Jute	-54
Sawnwood	-62

TABLE I.8 (Concluded)

	1973 to 1977
Soyabean	-66
Maize	-68
Sorghum	-69
Plywood	-83
Sugar	-83
Linseed Oil	-88
Fish Meal	-91
Rice	-106
Beef	-113
Wheat	-128
Wool	-130

Source: World Bank, Commodity Trade and Price Trends (Washington, D.C.: August 1978).

however, still remained higher than the levels experienced in the period 1960-72.

Some Implications of Commodity Price Movements. The tremendous increase in the value of petroleum exports (entirely due to the increase in realized price from $1.80 a barrel in 1970 to $13.33 per barrel till 1977) has changed the economic prospects of the oil producing countries. Without going into the associated problems of "absorptive capacity" and the overall financial implications of that change for the world economy, the result of the increased price of oil as a result of OPEC action has meant that 15 countries (Algeria, Bahrain, Bolivia, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Oman, Qatar, Saudi Arabia, Trinidad and Tobago, United Arab Emirates and Venezuela) with a population of about 300 million, have emerged from a position of being relatively poor or "low-income" countries to relatively affluent positions with vastly improved prospects for future economic growth.6/

The non-oil producing countries (with the exception of certain labor surplus countries--e.g. Egypt, Pakistan and the Yemen Arab Republic which have benefitted from increased employment opportunities in OPEC countries) have been left in a worse-off position than before. The developed Western countries have, to some extent, adjusted by compensatory price increases on their manufactures and primary commodities and through use of their sophisticated financing

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6/ Population figures are from International Bank for Reconstruction Development, World Bank Atlas (Washington, D.C.: 1978), p. 8.

mechanisms (including the use of their currencies as reserve currencies). Less-developed countries, on the other hand, have been by and large forced to pay higher prices both for the products of the oil-producing countries and for those of developed countries. Less developed country exports continue to be affected by both price declines and price instability. The recent past has, accordingly, seen a concerted effort by these countries to increase prices of their export commodities.

C. Proposals to Support Primary Commodity Prices, including the call for a "New International Economic Order"

The Sixth Special Session of the United Nations (April 1974) was devoted solely to the problems of raw materials and development. It reviewed "... the continuing severe economic imbalance in the relations between developed and developing countries" and reached the conclusion that "all efforts should be made ... to evolve a just and equitable relationship between the prices of raw materials, primary commodities, semi-manufactured and manufactured goods exported by developing countries and the raw materials, primary commodities, food, manufactured and semi-manufactured goods and capital equipment imported by them".7/

The United Nations Conference on Trade and Development (UNCTAD) was charged by the General Assembly to evolve an "integrated program

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7/ From the "Program of Action of the establishment of a New International Economic Order", quoted in J.P. Hayes, Terms of Trade Policy for Primary Commodities, Commonwealth Economic Papers No. 4 (London: Commonwealth Secretariat, 1975), p. 3.

for commodities". UNCTAD's proposal for such an integrated program was based on five major components: (i) setting up international commodity buffer stocks; (ii) creation of a common fund for the financing of commodity stocks; (iii) a system of multilateral trade undertakings; (iv) compensatory financing of export fluctuations in commodity trade; and (v) trade measures to expand processing of primary commodities in developing countries.[8/] Studies completed by UNCTAD examine the first two elements of the program in depth and focus on the creation of a common fund for the financing of commodity stocks.[9/] As proposed by the Secretary General of UNCTAD, the $6 billion fund ($3 billion cash, $3 billion credit facilities) will finance stockpiles of ten "core" commodities produced by LDC's (coffee, cocoa, tea, sugar, jute, sisal, rubber, cotton, copper and tin) and a lesser value of selected other commodities (including wool, tungsten, lead and zinc) produced by both LDC's and developed countries. The fund could have either an "arms-length relationship" with commodity organizations--merely extending them loans at fixed interest--or it could buy participation in their buffer stocks and

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8/ United Nations, An Integrated Programme for Commodities - Report by the Secretary General of UNCTAD, UNCTAD document TD/B/C.1/166, supplement 1 and addendum 1, supplement 2, 3, 4, 5 (Geneva: December 9, 1974).

9/ United Nations, An Integrated Programme for Commodities - A Common Fund for the Financing of Commodity stocks: Amounts, Terms and Prospective Sources of Finance; Report by the Secretary General of UNCTAD, UNCTAD Document TD/B/C.1/184 (Geneva: June 24, 1975).

share in trading results. The fund would support floor prices and defend ceiling prices (both being reviewable from time to time) and may also have authority to ensure that export quotas or other forms of export regulation could be initiated at periods of serious excess of supplies. Whilst the fund is aimed primarily at stabilizing commodity prices; it is expected, in the long-run, to also lead to a somewhat higher level of prices for these commodities. The proposals regarding the fund are still under negotiation.

Proposals to support individual commodity prices have, to date, had little support from Western countries. The Lome Convention between the European Common Market and the 46 ACP (African, Caribbean and Pacific) states, while providing for stabilization of export earnings of ACP states, uses the "Stabex" principle, i.e., it provides for a guaranteed level of export earnings for a group of products which may be produced by a particular country without any notion of direct price support for individual products. Further, the group of products specified includes only one mineral--iron ore--and in a separate declaration the convention states that "for reasons of principle [it] is firmly opposed to the inclusion of mineral products in the list ... It is therefore agreeing to the inclusion of iron ore ... solely to enable overall agreement to be reached on the new convention. It will not fail to oppose any subsequent inclusion of minerals on that list."10/

10/ From the text of the Lome Convention, as reported in European Report No. 212 (Brussels: March 1, 1975), Feature p. 5.

D. Prospects for Primary Commodity Price Agreements and The Role of "Supply Management"

Some conclusions regarding primary commodity prices which can be drawn from the foregoing review are as follows: (i) historically, primary commodity prices have been subject to considerable instability; (ii) the behaviour of these prices affects the vital interests of major groups of countries; and (iii) conflicting interests of producers and consumers are unlikely to result in successful implementation of universally backed schemes for commodity price stabilization, particularly if the aim is to stabilize prices at higher than present day levels.

It is therefore increasingly probable that groups of producing countries will attempt to coordinate production and marketing policies of individual primary commodities in order to achieve a variety of objectives (higher prices, price stability, etc.). While the possibility has been raised that this will be resorted to by less-developed countries, it is also likely that all producers of primary commodities (both developed and less developed) will explore appropriate supply management mechanisms to ensure beneficial and remunerative prices. This thesis is aimed at investigating both the theoretical pre-conditions for such a move and the practical implications of applying such policies to selected individual commodities.

CHAPTER II

HISTORY OF COMMODITY PRODUCER GROUPINGS, SURVEY OF THE LITERATURE

Producers' alliances or cartels to control the supply of primary commodities have been subject to extensive examination. Even the terminology itself has been subject to debate. Mabro, in a lecture on OPEC, stated "OPEC is often referred to as a cartel. This is at best an approximation ..."[1]. Without entering the particular debate on whether OPEC is a cartel or not, the subject of our study is whether producers of primary commodities can group themselves to reach agreement on prices and/or market shares with or without production quotas. The words "producers' alliances" or "producer groupings" will be used throughout this analysis to reflect such coordinated action. This chapter reviews the historical experience of producer groupings (Sections A and B) and also the current literature on the subject (Sections C and D).

A. Raw Material Producer Groupings, 1918-45

Some of the earliest works on raw material producer groupings were those conducted by the League of Nations. Among the many studies produced by the League, a major work by Lovasy reviews the functioning of raw material producer groupings in the period 1918-45.[2]

1/ Robert Mabro, "Can OPEC hold the Line," Middle East Economic Survey, Vol. XVIII, No. 19 (London: Feb. 28, 1975), Supplement pp. 1-6.

2/ Gertud Lovasy, International Cartels, A League of Nations Memorandum (Lake Success, New York: 1947), pp. 3-7 and Attachment Tables 1 and 2.

Lovasy points out that the "greater" part of the world's essential minerals, and two important agricultural products (rubber and wood pulp) were subject to international "producer groupings" for varying periods between the two World Wars. Producer groups were formed for steel, smelter copper, lead, zinc, tin ore, aluminium, mercury, sulphur, potash, phosphate rock, petroleum, and, as mentioned earlier, for rubber and wood pulp. Their main purpose was to restrict or eliminate competition and raise and stabilize prices, which had been adversely affected by the cut in war production and the resultant emergence of excess capacity after the various major economies came out of the First World War. Later on, raw-material prices were adversely affected by the Great Depression. The methods adopted to achieve price stabilization included sales quotas, export quotas, and/or outright restriction of output. The activities of the steel groups, copper groups (which mainly comprised private producers) and the tin ore and rubber groups (with governments as members) are outlined below as an example of the general activities of producer groups during this period.

The first steel producer group (September 1926-March 1931) comprised Germany, France, Belgium, Luxemburg and Saar as the original members, with Australia, Czechoslovakia and Hungary joining en-bloc later in 1927. The object of the group was to eliminate severe competition existing in the industry by means of production quotas for crude steel. The drastic fall in steel export prices after 1929

could not be prevented as a result of the Great Depression, and there was considerable dissatisfaction among individual countries with their quotas. However, reservation of domestic markets to national producers was maintained, which resulted in stable domestic prices. The second steel grouping (June 1933-Autumn 1939) included Germany, France, Belgium, Luxemburg, Poland and Czechoslovakia, with the United Kingdom (1935) and the United States (1938) as co-operating countries. The purpose of this second group was to regulate exports and export prices, and to continue the reservation of domestic markets for national production. Export control (through global export quotas) was instituted, instead of the production controls of the first grouping. Minimum prices for export sales were established with fines for exceeding, and compensation for not exhausting, quotas. The success of the second group is indicated in Table II.1 below which shows the successful maintenance of domestic prices during 1932-38 and the gradual restoration of high export prices in the same period.

The first copper (smelter) producer grouping (1926-32) comprised private producers of the United States, Chile, the Belgian Congo and Germany, who were responsible for 90-95 percent of world production of the commodity. The main purpose of the group was to stabilize prices and eliminate middlemen. Prices were fixed by two central offices, and the open market was replaced by bargaining with each consumer separately. From 1929 onwards, restrictions on output were

TABLE II.1: Steel Price Indices
(1929 = 100)

	Export Price f.o.b. Antwerp	Domestic Price	
		Germany	France
1929	100	100	100
1930	84	91	86
1931	60	90	67
1932	43	78	70
1933	49	78	74
1934	55	78	75
1935	55	78	75
1936	56	78	81
1937	92	78	123
1938	88	78	145

Source: Gertud Lovasy, International Cartels, A League of Nations Memorandum (Lake Success, New York: 1947), pp. 3-7 and Attachment Tables 1 and 2.

applied. This grouping was generally unsuccessful in its objective of stabilizing prices, which rose sharply in boom years and fell during the depression. The latter could not be checked by output restriction and the introduction of a 4 cents (U.S. currency) per pound duty in the United States resulted in the grouping's termination. The second copper group (1935-40) comprised private producers of Chile, the Belgian Congo, Northern Rhodesia and Germany, with the United States and Germany as co-operating member countries. The main policy instrument employed was the restriction of output to about 70 percent of capacity. A steady increase in copper prices resulted, primarily as a result of this supply management.

The first tin ore producer grouping (1921-25) was a government pool with Malaya, the Netherlands and the East Indies as members. The limited purpose of the grouping was to dispose of surplus stocks. The mechanism adopted was that the governments of the group purchased stocks and released them, starting in 1923, at higher prices. The second tin grouping was formed in March 1931 and lasted till 1942, with the same original members plus Nigeria and Bolivia, and with Siam joining in September 1931 and French Indo-China, the Belgian Congo, Portugal and the United Kingdom joining in 1934. The purpose of this second grouping was to counteract the sharp price fall and dispose of excess stocks. A production restriction scheme was adopted and buying pools were formed to hold stocks for higher prices. The restriction schemes succeeded in keeping prices high;

but had the effect (as is usual in such schemes) of preserving high cost producers while low-cost producers were not producing to full capacity.

The first rubber grouping (1922-29) was formed by the Governments of Malaya and Ceylon (both then British colonies). The objective of the group was to raise and stabilize prices of rubber (at about 1s. to 1s. 3d. per lb., British currency) through sharp restrictions in output and exports. As a result of these actions, prices rose to desired levels and peaked at 4s. 7d. per lb. in 1925. However, prices declined thereafter--the major weakness of the scheme being the exclusion from the rubber grouping of the Netherlands East Indies which in turn rapidly increased its production. The second rubber grouping (1934-44) included Malaya, Ceylon, India, Burma, the Netherlands East Indies, French Indo-China, North Borneo and Sarawak. The object of the second grouping was to counteract over-production and raise and stabilize prices. Production quotas were adopted and exports were fixed from time to time as a percentage of basic quotas. New plantings were completely prohibited, but later allowed within certain limits. The scheme was considered to be generally effective (in part because of favourable business conditions) and succeeded in achieving moderate increases in prices and reducing stocks.

B. The Post-Second World War Experience of Commodity Producer Groupings

The post-Second World War years saw the beginning of the end of the colonial era. The raw-materials issue therefore assumed a new

dimension. Previously, the problems related to control of production and marketing by and among the major countries (some with extensive colonies themselves). The emergence of new political entities (many of them ex-colonies and all under-developed) with their own economic interest, as major existing or potential sources of raw materials, inevitably began to alter existing historical arrangements in this field. However, until recently, there were no dramatic developments because of the existence of large multinational corporations which dominated the raw-materials (and particularly the minerals) industry in all its varied aspects from production to marketing.

A recent United Nations study has pointed out that the domination of multinational corporations in a number of raw materials sectors has greatly declined in the recent past.3/ However, oligopolistic control still characterizes the raw materials industry (particularly in minerals). In steel, according to Varon and Nusbaumer, 20 corporations (with combined 1970 production of 241 million tons) were responsible for producing 57% of the world market economies' output for 1970.4/ With regard to iron ore, the same authors estimated (for 1968) that 30% of all ore traded originated in 'captive' mines (i.e., mines owned or controlled by steel companies and

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3/ United Nations, Multinational Corporations in World Development, Department of Economic and Social Affairs, Document No. ST/ECA/190 (New York: 1973).

4/ Bension Varon and Jacques Nusbaumer, The International Market for Iron Ore: Review and Outlook, Bank Staff Working Paper No. 160 (Washington, D.C.: International Bank for Reconstruction and Development, August 1973), pp. 10-11, Tables 2 and 7.

supplying their ore requirements), 36% was traded under long-term contracts and only 34 percent was traded in the free market.5/ With regard to nickel, one firm alone (The International Nickel Company of Canada) produced and sold 46% of the world's requirements for nickel in 1973.6/ The oligopolist structure of the oil industry is well known and many other minerals are produced and marketed under similar conditions. In the field of agricultural products, the case of bananas is perhaps the most striking. Three international firms (The United Fruit Company, Standard Fruit and Del Monte) together supplied about 70 percent of all bananas entering world trade (35%, 25% and 10%, respectively) in 1970-71[7/]. In cocoa, over 80 percent of the total production of chocolate and other cocoa products in the United States and Western Europe was controlled by nine companies during 1974-75.8/

5/ United States steel producers control more than half of Canada's and nearly all of Venezuela's iron ore production through 'captive' mines, according to Varon and Nusbaumer, op. cit.

6/ International Nickel Co. of Canada's nickel production and sales were 234.5 thousand metric tons in 1973 according to the Financial Times, Mining International Year Book, 1975 (London: 1975) p. 304, while western countries consumption of the metal for 1973 was 511.7 thousand metric tons according to Metallgesellschaft Aktiengesellschaft, Metal Statistics 1963-1973, 61st Edition (Frankfurt Am Main: 1974), pp. 4-5.

7/ United Nations, UNCTAD, The Marketing and Distribution System for Bananas, Document No. TD/B/C.1/162 (Geneva: December 1974), p. 28.

8/ United Nations, UNCTAD, "The Marketing and Distribution System for Cocoa," Document No. TD/B/C.1/164 (Geneva: January 9, 1975), p. 73.

Raw material producers' alliances of less-developed countries have been limited to a few commodities. The oldest and best known of these is OPEC--the Organization of Petroleum Exporting Countries. OPEC was founded in 1960 by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela and has gradually expanded to include most other major oil producers from less-developed countries (i.e., Indonesia, Algeria, Libya, United Arab Emirates, Qatar, Nigeria, Ecuador and Gabon). As Connelly and Perlman have pointed out, it was established as a reaction to the oil companies' reduction of posted prices for crude oil (the reference price for calculating Government revenue), and in the sixties OPEC's principal achievement was acknowledged to be that posted prices were not further eroded.9/ It was only in the early 70's that world events turned in OPEC's favour and enabled participating countries to vastly increase prices but also to obtain a majority share in production operations.10/ The concept of linking the price of oil to the cost of obtaining energy from alternative sources was also introduced by OPEC to explain the oil price increases of 1973.

Other producers' alliances of developing countries in the field of raw materials are more recent and include the important copper

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9/ Phillip Connelly and Robert Perlman, The Politics of Scarcity, (London: Oxford University Press, 1975), pp. 68-86.

10/ An interesting account of the OPEC experience is also found in Abbas Alnaswari, "The Collective Bargaining Power of Oil Producing Countries, Journal of World Trade Law, Vol. 7, No. 2, March-April, 1973, pp. 188-207.

producers organized through CIPEC (Conseil Intergovernmental des Pays Exportateurs de Cuivre), which was formed in June 1967 and comprises Chile, Zambia, Zaire, Peru and more recently, Australia, Papua New Guinea, Indonesia and Mauritania.[11] Major bauxite producers from less developed countries (Guinea, Guyana, Jamaica, Surinam and Sierra Leone joined with Australia and Yugoslavia to form the International Bauxite Asssociation in 1974.[12] The decision of Australia, a developed country, to join with less-developed countries, was important in that the interests of primary producing countries as a whole, whether developed or belonging to the Third World, coalesced for the first time. An Association of Mercury Producers, comprising companies rather than governments, but the companies in question operating largely under Government control, was formed in 1975 among producers from Turkey, Yugoslavia, Peru, Argentina, Spain and Italy.[13] The Association of Iron Ore Exporting countries was established in 1975 with Mauritania, Algeria, Chile, India, Venezuela and Australia as members, and with Tunisia, Peru, Sweden, Brazil and Sierra Leone being expected to join in the future.[14] Tungsten producers also created a "producers association" in 1975.[15] In

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11/ Connelly and Perlman, op. cit. pp. 82-88.

12/ Connelly and Perlman, op. cit. pp. 88-90.

13/ The New York Times, April 18, 1975, p. 47.

14/ The International Monetary Fund, International Monetary Fund Survey (Washington, D.C.: July 28, 1975), p. 221.

15/ C. Fred Bergsten, "The U.S. Now Must Deal with the other Cartels" The New York Times, June 1, 1975, p. E-4.

the field of phosphates, unilateral price increases by Morocco, which is the largest producer of the commodity after the United States and Russia, resulted in quadrupling of phosphate prices between 1973 and 1974.16/ The producers of natural rubber have organized themselves into a six-nation Association of Rubber producing Countries (ANRPC) comprising Indonesia, Malaysia, Thailand, Singapore, Sri Lanka and Vietnam, and have co-ordinated arrangements to set up a $470 million rubber buffer stock and procedures for a proposed co-ordinated marketing system among member countries.17/ Banana producers set up UPEB (Union de paises exportadores del banano) in 1974 with Colombia, Costa Rica, Honduras, and Guatemala as members.18/

International consultative organizations exist for rubber (The International Rubber Study Group founded in 1944), oils and fats (the Inter-Governmental Group on Oilseeds, Oils and Fats founded in September 1966), lead and zinc (the Lead and Zinc Study Group founded in 1960), and certain other commodities, and are normally composed of major exporting and importing countries, with other interested countries as observers. Such organizations normally are used to provide accurate statistical information, serve as a forum for discussion,

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16/ Middle East Monitor, Vol. IV, No. 14, July 15, 1974, p. 1.

17/ International Monetary Fund, International Monetary Fund Survey (Washington, D.C.: February 3, 1975), p. 43.

18/ United Nations UNCTAD, The Marketing and Distribution System for Bananas, op. cit.

and study issues, both technical and otherwise, of interest to the Group. No price or earnings targets are set.

Other "informal" groupings, meeting mainly under the auspices of the FAO (Food and Agriculture Organization of the United Nations), include those on tea; jute, kenaf and allied fibres; and sisal, henequen and abaca. These groupings attempt to set indicative price ranges (tea is an exception where no agreement could be reached), but in the absence of formal export quotas or buffer stocks their efforts have been largely ineffectual.

C. Prospects of Producers' Alliances in (non-Fuel) Primary Commodities - A Survey of the Literature

The current literature available on the subject is limited in extent but significant in nature. Some of the more important of these studies are discussed below with regard to their coverage, analytical techniques, and their major conclusions.

In a major pioneering study undertaken in 1972, Takeuchi examined the possibilities of effective action by CIPEC to enhance the export earnings of member countries.19/ His methodology focuses around the use of existing estimates of supply and demand price elasticities (and is discussed further in Chapter III of this thesis). Assuming that an oligopolist (CIPEC in this case) would be able to increase export earnings by restricting supply to the market if the

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19/ Kenji Takeuchi, "CIPEC and the Copper Export Earnings of Member Countries" The Developing Economies, Vol. X, Number 1 (Tokyo: March, 1972), pp. 3-29.

absolute value of price elasticity of demand is less than unity, Takeuchi points out that the short-run elasticity of demand for copper in the world as a whole lies in the range of (minus) 0.1 to 0.3 and the price elasticity of supply outside CIPEC lies between 0.2 and 0.4. In the short run, therefore, examination of these elasticity estimates indicate that prospects of a successful supply cut-back by CIPEC are fairly good. The longer term elasticities are, however, higher (with the long-run elasticity of demand being -2.8 for copper, and long-run elasticity of supply outside CIPEC being at least 0.7 and perhaps as high as 2.0). Therefore, the combination of CIPEC's total share of world production (40% at end 1969) and the value of the long-run elasticities of supply and demand outside the CIPEC, indicated to Takeuchi that CIPEC could not increase its export earnings from copper on a long-term basis by cutting back supply to the rest of the world. Takeuchi's study is confined only to the determination whether prima-facie a supply cut-back would be beneficial to CIPEC. No quantitative assessment of gains or losses was attempted.

C. Fred Bergsten of the Brookings Institution, in a series of three publications (1973-75), has stressed the threat that "the industrialized west" faces from the less-developed countries. In his first work on the subject he points out that the OPEC example could be followed by concerted action by copper, tin and bauxite producers (concerted action would reduce the risk to each that cheaper aluminum

or tin would substitute for higher priced copper or vice-versa).[20] Similar alliances of producers of coffee, cocoa and tea would preempt similar substitution. Thus subtle pricing and marketing strategies could boost consumer costs and producer gains without pushing countries to the development of substitutes which would require heavy initial investment and start up costs. All that was needed to pursue such co-operation was increased knowledge of the market and the potential gains from concerted action, self-confidence and leadership. Bergsten's second publication stresses that previous buyers' markets in primary commodities are becoming sellers' markets, and that there is a threat of producers' cartels in bauxite, tin, copper, rubber and bananas.[21] His third publication points out that, as of June 1975, cartels existed in 12 commodities.[22] Bergsten's penetrating analysis in all three studies is largely qualitative in nature. No supply or demand estimates were presented. Bergsten did not analyze the possibilities that any of the cartels he identifies will provide any substantial benefits to producers--either in the short or long run.

20/ C. Fred Bergsten, The Threat from the Third World (Washington, D.C.: The Brookings Institution, 1973).

21/ C. Fred Bergsten, Statement in "Global Scarcities in an Interdependent World, Hearings before the Subcommittee on Foreign Economic Policy of the Committee on Foreign Affairs," House of Representatives, 93rd. Congress, (Washington, D.C.: May 1974), pp. 118.

22/ C. Fred Bergsten, "The United States Now Must Deal With The Other Cartels," The New York Times, June 1, 1975, p. E-4.

Haque (1973) examined the prospects of OPEC type alliances being formed by developing countries for agricultural commodities.23/ He uses the following criteria to evaluate the chances of success of a producers' alliance trying to exploit elasticity of demand to its advantage: (i) a small number of producing countries, (ii) the commodity in question should be only marginally important as a source of export earnings or employment for each member country of the alliance, (iii) there should exist alternative productive employment opportunities for resources set free by reducing production, (iv) a rapidly growing demand and (v) absence of close substitutes, especially synthetic substitutes. Haque's analysis is conducted through reviewing each commodity by these criteria. He concludes that coffee, cocoa, tea, pepper and timber each represent cases where the producers possess and probably could exercise monopolistic strength. Haque's analysis is presented in largely qualitative terms. Quantification of potential gains was not undertaken in the analysis.

Varon and Takeuchi (1974) examined nine major minerals (iron ore, bauxite, copper, manganese ore, lead, nickel, phosphate, zinc and tin) produced largely be developing countries through examination of the demand situation facing these commodities. They conclude that long-run price-elasticities of demand for most of these commodities were fairly high (the price elasticities of demand of only three were

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23/ Irfan ul Haque, "Producers' Alliances Among Developing Countries" Journal of World Trade Law, Vol. 7, No. 5, September-October, 1973, pp. 511-526.

actually given: tin - 1.25, aluminum -1.35, copper -2.50) because of stockpiles, recycling possibilities, use of substitutes, global distribution of reserves, and the number of countries involved (none of this is discussed in any quantitative detail).[24/] They do, however, state that "possibilities (for new OPEC's) do exist in a few minerals"--bauxite and phosphates are specifically mentioned. Cartelization possibilities of each commodity are discussed in isolation.

Landsberg (1974) feels that there is little likelihood that other raw materials exporters can emulate the success of OPEC because of: (i) their geographical and political diversity; (ii) their general lack of financial staying power (which for most raw-material producers is generally far inferior to that of OPEC); (iii) the fact that many of the supplier countries are heavily involved with the importing countries in a diversified trade pattern, pointing to the potential for negotiation rather than unilateral action, and (iv) the fact that long term cross-elasticities are likely to be high, i.e., substitutes are generally easily available over the longer term.[25/] His analysis of the above is based on a survey of essential raw materials and includes a presentation of estimates of price

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24/ Bension Varon and Kenji Takeuchi, "Developing Countries and Non-Fuel Minerals:, Foreign Affairs, Volume 52, No. 3 (Washington, D.C.: April 1974), pp. 497-510.

25/ Hans Landsberg, statement in Global Scarcities in an Interdependent World, Hearings before the Subcommittee on Foreign Economic Policy of the Committee on Foreign Affairs, House of Representatives, 93rd Congress, (Washington, D.C.: May 1974), pp. 133-139.

elasticity of demand for certain commodities. Landsberg also points out that price increases of other minerals, in any case, are likely to be less disruptive than those for oil, because the value of ores is heavily diluted in the end product. For example, bauxite at the (then) prevailing price of $9 to $15 a ton is less than 10% of the total cost of an aluminum ingot (over $600/ton), even considering that it takes 4 tons of bauxite to make 1 ton of aluminum. In another example, he points out that in 1972 a 25 H.P. motor sold for about $170. The 18 pounds of copper it contained were worth $9, or a little over 5% of the cost of the motor.

Burrows (1974) bases his discussion of producer-country cartels, on an examination of short- and long-run price elasticities of demand. He points out that although the optimal price to maximize revenue will be greater, the smaller the demand price elasticities outside a cartel, there exists some ambiguities as to what such cartels may attempt to maximize (foreign exchange revenues, total revenues, profits, etc.).26/ Potential gains from a cartel are a direct result of price and output policies. However, difficulties in establishing successful cartels relate to the distribution of output reductions among cartel members as well as the enforcement of such agreements. This is affected by the number of actual and potential

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26/ James C. Burrows, Statement in Outlook for Prices and Supplies of Industrial Raw Materials, Hearings before the Subcommittee on Economic Growth on the Joint Economic Committee, Congress of the United States, 93rd Congress, (Washington, D.C.: June 1974), pp. 55-92.

suppliers, production costs, etc. Burrows examines both the short-run (1-2 years) and long run (3-5 years) price elasticities of demand for certain metals to reach the conclusion that risks of cartelization exist for only two metals--bauxite and chromite. Burrows also feels that if the prices of all raw materials imported into the United States doubled, the ultimate effect on prices would not be more than 3-4%.27/

Hayes (1975), in a brief discussion of the possibilities of OPEC type actions for other primary commodities, stresses the difficulties of co-ordination as the prime deterrent factor in producers' alliances.28/ Commodities which are identified by him with possibilities for concerted action are tea, coffee and cocoa; and separately, pepper. Estimates of demand and supply price elasticities are not discussed.

Connelly and Perlman (1975) discuss the general problem of resources in a substantial qualitative analysis.29/ They also point out the increasingly independent position being taken by two resource-rich developed countries--Canada and Australia. They stress that relationships between industrialized resource-importers and suppliers of resources are currently in a state of flux (with many traditional relationships breaking down) and that most industrial

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27/ James C. Burrows, op. cit. p. 60.

28/ J. P. Hayes, op. cit. pp. 30-31.

29/ Phillip Connelly and Robert Perlman, op. cit. pp. 142-143.

nations have no choice but to adopt a policy of enhancing the security of supplies from developing countries' exporters, either within a bilateral or multilateral framework. Their analysis does not include presentation of supply or demand price elasticities for the commodities reviewed or an evaluation of likely candidates for "supply restriction" type actions.

Stern and Tims (1975) also examine the possibilities of controlling the supplies of major commodities produced by developing countries.30/ Criteria used are (i) LDC share of world trade and world production, (ii) gestation period of new investments, (iii) storage possibilities, (iv) synthetic substitutes as a percentage of total supplies, and (v) the demand structure and essentiality (this last criterion--essentiality - is discussed in a general manner). Prospects for supply management are judged generally on the basis of the above criteria and are considered to be best in rubber and tin, except that the latter faces the problem of a large United States stockpile (equivalent to a year's consumption). For other minerals, particularly bauxite, copper and manganese, they point out that if developed countries like Canada, Australia and Sweden join the effort to control supply, producers would be in an extremely strong position to set prices for exports. Stern and Tims end their discussion on a warning note that "if it is legitimate for governments to limit

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30/ Ernest Stern, and Wouter Tims, "The Relative Bargaining Strengths of the Developing Countries", American Journal of Agricultural Economics, Volume 57, No. 2, May 1975, pp. 225-235.

production in order to set the export price for a primary product, it would be equally legitimate for governments to seek to maintain the prices of wheat, fertilizer, or generating equipment".

D. Conclusions on Existing Studies of Commodity Supply Management

As can be seen from the above review, existing studies on the subject are somewhat limited in their coverage and the techniques used for analysis need improvement. This is partly unavoidable because of the complexity of issues which necessarily form part of any such study. Our review of existing studies (Section C above) shows that most authors (e.g., Bergsten, Haque, Hayes, Connelly and Perlman) have focused on the institutional and political problems associated with supply management. Landsberg and Burrows have focussed on the issues relative to aggregate demand facing potential commodity supply managers (through an examination of short-and long-run demand price elasticities). Their analysis, therefore, remain incomplete, ignoring as it does, important questions of supply. Takeuchi, however, has developed a simple, but useful formulation of examining prospects of supply management through the use of demand and supply price elasticity estimates.

This thesis hopes to extend the pioneering work on commodity supply management initiated by Takeuchi and others. The methodology proposed for further detailed analysis is discussed in the next chapter.

CHAPTER III

METHODOLOGY FOR EXAMINING EFFECTIVE SUPPLY MANAGEMENT

A. Economic Interpretation of Supply Management Behaviour

Supply management by primary product producing countries in order to maximize revenues from the export of the commodity in question, could be undertaken either by placing quantitative restrictions on exports of the commodity or by the imposition of a higher export price (both mechanisms, of course, having the same ultimate effect viz. lower volume of exports at higher prices) if the price elasticity of demand for the commodity is less than (minus) 1. Two simple economic interpretations would justify this behaviour. First, any primary producer faced with less than perfectly elastic demand for its product would find it to its advantage to impose an export tax (based on the optimum tariff argument).1/ As Mabro correctly points out, there are practical difficulties in determining the correct rate of taxation and problems trading off short-term objectives and long-term economic interests but there are no other objections to the argument.2/ The right of a country, especially a developing country, to give priority to its economic welfare over the welfare of other countries (even other developing countries) is seldom questioned. The second interpretation, applicable to mineral

1/ C.P. Kindelberger, International Economics (Homewood Illinois: Richard D. Irwin, Inc., 1973) pp. 117, 450, 480.

2/ R. Mabro, Can OPEC hold the Line, op. cit., pp. 1-6.

resources, recognizes that it is a depleting resource (which implies an interdependence between present production and future availabilities). Thus a case would exist for fiscal measures or a production plan, whether monopoly power exists or not, when present prices diverge from expected future prices properly discounted.3/

B. Single Commodity Supply Management

We propose, in our investigation of the possibilities of effective supply management of primary commodities, to select two major internationally traded primary commodities and handle each case as a single commodity supply management problem; or more specially, to address the question whether the commodity under consideration is capable of supply management by a group of countries with mutual interests (i.e., either a group of developed countries, or less developed countries). The broad grouping of developed countries and less developed countries as separate interest entities is justified primarily in terms of consumption of particular commodities. There can be no doubt that particular raw materials are produced both by developed and less developed countries, and that as producers these countries may have a vested interest in coordinating their production of these commodities. However, each country is likely to have an interest in a commodity both as a producer and as a consumer, and in

3/ Harold Hotelling, "The Economics of Exhaustible Resources," Journal of Political Economy, Volume 39, April 1931, pp. 137-175; O.C. Herfindahl, "Depletion and Economic Theory", Resource Economics (Baltimore: John Hopkins University Press, 1974), pp. 64-92.

many cases its interest as a consumer is determined by its level of development. Less developed countries, with their lower incomes, are likely to be smaller consumers of major raw materials (the major exception to this being food) and are very likely to join producer groupings with other LDCs to raise the prices of these commodities. Developed countries are major consumers of a large number of raw materials and are therefore unlikely to join producer groupings for most commodities because of the conflict between producer and consumer interests. In certain exceptional cases, however, the developed countries may be willing to form a producer grouping if their interest as producers is greater than as consumers; the only obvious case is that of the production of food grains, where a major portion of production may be exported to less developed countries and centrally planned economies, and where the interests of consumers may not be so vitally affected because of the smaller role of food in family budgets. In such cases (and particularly in the case of foodgrains), less developed countries are unlikely to join developed countries in a producer grouping because of their interest as consumers. Exceptions to these broad generalizations are certainly possible (e.g., Australia's participation with less developed countries with regard to a supply management scheme for bauxite), but are not likely to be significant in the cases of commodities to be reviewed in this thesis.

One interesting question addressed in this thesis centres around the selection (through an appropriate methodology) of two commodities

which prima-facie appear to be good candidates for supply management by a producer grouping. The major question relates to the determination of appropriate price levels for the commodity which will maximize either (i) total revenues (or total export earnings) from the sale of the commodity for a particular producers' group--this being normally the basic objective of LDCs since they normally face severe foreign exchange shortages and would thus wish to maximize their foreign exchange earnings even if this implied a non-optimal (from the profit maximizing point of view) use of local non-tradeable resources; or (ii) total profits (i.e., total revenues minus total costs including costs of non-tradeable inputs) from the sale of the commodity which would accrue to a producers' group (which would normally be the objective of developed countries or more resource conscious LDCs). The quantification of benefits accruing from such supply management schemes is also an important element of this study.

In order to deal appropriately with these questions we first proceed to examine conventional economic method of dealing with supply management problems (largely associated with theories of oligopoly). This is done in the next section (Section C) of this chapter. The methodology proposed to be used in our analysis is then presented in Section D (and detailed in Sub-sections i-xi). Its limitations are discussed in Section E. The selection of two commodities which appear to be prima-facie suitable for supply management is discussed in Section F.

C. Supply Management and Theories of Oligopoly

The very substantial literature on the theories of oligopoly and particularly those models known as the "leader-follower" models, give important insights into how supply management by a producers' group could conceivably be undertaken. The more significant of these models are discussed below.

The earliest "leader-follower" model is associated with Stackelberg.[4/] Unlike Cournot who assumed that each seller ignores the effects of his actions on the strategies of others, Stackelberg assumed that one particular seller can manipulate the reactions of the others. Thus, for the case of two sellers with prices as independent variables, the constant profit curves of Stackelberg can be expressed in the following functional form.[5/]

$$g1 = g1\ (p1, p2)$$

$$g2 = g2\ (p1, p2)$$

where g1, g2 are profits made by sellers 1 and 2 and

p1, p2 are prices charged by sellers 1 and 2.

To get the solution of Stackelberg's "leadership equilibrium," the sellers are assumed to behave as follows: (i) One seller, say seller 1, would regard the existing price of the other seller, say seller 2, as a datum and maximize profits accordingly. In other

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4/ H. von Stackelberg, Marktform und Gleichgewicht (Berlin: 1934).

5/ Tun Thin, Theory of Markets, (Cambridge, Massachusetts: Harvard University Press, 1960), pp. 51-52.

words, seller 1 equates $\frac{dg1}{dp1}$ to zero, assuming $p2 = \overset{o}{p}2$ a parameter, (ii) Seller 2, on the other hand, maximizes its profits on the assumption that seller 1 would behave as in (i) above. In other words, seller 2 in maximizing his profits g2 (p1, p2) assumes that seller 1 would equate $\frac{dg1}{dp1} = 0$ assuming $p2 = \overset{o}{p}2$. Thus, the problems become one of maximizing the function g2 (p1, p2) with $\frac{dg1}{dp1} = 0$ as a subsidiary condition. As the number of subsidiary conditions is less the number of unknown variables, p1 and p2 can be solved. A seller who behaves like seller 1 is Stackelberg's "follower", and the one who behaves like seller 2 is Stackelberg's "leader."

A more significant "leader-follower" model of oligopoly was proposed by Zeuthen and developed further by Stigler.6/ Stigler derived price-output results under the following two conditions: (i) one seller sells such a large proportion of the commodity in question that the other (smaller firms) individually ignore any effect that they may have on prices; and (ii) this dominant seller behaves passively; i.e., it sets the price and sells the remainder after the minor firms have sold all they wish at the ruling price. The general solution of Stigler's model is as follows:

If the demand function of an industry is represented by $p = f(x) = f(x1 + x2)$, where p is price, x the total output of the industry, and x1 and x2 are the outputs of the dominant and minor

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6/ Frederic Zeuthen, Problems of Monopoly (London: Longmans, Green and Co., 1930), pp. 17-23. George J. Stigler, "Notes on the Theory of Duopoly," Journal of Political Economy, Vol. 48, 1940, pp. 521-541.

firms respectively, and if $\emptyset$ (x1) is the total cost function of the dominant firm and θ (p) the supply function of the minor firms, then the net profit of the dominant firm is x1 p - $\emptyset$ (x1), which attains a maximum when

$$p + x_1 \frac{dp}{dx_1} - \emptyset'(x_1) = 0$$

Taking the derivative of the demand function with respect to x_1 yields

$$\frac{dp}{dx_I} = \frac{f'(x)}{1 - f'(x)\theta'(p)}$$

Substituting this into the marginal profit function gives

$$p + x_1 \left(\frac{f'(x)}{1-f'(x)\,\theta'(p)}\right) = \emptyset'(x_1)$$

Defining the elasticity of demand, n = p/ [xf'(x)] and the elasticity of supply of the minor firms E= [pθ'(p)]/x2, and letting k = x_1/x, the general solution is

$$p\left(1+\frac{k}{n-E\,(1-k)}\right) = \emptyset'(x_1)$$

The Zeuthen/Stigler formulation is generally accepted as an important contribution to the theory of oligopoly. In its simplest form, it can be stated as follows. The "dominant producer" situation is one in which the price leader has control over the industry price and its own output but not over its rival's output. The dominant producer behaves passively in regard to the output of the small producers, merely estimating the quantities that they will produce at each

alternative price that it may choose. The dominant firm isolates its own demand curve by subtracting from the industry demands curve the estimated total quantities produced by all its rivals at each price. It is then assumed to maximize its profits in the usual fashion.

Theorists who have accepted the "dominant firm" analysis of oligopoly behaviour include Machlup and Boulding, who have associated it with large United States industries such as steel, cement, cans, meat-packing and cigarettes.7/ Critics of the analysis include Fellner, Cyert and March, and Worcester.8/ Fellner argues that in oligopolistic markets there is a tendency towards the maximization of the joint profits of the group and toward division of these profits. Cyert and March question the goal of profit maximization and replace it instead with the concept of an "acceptable" level of profits. They also point out that dominant firms tend to lose their share of industry sales. Worcester explains that static profit maximization confers short run profits on the competitive fringe and therefore the dynamic inducement will be for the expansion of that fringe at the cost of the relative, or even absolute, market share of the dominant producer. The appropriate strategy for the dominant producer could

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7/ Fritz Machlup, Economics of Sellers' Competition (Baltimore: 1952), pp. 495-500; K.E. Boulding, Economic Analysis (Harper and Row, 1955) pp. 638-639.

8/ William Fellner, Competition Amongst the Few (New York: Alfred A. Knopf, 1949), p. 33; R.M. Cyert and J.G. March, "Organizational Factors in the Theory of Oligopoly," Quarterly Journal of Economics, Volume LXX, February 1956, pp. 58-62; Dean A. Worcester, Jr., "Why Dominant Firms Decline," Journal of Political Economy, Volume LXV, August 1957, pp. 338-346.

therefore vary between: (i) maximizing its own profits even if this involves setting a price so high that it means "supranormal" profits for the other producers and therefore substantial incentives for them to expand; (ii) setting the price at a relatively low level which leaves the other firms with no "supra-normal" profits even if this means foregoing some of the profit advantages which would accrue to the dominant producer; and (iii) setting the price somewhere between (i) and (ii) so that it could gain some advantage of being the dominant producer while still reducing the incentive for the competitive fringe to expand. Further developments of this debate include a substantial literature on limit pricing to deter entry.9/

Thus the "dominant producer" model has been extended in several sophisticated forms to explain industrial behaviour in the developed countries. We feel, however, that the original Zeuthen/Stigler model, appropriately used, can shed important light on commodity supply management by primary producers. The methodology proposed to be used in the thesis, therefore, builds upon the original Zeuthen/Stigler model and is presented below:

D. Thesis Methodology for Evaluating Commodity Supply Management

Our theoretical framework for evaluating commodity supply management is as follows:

9/ Joe S. Bain, Barriers to New Competition (Cambridge, Massachusetts: Harvard University Press, 1962); Franco Modigliani, "New Development on the Oligopoly Front", Journal of Political Economy, Vol. 66, 1958, pp. 215-232.

(i) Assume that existing world primary-commodity production is divided among a finite number of producers; then if the supply of the commodity is not infinitely elastic (for whatever reasons), and if the slope of the demand curve for the commodity is less than infinity, a supply cutback will lead to a higher price.

(ii) If the price elasticity of demand for the product (taken as a positive number) is less than unity, then this supply cutback by a single producer or a group of producers will result in a net increase in total revenue from the sale of that commodity. Thus revenues of all producers combined (i.e., including those not involved in the supply cutback) will be increased. Producers not involved in the supply cutback will, in all cases, benefit more (from higher unit prices and higher quantities, i.e., higher total revenues) since they would not have to restrict output. Producers involved in the supply cutback may or may not get more total revenues (although they will of course get higher unit prices) since the quantities they will be able to sell will be reduced both by lower quantities demanded at higher prices as well as by the increased supply by producers not involved in the supply cutback. The conditions necessary for a supply cutback to benefit producers (either through increasing total revenues or total profits) are developed in subsequent subsections (i-xii).

Producer action is assumed to take place as follows: (A) Initial moves to manage supply are initiated by a producers group only when the summary conditions for such action (developed later in this chapter) are satisfied. (B) Actual supply management is undertaken by a producers' group through imposition of a given supply price which, by virtue of the fact that the group concerned will supply the commodity only at that price, will become the world price for the commodity in question. The producer group becomes the price leader, the rest of the world price takers. The cost of this price leadership is restriction of producer-group supply to the level that satisfies only the "excess demand", viz. world demand at the increased price minus the increased supply of countries outside the group at the increased price. The producers outside the "producers' alliance" gain more than the producers within it. They therefore have a vested interest in the higher price. Since every producer outside the "supply management program" gains more, it is sometimes argued that there is a tendency to "cheat" within the producers' group. However, the major source of instability for the producers' alliance is the existence of buffer stocks held in consuming countries, which can be used to cause extreme fluctuations in demand and hence destroy the financial viability of the countries involved in supply management.10/ In a world where consuming countries

10/ Stephen W. Salant, "Exhaustible Resources and Industrial Structure: A Nash-Cournot Approach to the World Oil Market," Journal of Political Economy, Vol. 84, Number 5, October 1976.

are passive price-takers, this can be effectively neutralized by increasing the floor price through time by the rate of interest (which would allow the producing country to survive through a period of a temporary loss of foreign exchange earnings).11/

The extent of possible price movement is investigated by derivation of an "excess demand function" from a "world demand function" and "non-producer group countries supply functions" for the commodity (to be estimated). The excess demand function is then used to determine the appropriate prices where either total revenues or total profits are maximized. The gains and losses resulting from such price movements are then quantified.

The proposed methodology, which we consider to be a logical extension of the Takeuchi summary formulation, is discussed in greater detail in the subsections that follow. The presentation used below is intended to put forth in a systematic manner the important features which have to be taken into account in any commodity analysis as well to lay the structure for the individual commodity analyses presented in Chapter IV and V of this thesis. Thus subsections i to v below lay out the organisational structure of the commodity analysis, while subsections vi-xi within these elaborate further on the thesis methodology.

11/ Ibid.

(i) Commodity Characteristics, Competition from Substitutes ("Back Stop Technology"), Trend of Past Prices and Present Cost Structure

Analysis of possibilities of action by any group of producers of a primary commodity to control supply of the commodity would have to take into account the commodity's characteristics and usage, competition from substitutes, trends of past prices, and the present industry cost structure. Such a review will be incorporated in each commodity analysis and used to derive the excess demand function (subsections vi-xi below).

(ii) Structure of Production (including Recycling), Consumption Trade and World Reserves (in Relation to Estimated Future Consumption).

A review of the past and an evaluation of the present structure of world production, consumption and trade for the commodity concerned is obviously necessary for examining the potential for a producers' grouping. When the commodity is a mineral, it is also important to examine recycling possibilities (including the amount of recycling presently undertaken) and review the status of known world reserves (recoverable at various prices) including their relation to estimated future world consumption requirements. It is proposed to present all the necessary data on production and consumption to test the possibilities for initiating producer group action, and to estimate the excess demand function facing the producer group (subsections viii-xi below).

(iii) Marketing Structure

An important study by Radetzki has identified five factors that are likely to affect the division of gains among traders in commodities, viz. (i) market concentration among buyers and sellers, (ii) ability of trading partners to inflict losses on one another; (iii) shares of raw material costs in final product price; (iv) structure of the market in which the final product is sold; and (v) process of negotiation through which agreement is reached.[12/] We propose to examine (1) (iii) and (v) above in detail since these are the most pertinent factors with regard to this study, affecting the magnitudes of the price changes potentially possible (sub-sections vi to vii below).

(iv) Stockpiles

An important determinant of the price level of commodities has been the existence of stockpiles (both in grains and raw materials). The relationship between low grain prices in the sixties and the volume of stocks held by the U.S. Government has been stressed by Walters[13/];

12/ Marian Radetzki, Market Structure and Bargaining Power - A Study of Three International Mineral Markets (Washington, D.C.: International Bank for Reconstruction and Development, June 1976).

13/ Harry Walters, The World Food Situation and Prospects to 1985 (Washington, D.C.: U.S. Department of Agriculture, 1974) pp. 40-41.

also stockpiles, especially those of the United States, have--as pointed out by Varon and Takeuchi[14]--long affected the price of tin, and, to a lesser degree, manganese and zinc.

Our analysis will examine the position of stockpiles with respect to the commodity being investigated (including, if the commodity is an agricultural product, the question of physical location of stock-holding structures). The analysis will necessarily be general in nature, and will be aimed primarily at determining whether the volume of stockpiles held by consumers is sufficiently large to be used as elements of a price strategy. If this is the case, then the market situation becomes that of a bilateral monopoly and our analysis would have to be appropriately modified. However, as a general rule, we have the feeling that mechanisms exist by which the adverse effect of stockpiles on a producers grouping can be neutralized in the long run.

(v) Composition of Producers' Group

For each commodity where a producers' group already exists (e.g. CIPEC comprising the major copper producers), it is proposed to examine the two primary

14/ Bension Varon and Kenji Takeuchi, Developing Countries and Non-Fuel Minerals, op. cit. p. 506.

questions under investigation, i.e., whether it is possible to initiate producer-group action and, if so, what would be the appropriate optimal price movement. The consequences of enlargement of such a group by the addition of one or two large outside producers are also examined. Where a producers' group does not exist (e.g., the major wheat producers are not jointed in a formal grouping), a hypothetical alliance of major producers is created on the basis of analysis of country concentration of commodity production, and the analysis is conducted in the same way as if a producer group existed.

(vi) The Excess Demand Function

Consideration of the viability and nature of producer-group action must necessarily focus on the "excess demand function" being faced by such a group. As already noted, the excess demand function is derived by subtracting the rest of the world's supply function from the aggregate world demand function for the commodity in question. It is proposed to estimate such functions econometrically. Before embarking on this in individual commodity analysis, however, we first propose to undertake summary tests (sub-sections vii and viii below) on the basis of existing estimations of price elasticities of supply and demand to see whether the primary conditions relevant to

meaningful producer supply management exist. These, of course, lead to price elasticity of excess demand facing the producers' group.

(vii) Summary Tests for Initiating LDC producer Group Action - The Price Elasticity of Excess Demand[15/]

The following notation will be used to derive the price elasticity of excess demand facing a producers' group:

p: world commodity price

D_A: demand for the commodity by country A (who may or may not be members of the producers' group)

D_B: demand for the commodity by country B (who may or may not be members of the producers' group)

D_N: demand for the commodity by the rest of the world (who may or may not be members of the producers group)

$D_A + D_B + D_N$: total demand for the commodity in the world market

S_a: supply of the commodity by country a (not member of producers group)

S_b: supply of the commodity by country b (not member of producers group)

S_{n-g}: supply of the commodity by the rest of world excluding the producers' group

D_g: excess demand for the commodity supplied by the producers' group

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15/ The following derivation is based largely on conditions for optimal supply management developed by K. Lin Takeuchi, "CIPEC and the Copper Export Earnings of Member Countries," The Developing Economies, Vol. X, No. 1 (Tokyo: March 1972), pp. 3-29.

E_{DA}: price elasticity of demand for the commodity in country A

E_{DB}: price elasticity of demand for the commodity in country B

E_{DN}: price elasticity of demand for the commodity in the rest of the world

E_{sa}: price elasticity of supply for the commodity in country a

E_{sb}: price elasticity of supply for the commodity in country b

E_{sn-g}: price elasticity of supply for the commodity of the rest of the world excluding the producers' group

E_{DG}: price elasticity of excess demand for the commodity supply by the producers' group

If it is assumed that there is only one price for the commodity in the world market, then:

$$Dg(p) = D_A(p) + D_B(p) + D_N(p) - S_a(p) - S_b(p) - S_{n-g}(p) \quad (3\text{-I})$$

By differentiating both sides of the equation (3-I) with respect to p, we get:

$$\frac{dD_g}{dp} = \frac{dD_A}{dp} + \frac{dD_B}{dp} + \frac{dD_N}{dp} - \frac{dS_a}{dp} - \frac{dS_b}{dp} - \frac{dS_{n-g}}{dp} \quad (3\text{-II})$$

Multiplying both sides of (3-II) by $\frac{p}{D_g}$, we get:

$$\frac{dD_g}{dp}\cdot\frac{p}{D_g} = \frac{dD_A}{dp}\cdot\frac{p}{D_g} + \frac{dD_B}{dp}\cdot\frac{p}{D_g} + \frac{dD_N}{dp}\cdot\frac{p}{D_g} - \frac{dS_a}{dp}\cdot\frac{p}{D_g} - \frac{dS_b}{dp}\cdot\frac{p}{D_g} - \frac{dS_{n-g}}{dp}\cdot\frac{p}{D_g}$$

$$= \frac{dD_A}{dp}\cdot\frac{p}{D_g}\cdot\frac{D_A}{D_A} + \frac{dD_B}{dp}\cdot\frac{p}{D_g}\cdot\frac{D_B}{D_B} + \frac{dD_N}{dp}\cdot\frac{p}{D_g}\cdot\frac{D_N}{D_N} - \frac{dS_a}{dp}\cdot\frac{p}{D_g}\cdot\frac{S_a}{S_a} - \frac{dS_b}{dp}\cdot\frac{p}{D_g}\cdot\frac{S_b}{S_b} - \frac{ds_{n-g}}{dp}\cdot\frac{p}{D_g}\cdot\frac{S_{n-g}}{S_{n-g}}$$

or:

$$E_{DG} = \frac{D_A}{D_g}\cdot E_{DA} + \frac{D_B}{D_g}\cdot E_{DB} + \frac{D_N}{D_g}\cdot E_{DN} - \frac{S_A}{D_g}\cdot E_{SA} - \frac{S_B}{D_g}\cdot E_{SB} - \frac{S_{n-g}}{D_g}\cdot E_{sn-g} \quad (3\text{-III})$$

The elasticity of producer group demand (here defined as "excess demand" facing the producer group) is therefore equal to the elasticities of demand of all countries (including producer group countries) weighted by their individual demand minus the elasticities of supply of all countries outside the producers group weighted by their individual supply all divided by the excess demand for the commodity supplied by the producers group.

(viii) Objectives of Producers' Group and Price and Elasticity Conditions

Two alternative producers'-association objectives--revenue maximization and profit maximization--will be examined in this study. The elasticity conditions relevant for supply restrictions to increase revenue or profits are as follows:

Condition for Increasing Total Revenues is that the absolute value of E_{DG} must be less than unity

$$E_{DG} < 1 \qquad (3\text{-IV})$$

Condition for Increasing Total Profits by restricting supply is that:16/

$$\frac{P}{MC} < \frac{E_{DG}}{E_{DG} + 1} \qquad (3\text{-V})$$

16/ See Charles River Associates, A Frame-Work for Analyzing Commodity Supply Restrictions, Document No. NBS-GCR-LTIP 76-24, (Wahington, D.C.: National Bureau of Standards, August 1976), p. 25.

where P = price; MC = marginal cost; E_{DG} is elasticity of excess demand Condition (3-V) is derived follows:

The well known relationship between marginal revenue (MR) and the price elasticity of demand (E)[17] is:

$$MR = \frac{dR}{dQ} = \frac{d\,(PQ)}{dQ} = p + Q\,\frac{dP}{dQ} = P\left[1 + \frac{1}{E}\right],$$

where P = price, R = revenue and Q = quantity. Then in the context of the "elasticity for excess demand" we have

$$MR = P.\left[\frac{E_{DG} + 1}{E_{DG}}\right] \qquad (3\text{-VI})$$

For output restriction to be profitable, as opposed to revenue increasing, it must be true that at the initial position marginal revenue (MR)[18] should be below marginal cost (MC), i.e., an output restriction either increases revenues or decreases revenue by less than the fall in total cost; thus

$$MR < MC \qquad (3\text{-VII})$$

Substituting (3-VI) in (3-VIII)

$$P\left[\frac{E_{DG} + 1}{E_{DG}}\right] < MC \qquad (3\text{-VIII})$$

Re-arranging gives the condition for profitable restriction, viz.

$$\frac{P}{MC} < \frac{E_{DG}}{E_{DG} + 1}$$

17/ $E = \frac{P}{Q} \cdot \frac{dQ}{dP}$

18/ Note that this marginal revenue is not the same as in the case of a country acting individually, and as such there is no inconsistency in assuming MR (in this sense) < MC in the pre-alliance situation.

(ix) Summary Evaluation of Prospects for Successful Producer Action on the Basis of Supply and Demand Elasticities and Market Shares

Such evaluation will be undertaken for each commodity being reviewed by estimating "The Price Elasticity of Excess Demand", E_{DG}, facing a producers' group for both the short run (1 year) and long run (approximated by 3-5 years), using existing econometric estimates of price elasticities of supply and demand under various country grouping assumptions discussed in subsection (v). We will then apply the conditions developed in the pre-vious section (subsection (viii)) to evaluate whether prima facie a supply cutback would have favourable re-sults, given either the revenue maximizing or profit maximizing objective of the producers' group involved.

(x) The Optimal Price Movements Relevant to the Objectives of Revenue Maximization and Profit Maximization, and Quantification of Benefits (and Costs).

A more detailed evaluation of the prospects of producer group action for the commodity concerned will be conducted by our own estimation (through regression equations) of individual commodity sectors and the derivation of the "excess demand function" relevant to the producer grouping in question. The price elasticity of our own estimated "excess demand function" will also be compared to that derived from estimates of other scholars.

The excess demand function, also enables us to derive the 'optimum' prices relevant to achieving either the revenue-maximizing or profit-maximizing objective of a producers' group. We will concern ourselves with the initial price movement to achieve such an objective and examine the resulting benefits and costs thereof[19/]

Thus if the excess demand function has the form[20/]

Excess Demand = $a + bp + ...$

The total revenues (R) accruing to the producers group are equal to the price set by the producers group multiplied by the quantity demanded from the producers group (the excess demand) viz. $R = P\ [a + bp + ...]$. P can be set either to meet revenue maximizing or profit maximizing objectives. Setting $\frac{dR}{dP} = 0$ (first order condition of a maximum), we can solve P which would be the revenue-maximizing price for the producers group. Similarly, the profit-maximizing price P' can be found by maximizing $(P'-C)\ (a + bP + ...)$ where C is the average cost of one unit of output.

19/ The subsequent optimal price movements can be examined in the framework of dynamic simulation models. See for instance, Blitzer C., Meerans, A., and Stoutjesdijk, A. "A Dynamic Model of OPEC Trade and Production", Journal of Development Economics, Vol. 2, 1975, pp. 319-335.

20/ The form used here is illustrative. The function, of course, could have any form.

While this "optimizing" procedure can generate appropriate prices in each time period consistent with either revenue maximizing or profit maximizing objectives, in practice producer groups may find it inappropriate for administrative and other reasons to significantly adjust prices in each time period. Thus, while we will optimize in each time period (1 year) for our first commodity analysis, to illustrate the use of this methodology, we will adopt as a general procedure the use of a constant level of prices derived from our own estimates of the elasticity of the excess demand function profit- or revenue-maximizing instrument over a given time period (which we define as the "long term" or 5 years), using an appropriate discount rate (5 percent)21/. The various levels of production which will have to be undertaken to meet these alternative profit or revenue maximizing objectives will also be presented with our results. The production alternatives are likely to be important determinants in the decision of a producers' grouping to follow either a profit- or revenue-maximizing strategy. Countries involved in producers groupings' may choose to

21/ A 5 percent discount rate was selected on the basis that it was the average Euro-Dollar (London) interest rate for the period 1960-76 and reflects in a balanced way the average interest rates prevalent in the major industrial countries during this period. As a real rate of interest, it is certainly not too low.

maximize profits (rather than total revenues) and slow down the rate of mineral extraction in particular cases. We propose, therefore, in summing up the results of each commodity review, to incorporate the possible objectives of major producing countries in this regard.

The assumption of constant average (and therefore marginal) costs will only be used in our analysis if appropriate. Its use can normally be justified since (i) supply management schemes would normally imply output curtailment rather than output increases, in which case the standard arguments of increased variable costs of producing additional output with inferior mines (if a mineral) or inferior land (if an agriculture product) is not relevant; and (ii) the output curtailment envisaged is also normally not likely to be very substantial. However, if industry cost data is available in the form of "marginal costs" then such estimates would be used.

(xi) Assessment of Actual Likelihood of Formation of a Functional Producers' Alliance on the Basis of Individual-Country Assessment

Other important questions relate to the dependence of individual countries in the cartel on the export of the particular product. Landsberg has pointed out, for example, that Chile and Zambia derive about 80% of their export earnings from copper, Zaire about 50% and Peru

about 30%[22]. This, coupled with varying prospects for capacity expansion inside the producers grouping, would influence each country's attitude towards aggressive supply and price actions. These considerations are likely to be reinforced by the financial situation of individual countries (each with its urgent needs of finding enough foreign exchange to finance imports for necessary consumption and development), as well as political and technological relationships between the country concerned and particular consumers. Another important factor relates to "sunk costs", i.e., capital investments already made, for example, in plantations and mines. It has been argued by certain economists, like Theberge, that the United States should encourage" ... international lending agencies, the World Bank Group, the Asian Development Bank ... to allocate a large share of their lending portfolios to financing mineral sector development ... The more diversified the supply, the more foreign mineral capacity that is built, the greater the downward pressure on prices."[23]

22/ Hans Landsberg, Statement in "Global Scarcities in an Interdependent World," Hearings before the Subcommittee on Foreign Economic Policy of the Committee on Foreign Affairs, House of Representatives, 93rd Congress, (Washington, D.C.: U.S. Government Printing Office, May 1974), pp. 133-139.

23/ James Theberge, Statement in "Outlook for Prices and Supplies of Industrial Raw Materials," Hearings before the Subcommittee on Economic Growth on the Joint Economic Committee, Congress of the United States, 93rd Congress, (Washington, D.C.: U.S. Government Printing Office, June 1974), pp. 55-92.

Environmental considerations could also be important in determining response to cartel actions. The production of a particular commodity itself (e.g., copper smelting operations) or the production of a substitute for a commodity (e.g., coal mining through open-pit operations and its use as fuel as a substitute for oil) may inflict major costs on producing countries which they may not be willing to bear.

Another consideration which could influence success or failure of cartel-type actions is essentially political, i.e., the number of countries in the cartel and their complementarity or diversity of interests in fields other than those related to the particular commodity. It has often been stated (e.g., by Haque), in analyses of cartel actions, that a "small number of producing countries" would be more favourable to such action. The greater the number of members, the more the chance that some may "cheat", i.e., not restrict output as required by the cartel and thereby increase their total revenues further. We note here that the temptation for a small producer to "cheat" is much greater, since a major increase in its relatively small production will mean larger gain to it (proportionately) than a similar absolute increase in a large country's production (there is also less likelihood

of discovery and retaliation). The problem is not only complicated by the size of each individual producer (e.g., should production cuts be imposed on a pro-rated basis or in terms of the foreign exchange needs of member countries?), but also by the potential of individual producers to increase output (which may vary substantially). The case of OPEC (with 16 members) is sometimes quoted as nullifying the argument against large numbers. On the other hand, the existence of large "swing" producers in oil, like Saudi Arabia, Kuwait and Libya, with vast revenues accruing at even relatively low rates of production, tends (in the view of some authors) to make this a special case, since the overall level of production can be regulated by the production decisions of even two or three "swing" member countries.

E. Limitations of Thesis Methodology

The methodology proposed in this study should furnish useful insights into commodity supply management behaviour. The methodology does, however, suffer from a number of limitations, and these should be recognized from the outset. Its major weakness is that any partial analysis cannot take into account all the complexities of any given situation. Thus, for example, a country which is considered to be a logical candidate for a producers' grouping according to our analysis may, in fact, not join since it in turn fears being

adversely affected by the possible creation of another producers' grouping. Similarly, membership of producers' groupings could be affected by a variety of other economic or political factors.

Other pertinent criticisms of the methodology would relate to the use of either the profit-maximizing or revenue-maximizing objective as a relevant goal of a producers' group, the choice of an appropriate time period over which profits or revenues are to be discounted (while our choice of a five-year period is illustrative, there could be real differences in the time horizons of different member countries), and the appropriate social discount rate. Finally, the methodology is heavily dependent upon the use of econometric techniques whose limitations are well known; these are discussed briefly in the final chapter of the study.

F. Identification of Commodities Suitable For Investigation As Case Studies for Producer Supply Management

The following criteria have been used by us to select commodities as case studies: (i) the commodity concerned should be of substantial importance in world trade; (ii) a distinct interest group of countries (either developed, developing or centrally planned) should have a substantial share in production and trade of the commodity; and (iii) price elasticity of demand for the commodity in the short run should be less than unity before the formation of the producer grouping, and the longer-term price elasticities (again before the formulation of the producer grouping) should be low.

Tables III.1 and III.2 relate to the above criteria. The former shows that copper and wheat are the most important commodities in world trade after petroleum and petroleum products (being ranked number three and four, respectively). An examination of the price-elasticity of demand for these commodities (Table III.2) indicates their suitability for examination as to supply-management capabilities since elasticities in both the short and long run for the two appear to be rather low. The choice of copper and wheat has a further advantage in that they represent two separate commodity groups (minerals and agriculture), and that they are produced by two separate country groupings (less-developed and developed).

G. Existing Estimates of Price Elasticities of Copper and Wheat and Justification For Own Estimates

A summary review of existing studies of the world copper and wheat industries is presented in Appendices I and II respectively. It is proposed, however, to proceed in this thesis to estimate demand and supply functions for these commodities. There are several reasons for doing this. The most important relates to the objective of the relevant exercises. Existing studies are basically concerned with U.S. problems and are structured differently (i.e., they are concerned with different groups of countries). Other important reasons include the fact that very major structural changes have occurred in the past decade in most commodity markets and it would only be proper to estimate demand and supply functions using the most

TABLE III.1

Total Exports of Major Primary Commodities by Value and by Shares of Developed, Centrally Planned and Developing Economies, 1970

	Total Value US $Billion	Share of LDC's(%)	Share of CPE's(%)	Share of DC's(%)	Share of Canada (%)	Share of Australia (%)
Crude Petroleum	15.69	89.06	5.84	5.09	3.96	0.00
Petroleum Products	8.09	44.67	8.74	46.58	0.56	0.47
Copper	5.62	43.73	1.92	54.35	8.08	1.58
Wheat	3.07	4.34	11.84	83.82	21.43	13.21
Coffee	2.97	93.74	0.0	6.26	0.18	0.10
Woodpulp	2.59	1.76	2.48	95.76	29.22	0.02
Pulpwood & Logs	2.51	12.33	16.14	71.52	25.87	0.15
Sugar	2.45	68.70	6.49	24.80	0.41	6.89
Aluminium	2.44	4.82	11.50	83.68	17.61	1.88
Coal	2.32	0.32	27.79	71.89	1.21	8.62
Cotton	2.23	53.86	16.67	29.47	0.04	0.27
Fruit	2.22	34.93	1.81	63.26	0.74	1.58
Iron Ore	2.20	41.94	0.0	58.06	20.70	16.52
Maize	1.75	26.08	4.30	69.63	0.06	0.07
Beef	1.74	25.32	1.97	72.71	3.28	19.20
Lumber	1.67	41.31	18.56	40.13	4.21	0.03
Wool	1.65	11.21	1.83	86.96	0.12	44.17
Fish	1.53	24.29	0.05	75.66	13.63	2.92
Soybeans	1.25	2.41	0.0	97.59	0.24	0.00
Rubber	1.15	98.14	0.0	1.86	0.01	0.00
Cocoa	1.07	85.27	0.0	14.73	0.0	0.00
Tobacco	1.06	21.65	9.69	68.66	4.81	0.07
Nickel	1.02	7.25	0.28	92.46	43.81	1.25
Rice	0.89	37.08	0.13	62.79	0.0	1.86
Oilseed Cake	0.88	38.58	0.0	61.42	1.80	0.01
Milk	0.79	2.35	1.83	95.82	3.95	3.43
Hides	0.74	24.44	0.01	75.55	2.66	11.71
Cheese	0.73	0.79	4.04	95.17	2.19	2.78
Wine	0.73	2.68	8.40	88.91	0.07	0.49
Butter	0.65	0.65	11.63	87.72	0.00	8.71
Tin	0.60	77.19	0.07	22.74	0.00	0.80
Copper Ore	0.56	41.94	0.0	58.06	35.62	6.47
Barley	0.55	3.73	7.19	89.08	23.34	5.31
Pork	0.52	0.57	1.22	98.22	5.73	0.32
Nickel Ore	0.48	24.44	0.0	75.56	71.46	0.0
Crude Fertilizer	0.45	42.86	34.78	22.36	0.0	0.01
Furskins	0.43	2.82	12.93	84.25	6.26	0.63
Animal Fats & Oils	0.42	6.87	2.71	90.42	4.56	7.00
Lead	0.40	11.42	4.82	83.76	10.93	29.75
Zinc	0.39	11.53	14.14	74.34	22.11	10.92

TABLE III.1 (Concluded)

	Total Value US $Billion	Share of LDC's(%)	Share of CPE's(%)	Share of DC's(%)	Share of Canada (%)	Share of Australia (%)
Tea	0.38	80.30	2.69	17.00	1.31	0.0
Mutton & Lamb	0.36	4.50	0.83	94.67	0.80	23.25
Bacon	0.35	0.16	9.48	90.37	1.27	0.12
Soybean Oil	0.32	5.35	0.00	94.65	1.96	0.0
Poultry	0.30	0.49	12.26	87.25	0.31	0.46
Bauxite	0.29	88.00	0.0	12.00	0.95	0.00
Zinc Ore	0.25	13.95	0.0	86.05	45.55	0.05
Eggs	0.22	7.91	11.64	80.45	2.08	0.32
Groundnuts	0.19	78.54	0.19	21.27	0.00	0.00
Olive Oil	0.17	12.11	0.00	87.89	0.00	0.00
Palm Oil	0.16	94.23	0.00	5.78	0.00	0.00
Coconut Oil	0.16	86.92	0.00	13.08	0.00	0.00
Jute	0.15	94.99	0.07	4.94	0.05	0.04
Manganese Ore	0.15	51.11	15.14	33.76	0.00	0.00
Groundnut Oil	0.13	85.61	0.00	14.39	0.00	0.00
Lead Ore	0.12	11.52	0.00	88.48	27.91	0.00
Copra	0.10	99.48	0.28	0.24	0.00	0.00
Chrome Ore	0.10	22.15	40.85	37.00	0.00	0.01
Flax	0.08	3.51	17.10	79.39	0.00	0.08
Linseeds	0.07	1.05	0.49	98.46	77.56	0.01
Sisal	0.06	97.47	0.00	2.53	0.00	0.00
Cottonseed Oil	0.06	18.23	0.00	81.77	0.00	0.00
Tin Ore	0.05	64.23	0.00	35.77	0.81	0.00
Palm Kernel Oil	0.05	73.18	0.00	26.82	0.00	0.00
Palm Kernels	0.04	100.00	0.00	0.00	0.00	0.00
Linseed Oil	0.02	0.32	0.00	99.68	18.40	0.00

SOURCE: United Nations, General Assembly, Sixth Special Session, Document No. A/9544/Add. 1 (New York: April 22, 1974), pp. 14-25.

TABLE III.2: Country Shares of World Trade in Major Primary Commodities 1970, and Short- and Long-Run Price Elasticities of Demand

	LDC's Share (%)	LDC's + Australia + Canada Share (%)	LDC's + CPE's Share (%)	DC's Share (%)	DC's Minus Australia Minus Canada Share (%)	Short-run Price Elasticity of Demand (1-2 years)	Long-run Price Elasticity of Demand (3-5 years)
Petroleum-Crude	89.68	93.64	94.90	5.09	1.13	Inelastic	Inelastic
Non-Fuel Mineral							
Copper	43.73	51.81	45.65	54.35	44.69		
Copper ore	41.94	84.03	41.94	58.06	15.97	(-0.21[1]/	-0.90[1]/
Iron ore	41.94	79.16	41.94	58.06	20.84	Inelastic	-0.85[2]/
Tin	77.19	77.99	77.26	22.74	21.94	(-0.55[3]/	-1.25[3]/
Tin ore	64.23	65.04	64.23	35.77	34.96		
Aluminium	4.82	24.31	16.32	83.68	64.19		
Bauxite	88.00	88.95	88.00	12.00	11.05	(-0.13[4]/	-0.80[4]/
Manganese ore	51.11	51.11	66.24	33.76	33.76	Inelastic[5]/	Inelastic[5]/
Crude fertilizer	42.86	42.87	77.64	22.36	22.35	(Phosphate (Inelastic (Potash (inelastic	-0.27 to -2.88[6]/ -0.40 to -2.64[6]/
Chrome ore	22.15	22.16	63.00	37.00	36.99	0 to -0.2[7]/	Elastic[7]/
Agricultural Products							
Wheat	4.34	37.71	16.18	83.82	49.18	Inelastic	-0.20 to -0.50[8]/
Coffee	93.74	94.02	93.74	6.26	5.98	Inelastic	-0.74 to -1.5[9]/
Sugar	68.70	76.00	75.19	24.80	17.50	Inelastic	-0.21[10]/
Cotton	53.86	53.97	70.53	29.47	29.16	Inelastic	n.a.
Lumber	41.31	45.55	59.87	40.13	35.89	Inelastic	-0.3 to -3.5[11]/
Maize	26.08	26.21	30.38	69.63	69.50	n.a.	n.a.
Rubber	98.14	98.15	98.14	1.86	1.85	-0.22[12]/	-0.77[12]/
Cocoa	85.27	85.27	85.27	14.73	14.73	Inelastic	-0.42[13]/
Tea	80.30	81.61	82.99	17.00	15.69	-0.1[14]/	-0.7[14]/
Jute	94.99	95.08	95.06	4.94	4.85	n.a.	n.a.
Sisal	97.47	97.47	97.47	2.53	2.53	n.a.	n.a.

Source: See Attachment below.

TABLE III.2: Attachment

Source for Price Elasticities

1/ F.M. Fisher, P.H. Cootner, and N.N. Baily, "An Econometric Model of the World Copper Industry," The Bell Journal of Economics and Management Science, Vol. III, No. 2, Autumn 1972, pp. 568-609.
We note that in an earlier study by Charles River Associates, Inc., An Econometric Analysis of the Copper Industry, US Department of Commerce publication, PB 189 927, March 1970, short-term price elasticity of demand for copper was estimated for the US at about 0.34 and -0.81 for the long term price elasticity.

2/ Mo,N.Y., A Quantitative Econometric Analysis and Long-Run Projections of the Demand for Steel Mill Products, Information Circular 8451, (Washington, D.C.: Bureau of Mines, USDI), 1970.

3/ F.E. Banks, "An Econometric Model of the World Tin Economy - A Comment," Econometrica, Vol. 40, No. 4, July 1972.

4/ James C. Burrows, Vice President, Charles River Associates, Cambridge Mass., Statement in "Outlook for Prices and Supplies of Industrial Raw Materials...", op. cit. p. 71.
We note that an earlier study by the same firm, i.e., by Charles River Associates, Inc., An Economic Analysis of the Aluminium Industry (Cambridge, Mass.: March 1971) estimated short-run price elasticity of US demand for aluminium at about -0.20, and the long-run elasticity at about -1.35.

5/ Irfan ul Haque, Economic Analysis of Manganese Market (Washington, D.C.: International Bank for Reconstruction and Development), April 15, 1971.

6/ O. Hee, A Statistical Analysis of the US Demand for Phosphate Rock, Potash and Nitrogen (Washington, D.C.: Bureau of Mines, 1969), p. 55.

7/ James C. Burrows, "Outlook for Prices and Supplies of Industrial Raw Materials," op. cit. p. 71.

8/ I.S. Rojko, F.S. Urban, and J.J. Naive, World Demand Prospects for Grain in 1980 (Washington, D.C.: Foreign Agriculture Economic Report, 75, 1971, and F.G. Adams and J.R. Behrman, Econometric Models of World Agricultural Commodity Markets (Cambridge, Mass.: Ballinger Publishing Company, 1976), pp. 42-48.

TABLE III.2: Attachment (Concluded)

9/ E. Bacha, An Econometric Model of the World Coffee Market: The Impact of Brazilian Price Policy, Yale University PhD., 1968 (Ann Arbor, Mich.: University Microfilms, Inc.), p. 229.

10/ T.H. Bates and A. Schmitz, A Spatial Equilibrium Analysis of the World Sugar Economy, Giannini Foundation Monograph 22, (Berkeley: California Agricultural Experiment Station, May 1969), p. 42.

11/ W.L.M. McKillop, "Supply and Demand for Forest Products - An Econometric Study, Hilgardia, March 1967, pp. 36-40.

12/ B. Rattray, Short Term Rubber Model, UNCTAD Commodities Division Working Paper RM/III, August 1972, pp. 4 ff. and Appendix III.

13/ L.M. Goreux, Price Stabilization Policies in World Markets for Primary Commodities: An Application to Cocoa, Mimeographed, (Washington, D.C.: International Bank for Reconstruction and Development), Jan. 1972.

14/ V.N. Murti, An Econometric Study of the World Tea Economy 1948-1961, University of Penn. PhD. 1966, (Ann Arbor, Michigan: University Microfilms, Inc.), pp. 82-103, 120-128.

recent data available. Our estimated functions (presented in Chapters IV and V of this thesis) are specially geared to meeting the important issues raised in this thesis.

CHAPTER IV

THE COPPER MARKET

A. Commodity Characteristics, Competition from Substitutes, Trend of Past Prices and Present Cost Structure of the Industry

Mineral Characteristics, Uses and Substitutes. Copper's conductivity, malleability and resistance to corrosion have long made it a basic industrial material. End use statistics for the world are not available, but those for the United States for 1973 show that 52% was used for electrical purposes (largely as wire), 18% in construction, 13% in industrial machinery, 9% in transportation, 3% in ordnance and 5% for miscellaneous purposes[1]. Copper has the following substitutes: aluminium in the electrical industry, plastics in the construction and mechanical industries (especially in pipes and tubing), and stainless steel for a variety of uses. Of the losses which copper sustained to alternative materials, aluminium accounted for 54%, plastics 8%, stainless steel 5%, and other ferrous metals 18%; the remaining 15% was due to design changes which sometimes involved the complete elimination of copper[2]. Aluminium's popularity as a substitute is due largely to its price stability over the past 25 years compared to copper's, as well as its competitiveness with regard to prices. On the technical side, aluminium's

1/ U.S. Department of the Interior, Bureau of Mines, Commodity Data Summaries, 1974, (Washington, D.C.: Government Printing Office), p. 44.

2/ Ronald Prain, Copper - The Anatomy of an Industry, (London: Mining Journal Books Limited, 1975), pp. 154-155.

conductivity is only 62% that of copper, but weight for weight its current-carrying capacity is about the same.

Prices. In the United States (which produces and consumes more than one third of the refined copper of the non-centrally planned economies), the whole of the new mine production is sold domestically at a price referred to as the "U.S. producer price." Theoretically, prices are fixed independently by each U.S. mining company, but in practice the price is virtually the same for all producers.3/ On the other hand, the whole of the world's mine production traded internationally is sold at prices based on the LME (London Metal Exchange (LME). The LME is not itself a large market, but its quotations are used as a basis for pricing larger quantities of the metal (including almost all sales by LDCs). Table IV.1 shows that both U.S. producer prices and quotations on the LME are subject to a great deal of fluctuation, but in particular, it highlights the extreme sensitivity of the LME. This is because copper price varies primarily (with a lag) with industrial demand in developed countries as a whole. LME prices closely reflect the overall surplus in the world copper market (since LDC mine producing countries channel their surplus copper, in times of low world demand, into LME warehouse stocks). Finally, the marginal nature of the LME also adds to price

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3/ Ronald Prain, op. cit., pp. 94-112.

TABLE IV.1: COPPER PRICES, 1947-75

Year	U.S. Producer Price		L.M.E. Price	
	Current Prices	Constant 1974 Prices[1/]	Current Prices	Constant 1974 Prices[2/]
	US¢/lb	US¢/lb	US¢/lb	US¢/lb
1947	21.0	44.3	23.8	50.2
1948	22.0	42.9	24.4	47.6
1949	19.2	39.3	16.9	34.6
1950	21.2	41.6	22.6	44.6
1951	24.2	42.5	27.8	69.2
1952	24.2	44.0	33.0	58.4
1953	28.8	53.3	34.3	63.3
1954	29.7	55.0	31.4	57.8
1955	37.5	68.2	44.6	93.9
1956	41.8	72.0	41.5	84.5
1957	29.6	51.0	28.4	56.5
1958	25.8	43.7	25.1	50.2
1959	31.2	52.9	30.2	61.5
1960	32.1	54.4	31.2	62.5
1961	29.9	50.7	29.2	58.3
1962	30.6	51.9	29.7	59.1
1963	30.6	51.9	29.7	58.2
1964	32.0	54.2	43.1	82.9
1965	35.0	58.3	59.4	111.4
1966	36.2	58.4	70.1	128.6
1967	38.2	61.6	45.6	84.0
1968	41.8	65.3	56.7	104.0
1969	47.5	72.0	67.5	119.3
1970	57.7	84.9	63.9	107.9
1971	51.4	72.4	51.4	82.9
1972	50.6	68.4	45.5	67.4
1973	58.9	70.1	76.5	92.4
1974	76.6	76.6	93.4	93.4
1975	63.5	58.2	51.0	46.8

1/ Deflated by the U.S. wholesale price index
2/ Deflated by the U.S. wholesale price index until 1955, thereafter by the OECD wholesale price index

Source: Metallgesellschaft Aktiengesellschaft, Metal Statistics, (Frankfurt), various issues.

instability in the short run--with a few large buy or sell orders strongly influencing short-run prices.4/

In the past, the fact that both demand and supply were relatively price inelastic in the short term, combined adversely with the absence of any long term production policies aimed at promoting producer country interests (because of domination of the international copper market by multinational firms) and made it almost impossible to introduce stability into the copper market. Recent efforts by LDCs to gain sovereignty over their natural resources have resulted in major nationalizations in copper producing countries (primarily in Chile, Peru, Zaire and Zambia)5/. The formation of CIPEC (Section C below) and its subsequent attempts to introduce some order into the copper market have had only limited success. This is due largely to the fact that inadequate foreign resources and domestic economic requirements have made most copper producers in developing countries highly dependent on full utilization of copper capacity, so that they continue producing even if the price covers only the variable costs or even less.

Copper Industry Cost Structure. A study by the Commodity Research Unit in London (United Kingdom) estimated that copper from a

4/ Marion Radetzki, Market Structure and Bargaining Power - A Study of Three International Mineral Markets, Mimeographed, (Washington, D.C.: International Bank for Reconstruction and Development), June 1976.

5/ United Nations, ECOSOC, Permanent Sovereignty Over Natural Resources, UN Document A/9716. (New York: September 20, 1974), Annex p. 19.

new and fully integrated unit costs at least 75¢/lb (1974 prices) to produce profitably[6]. This excludes the high cost infrastructure which will be necessary for many projects currently being planned; addition of those costs would raise the viable price to 80¢/lb (1974 prices). Estimates of average total production costs at existing plants vary. Shearson, Haydon, Stone estimates them at about 63¢/lb (1975 prices) in the United States and 50¢/lb (1975 prices) in the major LDC copper producing countries[7]. The Metal Bulletin, on the other hand, estimates them at 60¢/lb (1975) in Canada, 60-70¢/lb (1975 prices) in the United States, and above 60¢/lb (1975 prices) in Zambia (the high costs for Zambia being due to current transportation problems). Average variable costs of currently operating mines were estimated by the Commodity Research Unit study to be between 22¢/lb and 46¢/lb (1974 prices) with 80 percent being in the 28¢/lb to 40¢/lb range. North America's average operating costs were estimated at about 9 percent above the free market average and 27% above the average for Australia, because of the low grades being currently mined.

An unpublished (and restricted) study done for CIPEC by the Battelle Memorial Institute has been quoted by Mikesell to illustrate the structure of operating costs in the copper industry.[8]

6/ As reported in Metal Bulletin Monthly (London), Feb. 18, 1975, p. 16.

7/ Shearson, Haydon, Stone, Inc. Newsletter, (New York: November 7, 1975), pp. 6, 7.

8/ Raymond F. Mikesell, The World Copper Industry, (Baltimore: The John Hopkins University Press, 1979), pp. 122-123.

Marginal cost estimates (referring to the additional cost from expanding the capacity of existing mines) were made for 1970 for CIPEC countries at 52 cents per pound and the United States at 51 cents per pound. Average costs for CIPEC amounted to 29 cents per pound and for the United States at 32 cents per pound (all in 1970 dollars).

B. Structure of Production, Consumption, Trade and World Reserves.

Total supply of copper comprises copper mine production and use of scrap, both old and new[9]. A detailed time series for market economies is given in Tables IV.2 and IV.3. Total copper consumption or demand for copper is defined as consumption of refined metal plus direct (or actual) use of scrap. The time series for consumption is given in Table IV.4. We note that the United States is virtually self-sufficient being only a marginal net importer of copper. The centrally planned economies are also self-sufficient (with net imports being about 100,000 tons in 1974)[10]. The international copper trade is thus largely confined, on the demand side, to Europe and Japan; and, on the supply side, mainly to the CIPEC countries (Australia, Chile, Peru, Zambia, Zaire, Indonesia, Papua New Guinea

9/ New scrap is included both in the supply and demand side in order to give a comprehensive picture of the copper market. See Franklin M. Fisher; Paul H. Cootner; and Martin N. Baily, "The World Copper Market" The Bell Journal of Economics and Management Science, Vol. 3, No. 2, 1972.

10/ Klaus Billerbeck, On Negotiating a New Order of the World Copper Market, (Berlin: German Development Institute, 1975), p. 5.

TABLE IV.2: COPPER MINE PRODUCTION, MARKET ECONOMIES, 1955-1975

(Thousand Metric Tons)

YEAR	U.S.A.	EUROPE	CANADA	CIPEC[1/]	OTHER LDCs	TOTAL
1955	906	109	296	1117	300	2728
1956	1002	114	322	1243	363	3044
1957	986	125	326	1275	378	3090
1958	888	133	313	1230	390	2954
1959	748	129	359	1517	401	3154
1960	980	130	399	1605	403	3617
1961	1057	137	398	1712	410	3714
1962	1114	149	415	1719	414	3811
1963	1101	152	411	1755	456	3875
1964	1131	156	442	1813	455	3997
1965	1226	150	461	1842	460	4139
1966	1297	144	459	1888	541	4329
1967	866	153	556	1929	553	4057
1968	1093	169	575	1991	585	4413
1969	1401	197	520	2102	605	4825
1970	1560	206	610	2140	649	5165
1971	1381	230	655	2154	702	5122
1972	1510	252	720	2419	729	5630
1973	1559	292	824	2613	749	6037
1974	1449	278	821	2829	758	6135
1975	1280	287	713	2651	743	5674

1/ Comprising Chile, Peru, Zambia and Zaire, Australia, Indonesia, Mauritania and Papua New Ghinea.

Source: Metallgesellschaft Aktiengesellschaft Metal Statistics, (Frankfurt), various issues; except for Mauritania production, which is from World Bureau of Metal Statistics, World Metal Statistics (London), September, 1976.

TABLE IV.3: SECONDARY COPPER SUPPLY, 1/ MARKET ECONOMIES, 1955-1975
(Thousand Metric Tons)

Year	U.S.A. Old Scrap	U.S.A. 2/ New Scrap	EUROPE Scrap	JAPAN Scrap	CANADA Scrap	AUSTRALIA Scrap	LDC Scrap	Total
1955	467	551	.....	.....	.....	1,085	.....	2,103
1956	425	547	.....	.....	.....	1,040	.....	2,012
1957	403	483	.....	.....	.....	978	.....	1,864
1958	373	482	.....	.....	.....	986	.....	1,841
1959	427	556	.....	.....	.....	1,104	.....	2,087
1960	390	516	924	231	40	12	90	2,203
1961	373	504	931	274	40	15	100	2,237
1962	377	569	943	258	40	12	111	2,310
1963	383	629	967	253	40	17	120	2,409
1964	430	715	1,071	340	45	21	149	2,771
1965	466	795	1,190	320	48	34	154	3,007
1966	485	842	1,214	314	61	24	123	3,063
1967	438	707	1,149	334	71	30	111	2,840
1968	473	742	1,282	394	72	35	131	3,129
1969	526	844	1,365	449	73	38	165	3,460
1970	457	788	1,332	464	61	41	151	3,294
1971	404	792	1,209	455	62	35	182	3,139
1972	416	880	1,232	458	69	35	155	3,245
1973	441	919	1,424	555	68	33	191	3,631
1974	439	878	1,397	521	62	32	198	3,527
1975	338	686	1,137	389	55	28	164	2,797

1/ Sum of production of secondary refined copper plus direct use of scrap.

2/ Defined as total scrap supply minus old scrap.

Source: Metallgesellschaft Aktiengesellschaft Metal Statistics, (Frankfurt), various issues.

TABLE IV.4: COPPER CONSUMPTION,[1] MARKET ECONOMIES, 1955-1975

(Thousand Metric Tons)

YEAR	U.S.A.	EUROPE	JAPAN	CANADA	CIPEC	OTHER[2] LDCs	TOTAL
1955	2,163	2,032	225	168	58	130	4,776
1956	2,115	2,029	277	169	48	125	4,763
1957	1,898	2,089	318	146	57	167	4,675
1958	1,766	2,174	297	153	68	203	4,661
1959	2,083	2,179	359	160	77	178	5,036
1960	1,866	2,529	474	147	84	323	5,423
1961	1,948	2,638	573	169	74	310	5,112
1962	2,134	2,542	501	177	91	332	5,111
1963	2,320	2,621	562	200	102	350	6,155
1964	2,483	2,896	738	235	117	420	6,881
1965	2,716	2,943	682	247	117	427	7,132
1966	3,054	2,778	711	296	124	327	7,290
1967	2,588	2,700	883	246	101	313	6,831
1968	2,555	2,948	1,018	265	121	383	7,290
1969	2,893	3,201	1,148	262	122	467	8,093
1970	2,672	3,275	1,183	273	130	458	7,991
1971	2,693	3,155	1,158	264	140	545	7,955
1972	2,976	3,310	1,306	267	142	562	8,563
1973	3,178	3,640	1,624	284	164	659	9,549
1974	2,873	3,576	1,275	307	147	659	8,890
1975	2,120	3,136	1,134	226	140	684	7,440

1/ Copper consumption or demand for copper is defined as consumption of refined copper plus direct (or actual) use of scrap.

2/ Residual.

Source: Metallgesellschaft Aktiengesellschaft Metal Statistics, (Frankfurt), various issues.

and Mauritania), and to some prominent non-members of CIPEC, viz. Turkey, the Phillipines, South Africa and Canada.

While recovery of copper from scrap is an important source of copper supply, actual recycling possibilities are more limited. The largest portion of scrap supply is new scrap, i.e., scrap which is waste generated in the fabrication of copper shapes and is therefore not an original source of copper (Table IV.3). It is not price sensitive and its quantity is largely a function of the total amount of fabricated copper. Old scrap, on the other hand, is obtained from copper products discarded after consumer use. Recycling relates to old scrap. We note that about 15 percent of total U.S. consumption of copper is fed by recycled copper (Tables IV.3 and IV.4). Supply of old scrap is fairly price sensitive. Overall, however, the share of truly recycled copper in total consumption is still relatively small. This means that the bulk of world supply of copper over the foreseeable future will still have to come from primary ore production.

World reserves of primary copper are currently estimated at 450 million short tons (identified resources), of which less than 20 million tons are in Western Europe, 90 million are in the United States and 40 million in Canada[11/]. These, however, incorporate ores of very low grades which are not profitably recoverable on the basis of existing technology and economic conditions. A more meaningful estimate of reserves is given in Table IV.5 below.

11/ U.S. Department of the Interior, Bureau of Mines, Copper, Bulletin 667, (Washington, D.C: 1975), p. 6.

TABLE IV.5: COPPER RESERVES RECOVERABLE AT VARIOUS PRICES
(million metric ton, 1974 Prices)

	US$0.84 Per lb	US$1.01 Per lb	US$1.18 Per lb	US$1.35 Per lb
World (mn. tons)	268	301	329	365
Centrally Planned Economies (mn. tons)	42	43	45	48
World excluding CPE's (mn. tons)	226	258	284	317
of which, U.S. (mn. tons)	73	85	85	90
Chile "	54	62	69	76
Peru "	14	19	24	29
Zambia "	20	21	23	25
Zaire "	19	20	22	25

Source: K. Takeuchi. "CIPEC and the Copper Export Earnings of Member Countries", The Developing Economies, Vol. X, No. 1, March 1972, p. 27. Price data were originally in 1970 prices and have been converted to 1974 prices using the wholesale price index for OECD countries (Appendix Table III.A).

In addition, the U.S. Bureau of Mines estimates that hypothetical and speculative copper resources of about 1.6 billion short tons (including as much as 450 million tons from sea-nodules) may exist on the earth's surface. These speculative resources will be available (if at all) at prices substantially above those indicted in Table IV.5.

Estimates of U.S. and world requirements for copper indicate that cumulative U.S. demand alone for the period 1968-2000 is likely to range between 75-87 million tons[12/]. Thus projected world

12/ L.L. Fischman and H.H. Landsberg. Adequacy of Non-Fuel Mineral and Forest Resources, reprinted as Chapter IV of Research Reports. Vol. III, edited by R.G. Ridker, Commission on Population Growth and the American Future (Washington, D.C.: 1973), p. 83.

consumption is likely to exhaust copper reserves presently identified at prices of US$1.35/lb (1974 prices); this should add an element of substantial caution in production and pricing policies designed to increase world welfare.

C. Marketing Structures

Primary copper production is highly concentrated. Using average 1972-74 mine production data (Table IV.2), we find that of total market economies' estimated mine production of about 5.932 million metric tons, about 1.505 million tons (25 percent) was produced in the United States, 0.788 million tons (13 percent) in Canada, 0.274 million tons (5 percent) in Europe, 0.095 million tons (2 percent) in Japan, 2.619 million tons (44 percent) in the CIPEC countries and about 0.650 million tons (11 percent) in other LDC's. The 1972-74 average production of CIPEC members and major LDC producers is shown in Table IV.6 below.

As already noted, CIPEC (Conseil Intergouvernmental des Pays Exportateurs de Cuivre) was formed in June 1967, comprising Chile, Peru, Zambia and Zaire. At this time, of the four countries, only Zaire had complete control over its mineral production[13/]. Chilean copper production was owned by Kennecott and Anaconda of the United States and Le Nickel of France; Peru's by Cerro of the United States;

13/ For details of these countries' gradual assertation of control over their own resources, see United Nations, Permanent Sovereignty over Natural Resources, op. cit.

TABLE IV.6: CIPEC AND MAJOR LDC COPPER PRODUCTION AVERAGE 1972-74

Country	Quantity (thousand tons)	Percent of Market Economy Production	Percent of Market Economy (excluding United States Production)
CIPEC	2,619	44.2	59.2
of which Chile	785	13.2	17.7
Zambia	707	11.9	16.0
Zaire	473	8.0	10.7
Australia	219	3.7	4.9
Peru	217	3.7	4.9
Papua New Guinea	164	2.8	3.7
Indonesia	35	0.6	0.8
Mauritania	19	0.3	0.4
Other LDCs	650	10.9	14.7
of which Phillippines	220	3.7	5.0
South and S.W. Africa	198	3.3	4.5
Turkey	31	0.5	0.7

Source: Metallgesellschaft Aktiengesellschaft Metal Statistics (Frankfurt), various issues

and Zambia's by American Metal Climax of the United States and the Anglo-American Corporation of South Africa. Since the formation of CIPEC, all these countries have either wholly or partially (51%) taken ownership of their copper mines and refining facilities. In the new member countries (Australia, Papau New Guinea, Indonesia and Mauritania), national companies are almost non-existent; Papua's major mine at Bougainville is owned by Rio Tinto Zinc of the United

States. However, the governments of all four countries are taking an increasing interest in their copper sector.

Within the United States, copper production is also highly concentrated. Thus, Table IV.7 shows that ten U.S. companies owned 94 percent of mining capacity in 1974. In addition, these companies also owned 90 percent of smelting and refining capacity, and only a slightly smaller share of semi-fabricating capacity in the same year.14/

TABLE IV.7: COPPER PRODUCTION OF MAJOR COMPANIES IN THE UNITED STATES, 1974

Company	Quantity (000 tons)	Percent of total
Top Ten Companies	1362	94.0
1. Kennecott Copper	402	27.7
2. Anaconda	190	13.1
3. Phelps Dodge	157 1/	10.8
4. Magna Copper	150	10.4
5. Cyprus Pima	82	5.7
6. ASARCO	81	5.6
7. Duval Sivorita	80	5.5
8. White Pine Copper	67	4.6
9. Inspiration Consolidated	56	3.9
10. Duval Corporation	52	3.6
11. Asamax Mining	45	3.1
Others	87	6.0

1/ Data for Phelps Dodge adjusted to exclude purchases from other companies.

Source: Metal Bulletin Monthly (London), No. 69, Sept. 19, 1976, p. 13.

14/ Metal Bulletin Monthly (London), No. 69, Sept. 19, 1976, p. 13.

Copper fabrication (from imported raw materials) is also highly concentrated in Europe and Japan. Eight major companies account for about two million tons of fabricating capacity (compared to total market economy consumption of about 6 million tons excluding the United States). Table IV.8 gives further details.

TABLE IV.8: LEADING NON-UNITED STATES COPPER FABRICATORS, 1974

Company	Capacity '000 tons	Geographical Location of Production
BICC	500	Australia, Canada, India, New Zealand, Pakistan, Portugal, United States
Sumitomo	295	Japan
Furukawa	240	Japan
Society Generale	240	Belgium, France
Delta Metal	220	United Kingdom
IMI	200	United Kingdom
Pirelli	200	Argentina, Italy, Spain, United Kingdom
Anaconda	180	Brazil, Canada, Mexico, United States

Source: Radetzski,...op. cit., based on Copper Mining, Smelting, Refining and Semi-fabricating Directory, Metal Bulletin Monthly (London), Special Issue, December 1974.

Thus market structures in the copper industry show high concentration on both the production and demand sides.

D. Copper Stocks

Data on copper stock holdings is limited. However, all available information indicates that the bulk of world stocks (both unrefined "blister" and refined copper) are normally held outside the CIPEC countries (note that Table IV.9 excludes "consumer," i.e., copper fabricators' stocks which are at least as substantial as

"producer stocks"). This, of course, weakens CIPEC's ability, in the short term, to influence prices substantially through supply management. For the long term, however, we note that the normal volume of stocks amounts to about one-fifth of the annual consumption of the developed countries and would, therefore, tend to be dissipated if consistent long-term supply management policies were adopted. The relationship between copper price and inventories is discussed further in Appendix IV.

TABLE IV.9: COPPER STOCKS
(000s of metric tons)

	1960	1970	1973	1975
Producers' Stocks	311	435	361	1,357
(London Metal Exchange) 1/	(15)	(180)	(35)	(504)
U.S. Government Stockpile	1,040	230	229	-
Producers' Stocks as Percent of Refined Production	7.4	7.1	5.4	21.6
Total Stocks as Percent of Refined Production 2/	32.2	10.9	8.8	21.6

1/ Producers' stock held at London Metal Exchange warehouses.

2/ The difference between "total stocks" and "producers' stocks" in this table is the U.S. Government stockpile--which has been steadily depleted since 1960. Data on "consumer stocks" (i.e., those held by copper fabricators) is not available.

Source: Gerhard Thiebach and Ray Helterline, Copper: Current Situation and Short-Term Outlook (Washington, D.C.: International Bank of Reconstruction and Development, May 1978) p. 15.

E. Summary Evaluation of Prospects for CIPEC Producer Group Action in Copper Using Available Estimates of Price Elasticities of Demand and Supply

A summary evaluation of prospects for CIPEC supply management can be undertaken by the use of estimates of price elasticities of demand and supply for copper undertaken by other scholars (discussed in Chapter III and Appendix I). The use of such elasticities in Table IV.10 indicates that the price elasticity of excess demand (E_{DG}) facing CIPEC is -0.91 in the short run and -2.64 in the longer run. This indicates (in a rough and ready manner) that, in the short run, a supply cutback per se would increase total revenues (since the price elasticity of excess demand is less than (minus) 1) if stocks were not used. As we have noted in our discussion on copper stocks in Section D above, present volumes of stocks are currently very high (about one-fifth of world consumption and production). Prospects for actual producer group action to be succesful in the short run, are accordingly much more limited. Over the long run, the price elasticity of -2.64 clearly indicates that supply restrictions would be detrimental to increasing total revenues unless CIPEC is substantially enlarged.

With regard to increasing total profits, however, we find that the condition for profitable restriction, $\frac{P}{MC} < \frac{E_{DG}}{E_{DG} + 1}$ indicates that in the long term any ratio of price to marginal cost less than 1.6 is unprofitable to producers. On the basis of our discussion of costs earlier in this Chapter, marginal costs[15/] of producing one

15/ Defined here as the cost of producing an additional unit of copper from existing capacity.

TABLE IV.10: COPPER, PRICE ELASTICITIES AND MARKET SHARES

	Price Elasticities		Quant. 1000 m. tons	Share of Excess Demand 6/			
	Short Term	Long Term	Av. 72-74	Alt. 1	Alt. 2	Alt. 3	Alt. 4
A. Demand			9,000 4/				
U.S.A.	-0.05 1/	-0.24 1/	3,009	1.36	1.02	1.00	0.80
Europe	-0.09 2/	-0.19 2/	3,509	1.58	1.18	1.17	0.93
Japan	-0.09 2/	-0.12 2/	1,402	0.63	0.47	0.47	0.37
Rest of the World	-0.15 1/	-0.15 1/	1,080	0.49	0.36	0.36	0.29
B. Supply			9,400 5/				
U.S. Mine Production	0.28 1/	0.61 1/	1,506	0.68	0.51	0.50	0.40
U.S. Old Scrap	0.42 2/	0.32 2/	432	0.19	0.15	0.14	0.12
U.S. New Scrap	0.00 1/	0.00 1/	892	0.40	0.30	0.30	0.24
Rest of World Scrap	0.21 2/	0.27 2/	2,144	0.97	0.72	0.71	0.57
Europe Mine Production	0.01 1/	0.61 3/	274	0.12	0.09	0.09	0.07
Canada Mine Production	0.03 1/	1.50 1/	788	0.36	0.27		
LDC Mine Production (exc. CIPEC)	0.25 2/	1.50 1/	745	0.34		0.25	
CIPEC Mine Production	0.25 2/	1.50 1/	2,619				
C. Excess Demand							
Alt. 1 Facing CIPEC Producers Group	-0.91	-2.64	2,219				
Alt. 2 Facing CIPEC & other LDCs	-0.66	-1.59	2,964				
Alt. 3 Facing CPIEC & Canada	-0.68	-1.54	3,007				
Alt. 4 Facing CIPEC & LDCs & Canada	-0.48	-0.94	3,752				

1/ From Charles River Associates, National Bureau of Standards, Paper NB S-GCR-ETIB 76-30, op. cit., p. 77.
2/ From F.M. Fisher, P.H. Cootner, and M.N. Baily, "An Econometric Model of the World Copper Industry," op. cit. The Bell Journal of Economics and Management Science, Vol. III, No. 2, Autumn 1972.
3/ Assumed conservatively to be as high as long-term price elasticity of supply of United States mine production (i.e., 0.61).
4/ From Table IV.4.
5/ From Tables IV.2 and IV.3.
6/ Quantity demanded (A) and quantity supplied (B) as share of quantity of excess demand (C).

unit of copper are about 60 percent higher than average net operating costs, which puts them in the range of between 45¢/lb and 64¢/lb (constant 1974 prices). Thus the appropriate profit maximizing price is between 72¢/lb-103¢/lb (constant 1974 prices). Since realized prices have approached this level very rarely (and have, in fact, slumped in the post 1974 period) it appears that possibilities exist for supply management of copper by CIPEC. Accordingly, we proceed to estimate the excess demand function faced by CIPEC, and to examine the price-setting alternatives available to the group as presently constituted, and also an enlarged group.

F. Detailed Evaluation of Prospects for Producer Group Action in Copper

Demand and Supply Functions in the Copper Market (excluding CPE's) - Estimation Methods: All demand and supply equations were formulated linearly - the simplest possible functional form which gives meaningful solutions[16/]. In addition, recognizing that many of the crucial reactions in the copper industry take a good deal of time, the corresponding equations were formulated in terms of distributed lags, with the dependent variable being influenced by past as well as present independent variables[17/]. The simplest and best-known formulation, the Koyck or geometric lag was employed.[18/]

16/ Carl F. Christ, Econometric Models and Methods, (New York: John Wiley and Sons, 1966) p. 57

17/ Fisher, Cootner and Baily, An Econometric Model of the World Copper Industry, op. cit., p. 573.

18/ L.M. Koyck, Distributed Lags and Investment Analysis, (Amsterdam: North Holland Publishing Co. 1954).

It was assumed that error terms were first-order auto-correlated, and corrective procedures were applied.[19] Variable were included directly on the basis of justification in economic theory. However, in accordance with normal estimation procedure where variables had no econometric significance, they were not included.

Demand: Copper consumption (demand) data presented in Table IV.4 above show that the major copper consumer areas are Western Europe, the United States and Japan (in declining order of importance). The description of the working of the copper market in this chapter also indicates that the principal elements of a copper demand equation must be the price of copper and measures of industrial activity.

The inclusion of price variables of substitute (e.g., aluminium) was rejected on the theoretical grounds that such inclusion would imply that it is necessary to interpret that the coefficient of the price variable in the demand equation represents the change in the demand for copper as a result of a change in the price of copper holding the price of substitutes constant whereas if the prices of substitutes are excluded from the estimating equation the coefficient of the copper price variable has to be interpreted as the change in

19/ This procedure consisted of estimating ρ (assumed to be the first order auto correlation coefficient of the disturbance in the equations) by regressing the residuals e_t and e_{t-1} and then transforming each variable of the original equations into a new series whose current value is the current value of the raw data minus ρ times the lagged value. See Christ, op. cit., p. 484.

demand for copper as a result of a change in the price of copper allowing substitute prices to find their equilibrium values[20]. The level of stocks was also not included in the estimating equation since as discussed in Appendix IV, the appropriate relationships are between inventory levels (as a proportion of demand and supply) and prices rather than between inventory levels and levels of consumption.

Separate demand equations were therefore estimated for Europe, the United States, Canada, Japan and the Rest of the World. The principal variables influencing copper demand (defined as use in production and not including changes in stocks) were considered, viz. (i) its price (lagged by one year since even a short-run adjustment to prices is likely to be delayed given the rigidities inherent in copper consumption) deflated by the appropriate wholesale price index (See Appendix III); (ii) the level of industrial activity (as measured by the index of industrial production); and (iii) the level of copper consumption in the previous year. Most of the variables used proved to be significant.

The data used relate to the time period 1955-74 (the period for which it proved possible to compute an aggregate wholesale price index for Europe and OECD - Appendix III), except in the case of Canada and the United States where data for the period 1949-74 were available. However, the lags involved in the equations and

20/ Frederick C. Mills, Statistical Methods (New York: Holt, 1952), and Edward J. Kane, Economic Statistics and Econometrics; An Introduction to Quantitative Economics, (New York: Harper and Row, 1968).

estimation methods resulted in the loss of two years at the start of the time period. In addition, in the case of the United States, the years 1966-67 were omitted because of the extraordinary influence of the Vietnam War.

The estimated equations are presented below (note that in these and all later equations the figures in parenthesis are t values and the figure represented as ρ is the estimated first order auto-correlation coefficient of the disturbance in the equation):

(1) $CMEUR_t = 1025 + 0.255\ CMEUR_{t-1} - 2.286\ PLME_{t-1} + 16.430\ EURI_t$

(1.28) (2.08) (3.97)

$\bar{R}^2 = 0.96$ $\rho = -0.16$ S.E.=109.8 Years 1955-74

(2) $CMUSA_t = 793 + 0.363\ CMUSA_{t-1} - 7.318\ PEMJ_{t-1} + 14.916\ USAI_t$

(1.75) (1.96) (4.57)

$\bar{R}^2 = 0.91$ $\rho = -0.06$ S.E. = 136.7 Years 1951-65, 1968-73

(3) $CMCAN_t = 60 + 0.445\ CMCAN_{t-1} - 0.700\ PEMJ_{t-1} + 1.377\ CANI_t$

(2.24) (1.38) (3.00)

$\bar{R}^2 = 0.90$ $\rho = -0.006$ S.E. = 19.1 Years 1951-74

(4) $CMJAP = 202 - 0.486\ PLME_{t-1} + 10.514\ JAPI_t$

(0.57) (19.74)

$\bar{R}^2 = 0.97$ D.W. = 1.78 S.E. = 76.9 Years 1957-74

(5) $CMRW = 148 - 1.4\ PLME_{t-1} + 6.09\ RWI_t$

(2.73) (14.50)

$\bar{R}^2 = 0.94$ D.W. = 1.47 S.E. = 45.7 Years 1957-74

Where:

CMEUR = European demand for copper

CMUSA = United States demand for copper

CMCAN = Canadian demand for copper

CMJAP = Japanese demand for copper

CMRW = Rest of world demand for copper

PLME = Copper price (LME spot of wire bars); annual average in US /lb, 1974 prices

PEMJ = Copper price (U.S. producer spot of wirebars); annual average in US /lb., 1974 prices

$EURI_t$ = Europe index of industrial production (United Nations Monthly Bulletin of Statistics)

$USAI_t$ = U.S. index of industrial production (United Nations Monthly Bulletin of Statistics)

$CANI_t$ = Canadian index of industrial production (United Nations Monthly Bulletin of Statistics)

$JAPI_t$ = Japanese index of industrial production (United Nations Monthly Bulletin of Statistics)

RWI_t = Developing countries index of industrial production (United Nations Monthly Bulletin of Statistics)

European copper consumption was found to be heavily influenced by level of industrial activity--a result to be expected from one of the most industrialized areas in the world. Price elasticity of copper demand was low, being estimated at -0.07 for the short run and -0.09 long run respectively.

United States copper consumption was also found to be closely related to the level of industrial activity. The price elasticity of

of copper demand was higher than that of Europe, being -0.17 in the short run and -0.25 in the long run.

Canadian copper consumption was found to be relatively less dependent on the level of industrial activity than Europe and the United States. This reflects the different structure of Canadian industry (with its emphasis on non-metallic manufactures, including pulp and paper, etc.). The price elasticity of copper demand in Canada was estimated at -0.19 in the short run and -0.31 in the long run.

Japanese consumption of copper was found to be nearly price inelastic and dependent almost largely on the level of Japanese industrial activity. There is no difference between short- and long-run elasticities. The price elasticity of copper demand in Japan was estimated at -0.05 at the point of means for the period. The rest of the world's consumption of copper was more price elastic than the case of Japan and also largely dependent on the level of industrial activity. There was also no difference here between short- and long-run elasticities. The elasticity of the rest of the world's copper consumption with regard to price is -0.23 at the point of means for the period.

Supply. As Tables IV.2 and IV.3 above indicated, the major sources of copper supply are mine production and secondary sources comprising new and old scrap. Our previous discussion of the copper market also suggests that the principal elements of primary (mine)

copper supply or mine production equation must be the price of copper and the level of mine production in the previous period (reflecting the effect of a certain level of capacity utilization which producers had become used to, as well as the fact that many of the crucial reactions in the copper industry take a good deal of time). The level of copper stocks was not considered as a significant variable affecting copper supply since it was assumed that such stocks would be reflected in the price (Appendix III). The principal elements of secondary supply equations were: (i) price; (ii) the level of previous production; and (iii) in the case of new scrap (which is a by-product of the actual copper fabrication processes) the total amount of copper use (consumption) actually taking place[21/].

Secondary supply equations were estimated separately for U.S. old and new scrap, while an aggregate equation was estimated for Rest-of-World scrap (due to the unavailability of appropriate data). Mine production equations were estimated for all major countries and groups excluding CIPEC (the United States, Europe, Canada and non-CIPEC less-developed countries). Data used in these estimations were generally for the period 1955-74, except for the United States where data for 1949-74 were used. The years 1959-61 and 1967-68 were omitted in the case of the United States in order to eliminate the effect of major copper strikes.

21/ The process of fabrication of copper products involves a substantial "waste" of refined copper. This "waste" is called "new scrap" and is refined again for further use.

The estimated equations are as follows:

(7) $USNS_t = -153 + 0.343\ CMUSA_t$

(24.60)

$\bar{R}^2 = 0.97$ D.W. = 1.63 SE = 26.3 Years 1955-74

(8) $USOS_t = 296 + 1.603\ PLME_t$

(9.52)

$\bar{R}^2 = 0.84$ D.W. 2.01 SE = 17.0 Years 1955-74

(9) $RWS_t = 8 + 0.829\ RWS_{t-1} + 2.808 PLME_t$

(8.14) (1.70)

$\bar{R}^2 = 0.91$ $\rho = 0.01$ SE = 117.2 Years 1955-74

(10) $USMP_t = 6 + 0.738\ USMP_{t-1} + 4.876\ PEMJ_t$

(5.69) (1.54)

$\bar{R}^2 = 0.90$ $\rho = 0.228$ SE = 93.1 Years 1950-58. 61-66, 70-74

(11) $EURMP_t = -8 + 1.072 EURMP_{t-1} + 0.045\ PLME_t$

(14.90) (0.34)

$\bar{R}^2 = 0.94$ $\rho = -0.06$ S.E. = 14.2 Years 1956-74

(12) $CANMP_t = -62 + 1,000\ CANMP_{t-1} + 1.29 PEMJ_t$

(9.78) (0.95)

$\bar{R}^2 = 0.96$ $\rho = -0.21$ S.E. = 40.4 Years 1957-74

(13) $LDCMP_t = -12 + 1.005 LDCMP_{t-1} + 0.376\ PLME_t$

(25,68) (1,78)

$\bar{R}^2 = 0.98$ $\rho = -0.09$ S.E. 19.9 Years 1956-74

Where in addition to variables previously defined:

USNS = U.S. new scrap

USOS = U.S. old scrap

RWS = World scrap, excluding U.S.

USMP = U.S. mine production

EURMP = European mine production

CANMP = Canadian mine production

LDCMP = Less-developed countries mine production (non-CIPEC)

U.S. new scrap supply, being a by-product of the copper fabrication process, was found to be entirely dependent on total copper use. Its relatively high proportion (34 percent) is a function of the actual process itself and is, in fact, lower than earlier historical experience.

G. Summary Implications of Price Elasticities of Estimated Supply and Demand Functions

The price elasticities of 'excess demand' (E_{DG}) facing CIPEC, as derived from our own estimates, are -0.88 for the short run and -1.90 for the long run (Table IV.11). These indicates that in the short run a supply cutback would be to CIPEC's advantage if stocks are not used. However, as noted in our earlier discussion on copper stocks, their present volume is currently very high. Prospects for successful producer group action by CIPEC are therefore very limited. For the long run, the implication of an 'excess demand' elasticity of over (minus) 1 is that total revenues will drop if supply

TABLE IV.11: COPPER PRICE ELASTICITIES[1/]

	Short Run[2/]			Long Run[3/]		
	"Own Est."	Fisher et. al[4/]	Charles River[5/]	"Own Est."	Fisher et. al.[4/]	Charles River[5/]
Demand						
United States	-0.17	-0.21	-0.05	-0.25	-0.90	-0.24
Europe	0.07	-0.09	n.a.	-0.09	-0.19	n.a.
Canada	-0.19	n.a.	n.a.	-0.31	n.a.	n.a.
Japan	-0.05	-0.09	n.a.	-0.05	-0.09	n.a.
Rest of the World	-0.23	n.a.	n.a.	-0.23	n.a.	n.a.
Supply						
U.S. Mine Production	0.14	0.45	0.28	0.42	1.67	0.61
U.S. Old Scrap	0.31	0.43	0.39	0.31	0.31	0.39
U.S. New Scrap	0.00	0.00	0.00	0.00	0.00	0.00
Rest of the World Scrap	0.15	0.25	0.21	0.52	0.16	0.27
Europe Mine Production	0.02	n.a.	n.a.	0.14	n.a.	n.a.
Canada Mine Production	0.15	0.18	0.03	0.76	14.84	1.50
LDC Mine Production (excluding CIPEC)	0.06	n.a.	n.a.	0.30	n.a.	n.a.
Excess Demand (E_{DG})[6/]						
Alternative 1 Facing CIPEC	-0.88			-1.90		
Alternative 2 Facing CIPEC Plus LDC's and Canada	-0.49			-0.91		

1/ At mean value of variables.
2/ 1 Year (the data being used is annual data).
3/ The long run being defined as a period where all adjustments are complete.
4/ F.M. Fisher, P.H. Cootner and N.N. Baily, "An Econometric Model of the World Copper Industry", op. cit.
5/ Charles River Associates, "An Econometric Analysis of the Copper Industry," op. cit.
6/ On the basis of 1972-74 market shares (Table IV.10).

restrictions are applied by CIPEC. On the other hand, if the goal of CIPEC is to increase total profits, then the condition for profitable restriction, $\frac{P}{MC} < \frac{E_{DG}}{E_{DG + 1}}$, implies than an appropriate long run profit maximizing price is between \$0.96/lb and \$1.35/lb (1974 prices) when marginal costs of producing copper are between 45¢/lb and 64¢/lb (1974 prices) respectively.

If CIPEC were enlarged to include other LDC's and Canada, then the prospects for successful producer-group action improve substantially. Our own estimates indicate that price elasticities of 'excess demand' facing such a group would be -0.49 for the short run and -0.91 for the long run, which implies that a supply cutback would raise total revenues.

H. The "Excess Demand" Function Facing CIPEC Producers; Projected Future Prices and their Implications

The actual "excess demand" function facing CIPEC producers is as follows:

(CMEUR + CMUSA + CMCAN + CMJAP + CMRW) - (USNS + USOS + RWS + USMP + EURMP + CANMP + LDCMP)

The function can, of course, be manipulated to exclude any members of the producers' group or enlarge the group by the inclusion of new members (e.g., Canada and non-CIPEC LDC's).

The pricing alternatives available to CIPEC, with their consequent revenue and profit implications, were examined by (i) assuming

that one copper price would prevail in the whole market, and (ii) estimating growth rates of industrial production on the basis of OECD projections (Table IV.12).

TABLE IV.12: INDEX OF INDUSTRIAL PRODUCTION (1970 = 100)

	Actual		Projected			
	1975	1976	1977	1978	1979	1980
Europe	111	115	122	129	136	144
United States	109	122	131	141	152	163
Canada	120	126	134	143	153	163
Japan	110	123	132	143	154	165
Less-Developed Countries (including CIPEC)	135	143	154	165	178	191

Source: OECD, "A Growth Scenario to 1980", Economic Outlook, Vol. 19, (Paris: July 1976).

Table IV.13 shows the pricing alternatives available to CIPEC with existing members. The methodology used involves the manipulation of the actual excess demand function in order to assess optimal price movements. The results essentially reinforce our summary evaluation of Section G in this Chapter, that increasing the level of

TABLE IV.13: PRICING ALTERNATIVES AVAILABLE TO CIPEC WITH EXISTING MEMBERS
(Quantity in '000 metric tons)
(Revenue/Profit in $US million - constant 1974 Prices)

	1975	1976	1977	1978	1979	1980	Total Production 1976-80	Discounted (5%) Present Value 1976-80
Alternative 1: (Actual/'Normal' Forecasts)								
Price, US¢/lb. (1974 Price level)	51.0[1]	53.0[2]	65.0	78.5	78.5	78.5	..	..
Quantity Demanded from CIPEC Countries for direct consumption (estimated from model)	(1,171)	3,087	3,678	4,200	4,432	4,955	20,352	..
Total Revenue accruing to CIPEC Countries ($ Million)	(1,317)	3,608	5,280	7,251	7,671	8,588	..	28,876
Total Profits accruing to CIPEC Countries[3] ($ Million)	(129)	884	2,036	3,547	3,762	4,217	..	12,757
Alternative 2: (Myopic Revenue Maximization by CIPEC)								
Price, US¢/lb. (1974 Price level)	76.0	148.0	118.7	146.7	138.3	155.2	..	..
Quantity Demanded from CIPEC Countries for direct consumption (estimated from model)	(866)	1,685	1,308	1,615	1,523	1,708	7,839	..
Total Revenue accruing to CIPEC Countries ($ Million)	(1,451)	5,498	3,423	5,224	4,644	5,845	..	22,313
Total Profits accruing to CIPEC Countries[3] ($ Million)	(687)	4,012	2,269	3,800	3,301	4,339	..	16,031
Alternative 3: (Myopic Revenue Maximization by CIPEC)								
Price, US¢/lb. (1974 Price level)	95.9	160.6	124.0	154.9	146.1	163.8	..	..
Quantity Demanded from CIPEC Countries for direct consumption (estimated from model)	(677)	1,313	930	1,266	1,167	1,364	6,040	..
Total Revenue accruing to CIPEC Countries ($ Million)	(1,431)	4,649	2,543	4,324	3,760	4,926	..	18,291
Total Profits accruing to CIPEC Countries[3] ($ Million)	(835)	3,492	1,723	3,207	2,730	3,723	..	13,462

TABLE IV.13 (Continued)

	1975	1976	1977	1978	1979	1980	Total Production 1976-80	Discounted (5%) Present Value 1976-80
Alternative 4: Profit Maximization Sensitivity I)								
Price, US¢/lb. (1974 Price level)	90.0	90.0	90.0	90.0	90.0	90.0	..	..
Quantity Demanded from CIPEC Countries for direct consumption (estimated from model)	(680)	2,231	2,473	3,073	3,457	4,023	15,257	..
Total Revenue accruing to CIPEC Countries ($ Million)	(1,349)	4,427	4,908	6,098	6,860	7,983	..	27,047
Total Profits accruing to CIPEC Countries[3/] ($ Million)	(750)	2,460	2,727	3,388	3,811	4,435	..	15,068
Alternative 5: Profit Maximization Sensitivity II)								
Price, US¢/lb. (1974 Price level)	95.9	96.0	96.0	96.0	96.0	96.0	..	..
Quantity Demanded from CIPEC Countries for direct consumption (estimated from model)	(677)	2,025	2,297	2,890	3,252	3,756	14,220	..
Total Revenue accruing to CIPEC Countries ($ Million)	(1,431)	4,287	4,862	6,118	6,884	8,035	..	27,019
Total Profits accruing to CIPEC Countries[3/] ($ Million)	(835)	2,500	2,836	3,569	4,016	4,638	..	15,720
Alternative 6: Profit Maximization Sensitivity III)								
Price, US¢/lb. (1974 Price level)	100.0	100.0	100.0	100.0	100.0	100.0	..	..
Quantity Demanded from CIPEC Countries for direct consumption (estimated from model)	(554)	1,835	2,134	2,582	2,759	3,130	12,400	..
Total Revenue accruing to CIPEC Countries ($ Million)	(1,222)	4,046	4,705	5,693	6,084	6,902	..	24,621
Total Profits accruing to CIPEC Countries[3/] ($ Million)	(733)	2,428	2,823	3,413	3,650	4,140	..	14,770

TABLE IV.13 (Concluded)

1/ Realized prices in 1975 were LME US51¢/lb. and EMJ US63.5¢/lb. (current prices).
2/ Realized prices in 1976 were LME US64¢/lb. and EMJ US63.5¢/lb. (current prices).
3/ The profit calculations are based on average total cost being estimated at 50¢/lb. (constant 1974 prices) on the basis of the Shearson, Haydon and Stone estimates discussed in Section A of this Chapter.

prices is unlikely to increase total revenues (or CIPEC export earnings) but will certainly increase total profits[22/]. It also indicates that an appropriate pricing policy for CIPEC, as presently constituted, would be to aim for prices between 96-100¢/lb (constant 1974 prices). This price would give almost the same revenues and higher profits as lower present-day prices, besides reducing depletion and slowing down the need for expensive new investments.

Alternative I in Table IV.13 presents what we could term "normal price forecasts" reflecting essentially the assumption that the low copper prices experienced in 1975 and 1976 would recover to the average of LME prices for the 1972-73 period (i.e., 78.5¢/lb, at constant 1974 prices). Under this assumption, cumulative copper production by CIPEC for the 1976-80 period is likely to amount to about 20.35 million metric tons, total revenues accruing to CIPEC $28.9 billion, and total profits $12.7 billion. These revenues and profits represent estimates of discounted present value (using a discount rate of 5 percent as discussed in Chapter III) and are in constant 1974 prices. All subsequent revenue and profit estimates presented below are in similar terms.

Alternative II in Table IV.13 presents what we call "myopic revenue maximization" by CIPEC. Here CIPEC is assumed to behave "myopically" by using the excess demand function to optimize revenue

22/ The profit calculations are based on average total cost being estimated conservatively at about 50¢/lb (constant 1974 prices) on the basis of the Shearson, Haydon and Stone estimates discussed in Section A of this Chapter.

in each annual time period. Price setting is short-sighted in that the revenue maximizing prices, particularly in the earlier period, show wide variations; thus the price for 1976 is substantially higher than the price for 1975. A policy of sharp price and quantity variation on an annual basis is unlikely to appeal to a producers' group. The magnitude of the price changes envisaged (being substantially out of the realm of realized experience) also make the econometric results of such price changes unreliable.

It is important to note, however, that the initial revenue maximization price generated by our model for 1975 (76¢/lb., constant 1974 prices), if maintained over the entire period (as is almost the case in Alternative 1 for the 1978-1980 period), would result in the highest annual and cumulative total revenues for the period.

Similarly, while "myopic profit maximization" may be an unreliable pricing strategy for CIPEC (Alternative 3), the initial profit maximization price generated by our model for 1975 (95.9¢/lb., constant 1974 prices), if maintained over the entire period 1976-80, would result in the highest annual and cumulative profits. Alternative 5 presents results under this pricing strategy. Constant prices of 96¢/lb (1974 prices) would result in total cumulative CIPEC revenues of $27 billion and profits of $15.7 billion, and would involve CIPEC production of only 14.22 million metric tons.

Two alternative constant price scenarios of 90¢/lb and 100¢/lb. (1974 prices) were also undertaken to test the viability of

the constant profit-maximizing price (96¢/lb.) discussed above. The lower price of 90¢/lb. gave almost the same CIPEC revenues of $27 billion, but slightly lower profits of $15.1 billion (Alternative 4). The higher price of 100¢/lb. gave both lower revenues of $24.6 billion and lower profits of $14.8 billion (Alternative 6).

The conclusions that emerge from our results are fairly specific. CIPEC, as presently constituted, should endeavour to set prices between 96-100¢/lb. (constant 1974 prices) if it wishes to achieve maximum profits and conserve mineral reserves. Total revenues obtainable at this price are not likely to be substantially different from those available from lower revenue maximizing prices.

Table IV.14 shows the pricing alternatives available to a CIPEC enlarged with the inclusion of all other developing countries and Canada. Here, as is to be expected, higher prices (around $1.20/lb, constant 1974 prices) are sustainable. More specifically a producers' grouping comprising these countries and maintaining a price level close to that actually realized during 1974 (78¢/lb, 1974 prices) would produce about 28.9 million tons of copper and realize total revenues of about $35.8 billion and total profits of about $17.9 billion (present value, 1974 prices) during the period 1974-1980. On the other hand, if prices were set by this group at $1.25/lb (constant 1974 prices) they would not only have to produce much less (18.9 million tons) but would also gain higher total revenues ($46.8 billion, constant 1974 prices) and higher total profit

TABLE IV.14: PRICING ALTERNATIVES AVAILABLE TO ENLARGE CIPEC
(Existing Members + LDC's + Canada)
(Quantity in '000 metric tons)
(Revenue/Profit in US $ million - constant 1974 Prices)

	1975	1976	1977	1978	1979	1980	Total Production 1976-80	Discounted (5%) Present Value 1976-80
Alternative 1: (Actual/'Normal' Forecasts)								
Price, US¢/lb (1974 Price level)	51.0[1]	53.0[1]	65.0	78.5	78.5	78.5	..	..
Quantity Demanded from CIPEC Countries for direct consumption (estimated from model)	(2,765)	4,695	5,321	5,899	6,188	6,768	28,871	..
Total Revenue accruing to CIPEC Countries ($ Million)	(3,109)	5,487	7,638	4,619	10,711	11,730	..	35,847
Total Profits accruing to CIPEC Countries[2] ($ Million)	(670)	1,346	2,945	4,982	5,253	5,760	..	17,943
Alternative 2: (Profit Maximization Sensitivity II)								
Price, US¢/lb (1974 Price level)	105.0	105.0	105.0	105.0	105.0	105.0	..	..
Quantity Demanded from CIPEC Countries for direct consumption (estimated from model)	(2,261)	3,561	3,856	4,326	4,884	5,402	22,029	..
Total Revenue accruing to CIPEC Countries ($ Million)	(5,235)	8,224	8,928	10,015	11,308	12,506	..	45,860
Total Profits accruing to CIPEC Countries[2] ($ Million)	(3,240)	5,233	5,527	5,694	7,000	7,742	..	30,912
Alternative 3: (Profit Maximization Sensitivity III)								
Price, US¢/lb (1974 Price level)	120.0	120.0	120.0	120.0	120.0	120.0	..	..
Quantity Demanded from CIPEC Countries for direct consumption (estimated from model)	(2,122)	3,203	3,409	3,818	4,333	4,861	19,624	..
Total Revenue accruing to CIPEC Countries ($ Million)	(5,615)	8,475	9,020	11,465	10,796	12,862	..	47,364
Total Profits accruing to CIPEC Countries[2] ($ Million)	(3,743)	5,650	6,013	6,735	7,043	8,575	..	31,138

TABLE IV.14 (Concluded)

	1975	1976	1977	1978	1979	1980	Total Production 1976-80	Discounted (5%) Present Value 1976-80
Alternative 4: (Profit Maximization Sensitivity IV)								
Price, US¢/lb (1974 Price level)	125.0	125.0	125.0	125.0	125.0	125.0	..	..
Quantity Demanded from CIPEC Countries for direct consumption (estimated from model)	(2,074)	3,108	3,269	3,638	4,136	4,719	18,870	..
Total Revenue accruing to CIPEC Countries ($ Million)	(5,716)	8,566	9,010	10,027	11,400	13,006	..	46,783
Total Profits accruing to CIPEC Countries[2/] ($ Million)	(3,887)	5,825	6,127	6,816	7,752	8,845	..	31,810

1/ Actual prices

2/ The profit calculations are based on average total cost being estimated conservatively at 50 /lb. (constant 1974 prices).

($31.8 billion, constant 1974 prices) during the same period. Other pricing alternative available to such a group are presented as Alternatives 2 and 3 in Table IV.14.

I. Assessment of Whether a Functional Producers' Alliance in Copper Could Actually be Formed Taking into Account Individual Country Questions

The foregoing analysis indicates that there is a strong case for supply management both by CIPEC as a group or in association with resource-conscious countries such as Canada. Whether the existing producers' alliance of CIPEC can actually be made functional is difficult to assess. Major CIPEC countries, particularly Chile and Zaire are, highly amenable to consumer country pressures.[23/] In addition, almost all CIPEC countries are less-developed countries with inadequate foreign reserves and facing extreme shortages of foreign exchange. Their ability, therefore, to indulge in active, sustained supply management appears to be limited.

23/ Helge Hveem, International Anti-Domination Struggle and The "Organization" of Raw Materials (Oslo: International Peace Research Institute, February 1974).

CHAPTER V

THE WHEAT MARKET

A. Commodity Characteristics, Competition from Substitutes, Trend of Past Prices and Present Cost Structure of The Industry

Commodity Characteristics, Uses and Substitutes. Wheat accounts for about 30 percent of world grain production and provides about 20 percent of the calories consumed by the world's population. There are several different varieties of wheat. There are three broad botanical classifications -- common, club and durum; and three broad commercial classifications -- hard, soft and durum. In addition, wheat classes also depend upon colour of kernel -- dark, yellow, red or white -- time of sowing -- fall or spring -- location of sown area, etc. However, while recognizing these quality differences, one can consider wheat a homogenous commodity for purposes of economic analysis.1/

The bulk of the world's wheat is used primarily as food (largely bakers' products including bread, rolls, biscuits, etc., and macaroni). It is also used as animal feed (both in the form of grain or byproducts from flour milling and as forage, depending upon the price relationship between it and other feed crops). Industrial use of wheat is relatively minor, being largely confined to use as starch and gluten and as a component of hardwood and plywood adhesives. During World War II, wheat served as a major raw material for the

1/ The prices of different varieties of wheat have historically always moved together (Appendix V).

production of ethyl alcohol (used in the manufacture of munitions and synthetic rubber). Aggregate end use statistics are not available, but selected data for the European Economic Community (EEC) for 1972-73 show that 69% was used as human food, 24.5% as animal feed, 5.4% as seed and 1.1 percent for industrial and other uses[2/]. In the United States, for the same year, 76.6% was used as human food, 13.0% as animal feed and 10.4% as seed[3/].

In the developing countries, the major substitutes for wheat include rice, maize and other coarse grains (rye, barley, millet, sorghum, etc.) In the developed countries, the main substitute is maize (particularly in its use as animal feed). The substitution effects of particular grains vary, and are tempered strongly by taste and quality factors in human consumption. Substitution, however, between wheat and other grains is very prominent in its use as animal feed. The consumption of wheat is also affected by consumers' income. In high-income countries, the income-elasticity of demand for wheat as food is negative; in lower countries, it is generally positive.

Prices. Except for the major wheat-exporting countries (including the United States, Canada, Australia and Argentina), where domestic and export prices generally coincide, wheat markets show considerable price differentials. Thus EEC wheat prices are

2/ George E. Inglett, Wheat: Production and Utilization, (Westport: The Avi Publishing Co. Inc., 1974), pp. 399-401.

3/ International Wheat Council, World Wheat Statistics (London, 1977), p. 47.

generally higher than international prices (i.e., EEC wheat producers are effectively subsidized). In less developed countries (LDC's) and centrally planned economies (CPE's), on the other hand, prices for domestically produced wheat are substantially lower than international prices (i.e., domestic consumers of wheat are effectively subsidized).4/ Various econometric studies, however, indicate that international prices in both CPE's and LDC's are able, more slowly but definitely, to adjust themselves to what are perceived as "stable" international wheat price levels.5/

The international market for wheat is generally deemed to be fairly competitive. However, all the major exporting countries maintain support-price levels and thereby set an effective floor to the price of wheat. In addition, three of the major exporting countries have agricultural marketing boards which have a monopoly over domestic procurement and external sales, viz. The Canadian Wheat Board,6/ The Australian Wheat Board and Argentina's Junta Nacional de Granos. Wheat supply is also controlled (most of the time) through acreage restrictions in most exporting countries (including the United States). All these factors have a substantial influence on prices.

4/ Ibid., p. 48.

5/ F. Gerard Adams and Jere R. Behrman, Econometric Models of World Agricultural Commodity Markets, (Cambridge, Mass.: Ballinger Publishing Co., 1976) p. 44.

6/ Ontario produced wheat is controlled by the Ontario Wheat Producer Marketing Board.

International wheat prices remained remarkably stable in current prices in the period 1954-72 (see Table V.1). This was primarily the result of relatively liberal production policies by the main exporting countries (particularly the United States and Canada), which attempted to maintain farm incomes by encouraging substantial production through guaranteed support prices (although crop land 'set aside' was also used as a policy instrument). Surpluses generated through this policy were disposed of largely through subsidized sales to less developed countries. This system was given a shock in the period 1973-75, when crop failures resulted in the Soviet Union unexpectedly buying extremely large quantities of wheat. As a result, wheat prices almost tripled (in current dollars) to about US $200 per metric ton in the period 1972-74. While some decline has occurred since then, wheat prices have remained substantially higher in real terms than the levels experienced in the late fifties and sixties. This is in large part due to the more restrictive production policies being followed by the major exporting countries. These production policies are discussed later on in this chapter.

Wheat Industry Cost Structure. Average per unit production costs (excluding land but including "management" costs) have been estimated for the United States at $2.55/bushel ($94/metric ton) in 1976; $2.43/bushel ($89/metric ton) in 1977 and $2.31-$2.62/bushel ($85-$96/metric ton) in 1978[7/]. Data regarding marginal costs of

7/ U.S. Congress, Senate, Committee on Agriculture, Nutrition and Forestry, Costs of Producing Selected Crops in the United States - 1976, 1977 and Projections for 1978, (Washington, D.C.: Government Printing Office, 1978), p. XI.

TABLE V.1: WHEAT EXPORT PRICES, 1949/50 - 1975/76

(U.S. $ metric ton)

	Argentina No. 2 Semi-Hard f.o.b. Buenos Aires[1]	Australia F.A.Q. Bulk f.o.b. Ports[1]	Canada Western Red Spring 13.5% f.o.b. Thunder Bay[1]	USA No. 2 Dark Northern Springs f.o.b. gulf[1]	EEC Standard[1]	UN Export Price Index 1963-100[2]	Deflated UN Export Price Index 1963-100[3]
1949/50[4]	91	66 80	66 74	68 68	--	--	--
1950/51[4]	71	66 77	68 73	69 92	--	108	164
1951/52[4]	91	67 85	68 85	74 96	--	116	159
1952/53[4]	93	68 87	68 81	75 94	--	116	149
1953/54[4]	82	68	70	75 78	--	120	154
1954/55	68	60	65	66	--	105	131
1955/56	52	54	64	62	--	98	121
1956/57	56	56	64	63	--	96	113
1957/58	60	60	62	62	--	96	109
1958/59	57	57	63	62	--	96	106
1959/60	58	55	64	61	--	95	103
1960/61	60	55	62	62	--	94	100
1961/62	62	60	66	63	--	97	101
1962/63	61	59	67	71	--	101	103
1963/64	67	62	69	68	--	100	100
1964/65	59	58	68	67	--	104	101
1965/66	55	59	68	64	--	95	90
1966/67	59	63	72	68	--	102	94
1967/68	62	58	66	66	--	103	91
1969/70	56	54	64	62	62	94	76
1970/71	57	58	67	67	82	93	72
1971/72	62	58	65	66	70	97	70
1972/74	86	91	92	91	117	108	75
1973/74	--	195	202	184	192	187	121
1974/75	163	167	198	192	189	270	156
1975/76	144	147	174	176	177	240	124

1/ International Wheat Council, World Wheat Statistics (London), various issues.

2/ United Nations, Price Movements of Basic Commodities in International Trade: 1950-70 (New York: 1972), p. 10 for data pertaining to 1950-70; and United Nations, Monthly Bulletin of Statistics (New York: September 1976), p. XX for data pertaining to 1971-75.

3/ Deflated by OECD GNP (market prices) deflator from National Amounts of OECD Countries (Paris: OECD, 1973).

4/ Separate (lower) export prices prevailed for certain countries covered by an international wheat agreement for the years 1949/50 -1953/54.

production of wheat are not available. However, in the case of wheat the assumption of constant average (and therefore marginal) costs appears reasonable (as discussed in Chapter III), since in our analysis a supply management scheme would normally imply output curtailment rather than output increases in which case the standard argument of increased variable costs of producing additional wheat on inferior land is not relevant.

Since these costs are considerably below realized market prices, there has been considerable controversy (at least in the United States) over the production cost to be attributed to land. Currently, two methods are in use. The "current market value" methodology (land value x average interest rate on real estate loans by the U.S. Federal Land Bank) gives an average cost of $1.33/bushel ($49/metric ton) in 1976; $1.24/bushel ($46/metric ton) in 1977 and $1.30/bushel ($48/metric ton) in 1978. The "acquisition value" methodology (i.e., the value of the land at the time of acquisition--in practice, the average value of crop land during the last 35 years for owner-operated land) gives an average cost of $0.82/bushel ($30/metric ton) in 1976; $0.67/bushel ($25/metric ton) in 1977; and $0.71/bushel ($26/metric ton) in 1978.8/ The "value" of land, in effect, depends upon the surpluses being realized (and these surpluses were substantial in the past 1972-1974 period). There is, therefore, an effort by the national government, agricultural ministries and

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8/ Ibid.

export agencies to ensure the continued prevalence of high export prices.

B. Structure of Wheat Production, Export and Export Marketing

As Table V.2 indicates, the centrally planned economies produce the bulk of the world's wheat (an average of 40 percent for the period 1974-1976). However, these economies are still net importers of wheat (Table V.8), and they use a considerable portion of total wheat available for purposes of animal feed. The developed countries (particularly the United States, Canada, Australia and the EEC) are the world's largest exporters of wheat. In 1974-76, the United States, Canada and Australia accounted, on average, for 60 percent of developed countries' production and about 77 percent of total world exports.9/ This section will focus on the production policies of the major exporting countries, viz. the United States, Canada, Australia and the EEC.

U.S. Wheat Production and Exports. The United States is the largest producer of wheat of the developed countries. It is also the world's largest exporter of wheat, accounting by itself for more than 45 percent of total exports (see Table V.3 below).

U.S. policy objectives and production targets are usefully summarized as follows: "The United States Government recognizes that

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9/ International Wheat Council, World Wheat Statistics (London: 1977), p. 25.

TABLE V.2: WORLD WHEAT PRODUCTION

(thousand metric tons)

YEAR	WORLD	DEVELOPED COUNTRIES	U.S. + CANADA + AUSTRALIA	CENTRALLY PLANNED ECONOMIES	LESS DEVELOPED COUNTRIES	ARGENTINA
1951	171,200	77,861	n/a	n/a	n/a	2,100
1952	206,000	94,383	59,973	n/a	n/a	7,634
1953	203,500	90,013	54,569	72,852	40,635	6,200
1954	194,800	79,115	40,435	75,600	40,085	7,690
1955	206,500	82,372	44,889	82,352	41,776	5,250
1956	226,500	80,958	46,527	104,738	40,804	7,100
1957	221,500	82,140	39,354	98,262	41,098	5,810
1958	252,600	97,561	56,354	119,937	35,102	6,720
1959	243,684	88,854	47,935	118,584	36,246	5,837
1960	243,067	97,048	58,426	103,222	42,799	4,200
1961	227,977	85,402	48,045	99,809	42,766	5,725
1962	258,379	100,427	53,464	108,484	49,468	5,700
1962	258,379	100,427	53,464	108,484	49,468	5,700
1963	239,542	103,300	59,826	89,372	46,870	8,940
1964	277,125	110,893	61,317	115,918	50,314	11,260
1965	267,419	111,728	60,546	107,979	47,712	6,079
1966	310,156	117,496	70,914	119,546	73,314	6,247
1967	299,062	119,501	64,716	126,432	53,129	7,320
1968	331,469	129,608	74,858	141,709	60,152	5,740
1969	314,429	120,956	68,078	129,408	64,065	7,020
1970	319,086	103,430	54,698	144,899	70,757	4,920
1971	376,529	132,734	74,554	173,151	70,644	7,541
1972	347,320	121,944	63,151	147,154	78,222	7,900
1973	376,529	132,734	74,554	173,151	70,644	7,541
1974	360,341	138,749	73,537	149,143	72,449	5,970
1975	355,824	142,654	87,160	131,828	81,342	8,570
1976	417,478	153,743	93,967	168,687	95,048	11,200

Source: United Nations, Food and Agricultural Organization, FAO Production Yearbook (Rome), various issues; and United Nations, Statistical Yearbook (New York), various issues.

TABLE V.3: U.S. WHEAT PRODUCTION AND EXPORTS

	1973/74	1974/75	1975/76
U.S. Production, Million Tons	46.4	48.9	58.1
(U.S. Production % of World Total)	(12.3)	(13.6)	(16.4)
U.S. Export, Million Tons	31.1	28.3	31.5
(U.S. Exports % of World Total)	(48.8)	(44.6)	(47.4)
U.S. Wheat Export Value, $ Billion	4.2	4.6	5.3

Source: International Wheat Council, World Wheat Statistics (London: 1977), pp. 17, 25; United Nations, Yearbook of International Trade Statistics (New York: 1975), pp. 31, 36.

American farmers are capable of producing grains in greater quantities than can be used or disposed of through available outlets in most years; that grain prices are subject to wide fluctuations . . . and that farm operators cannot adjust supplies to requirements without some system to facilitate their co-operation."10/ U.S. regulation of production operates through "target" or support prices and "loan rates". The "target" price system entitles farmers to receive deficiency payments computed on the difference between the target price and either the national weighted average market price received by farmers during the first five months of the marketing year or the "loan rate", whichever is higher. The price support

10/ United Nations, Food and Agriculture Organization, National Grain Policies (Rome: 1976), p. 251.

"loan rate" is the price at which the U.S. Government will lend to a producer using his harvest as collateral. The "loan rate" can also serve as a floor price since the Government undertakes, at the producers' discretion, to take title of the commodity once the loan has expired. This mechanism, in effect, provides farmers with interim financing, permitting them to take advantage of increases in market prices without the risk of price declines below the loan level. The support system is tied to "set aside" or acreage not planted (e.g., 20 percent "set aside" means that a farmer cannot plant more than 80 percent of the wheat acreage that he planted the previous year). Thus a farmer who does not observe the "set aside" provisions cannot avail himself of target (support) price payment or the "loan rate" provisions.11/ The result of the system is that the U.S. authorities can, in effect, control the quantity of wheat produced in the United States.

U.S. Export Marketing. U.S. grain marketing (including marketing of wheat procured under "loan" provisions by the concerned agency--the Commodity Credit Corporation) is conducted through commercial channels. Wheat surpluses are disposed of through Public Law 480, which allocates sums of money for concessional food assistance to appropriate countries for purchase through regular commercial channels. There is, however, considerable sales concentration in the "free market" system. While detailed data are not available (because

11/ International Wheat Council, Review of the World Wheat Situation (London: 1977), pp. 62-64.

of secrecy by the firms concerned), it is estimated that five firms - Cargill, Continental, Cook, Dreyfus and Bunge - control 90 percent of U.S. grain exports and 70 percent of world grain exports.[12/] Cargill and Continental, each with sales of about $2.5 billion per annum, are owned by interests resident in the United States, as are Cook and Dreyfus, headquarted in Paris, and Bunge in Argentina.

Canadian Wheat Production and Exports. Canada ranks number three (after the United States and France) in developed countries' production of wheat. However, it is the world's second largest exporter of the commodity. Canada's wheat exports amounted to about 18 percent of the world's total during 1973-75. Canadian production and exports are summarized in Table V.4 below.

TABLE V.4: CANADIAN WHEAT PRODUCTION & EXPORTS

	1973/74	1974/75	1975/76
Canadian Prod. Million Tons	16.5	13.3	17.1
(Canadian Prod. % of World Total)	(4.4)	(3.7)	(4.8)
Canadian Exports, Million Tons	11.7	11.2	12.1
(Canadian Exports % of World Total)	(18.6)	(17.7)	(18.2)
Canadian Wheat Export Value, $ Billion	1.3	2.2	2.1

Source: International Wheat Council, World Wheat Statistics (London: 1977) pp. 17,25; and United Nations Yearbook of International Trade Statistics (New York: 1975) pp. 31,36.

12/ J. Freivalds, Grain Trade - The Key to World Power and Human Survival (New York: Stein and Day, 1976), pp. 116-121.

Canadian wheat production policy is aimed at shielding producers from the most serious price fluctuations, while maintaining flexibility in production and encouraging farmers to make voluntary adjustments to changing price conditions. The system works through guaranteed prices or so-called "initial payments" for basic grades of wheat delivered to the Canadian Wheat Board. These are established each year before the crop is planted and are, in effect, federal government-guaranteed floor prices, as any deficits incurred by the Board in its marketing operations are paid for by the federal government. Sales proceeds from the marketing of grains by the Canadian Wheat Board are pooled and returned to wheat producers. No mandatory acreage restrictions on wheat are levied for access to this system (as in the United States), but the government normally "recommends" acreage increases or reductions. Thus, for example, the Minister in charge of the Canadian Wheat Board recommended that total spring plantings of Canadian wheat for the 1977-78 season be reduced by 7% below the previous year level.13/ However, physical control over wheat production by the Canadian Wheat Board is ensured through the "delivery quota" system. Delivery quotas are set by the Board (on the basis of information provided by producers) and are in operation for a limited period of time; producers wishing to take advantage of the delivery opportunity have to deliver the grain during the period in which the quota remains in effect.

13/ International Wheat Council, Review of the World Wheat Situation, op. cit., p. 58.

Canadian Export Marketing. The Canadian Wheat Board has a monopoly over all Canadian exports of wheat and also over a major portion of domestic sales (the other agency selling domestically is the Ontario Wheat Producer Marketing Board). Sales are made to private grain traders (who in turn sell to domestic and foreign buyers), and also directly to foreign governments. Credit facilities, when required, are provided by the government.

Australian Wheat Production and Exports. Australia's wheat production is also largely export-oriented, and the country ranks third among world exporters (Table V.5). Production is supported through a "stabilization" or support price scheme. Acreage restrictions are not imposed, but the level of production can be controlled very rigidly through a system of "quotas" on deliveries of wheat from producers which are set by the Australian Wheat Board.

TABLE V.5: AUSTRALIAN WHEAT PRODUCTION AND EXPORTS

	1973/74	1974/75	1975/76
Australian Prod. Million Tons	12.1	11.6	12.3
(Australian % of World Total)	(3.2)	(3.2)	(3.5)
Australian Exports, Million Tons	5.5	8.1	8.1
(Australian % of World Total)	(8.7)	(12.8)	(12.2)
Australian Wheat Export Value, $ Billion	0.3	1.4	1.5

Source: International Wheat Council, World Wheat Statistics (London: 1977) pp. 17,26; and United Nations, Yearbook of International Trade Statistics (New York: 1975), pp. 31,36.

Australian Export Marketing. Ownership of all wheat produced in Australia (except wheat retained on farms for seeding and for stock feeding) is vested in the Australian Wheat Board. In addition, the Board is the sole authority responsible for the marketing of wheat within Australia and of wheat and wheat products for export.14/

European Economic Community (EEC) Wheat Production and Exports. The EEC is a major wheat producer operating under a system of intervention or support prices (which have in "normal" years been substantially above world market prices). The Community produces mainly "soft" wheats (not particularly suited for bread making) and therefore imports a substantial quantity of "hard" wheats (see Table V.6). Its own surplus of "soft" wheat is exported through a system of subsidies (when international prices are lower than domestic prices). While Common Market grain regulations do not provide for any direct supply management, the level of "intervention" prices does constitute to some extent an instrument for guiding production.

EEC Export Marketing. Grain marketing (including that for export) is conducted through private trade channels. There are no unified national or Community marketing organizations. Control over exports, is to some extent, secured by means of a licensing scheme which requires an export licence for all grain exports (including wheat). The licences stipulate both the quantity and the time period

14/ United Nations, Food and Agriculture Organization, National Grain Policies, op. cit., p. 57.

within which the wheat must be exported and are backed by security guarantees.

TABLE V.6: EEC WHEAT PRODUCTION AND EXPORTS

	1973/74	1974/75	1975/76
EEC Prod. Million Tons	41.4	45.4	38.1
(EEC % of World Total)	(11.0)	(12.6)	(10.8)
EEC Export Million Tons	5.5	7.1	7.7
(EEC % of World Total)	(8.7)	(11.1)	(11.6)
EEC Imports, Million Tons	5.7	5.3	6.4
(EEC % of World Total)	(9.0)	(8.4)	(9.6)
EEC Wheat Export, Value $ Billion	1.5	1.8	2.2
EEC Wheat Import, Value $ Billion	1.5	1.9	2.2

Source: International Wheat Council, World Wheat Statistics (London: 1977), p. 17,25; and United Nations, Yearbook of International Trade Statistics (New York: 1975), p. 31,36.

Thus the major developed wheat exporting countries (particularly the United States, Canada and Australia) possess the capacity both to regulate production and to control the level of their exports.

C. Wheat Consumption and Imports

As Table V.7 indicates, the centrally planned economies consume about 47 percent of the world's wheat, the less developed countries about 30 percent and the developed countries about 23 percent. This compares with their production capabilities of about 42 percent, 21

TABLE V.7: WORLD WHEAT CONSUMPTION/USE, 1960-1976

(thousand metric tons)

YEAR	WORLD	DEVELOPED COUNTRIES	CENTRALLY PLANNED ECONOMIES	LESS DEVELOPED COUNTRIES
1960	234,230	74,581	103,529	56,120
1961	237,435	73,316	107,007	57,112
1962	247,930	75,081	112,458	60,391
1963	243,466	74,601	105,953	62,912
1964	260,689	77,529	118,422	64,738
1965	282,061	81,007	132,855	68,199
1966	281,426	79,154	130,425	71,847
1967	288,478	78,765	136,018	73,695
1968	303,039	83,279	142,111	77,649
1969	323,825	86,179	153,657	83,989
1970	338,940	87,215	165,473	86,252
1971	342,450	90,122	162,054	90,274
1972	362,306	90,913	172,919	98,474
1973	358,767	85,752	170,512	102,503
1974	359,244	85,336	171,939	101,969
1975	354,530	82,779	164,936	106,815
1976	371,734	85,439	175,576	110,719

Source: U.S. Department of Agriculture, Foreign Agricultural Service, Foreign Agricultural Circular on Grains (Washington, D.C.), various issues.

percent and 37 percent, respectively (average production for 1973-75, Table V.2).

The LDC's are the world's largest wheat importers (Table V.8). Those which in normal years import more than 1 million tons of wheat each include Brazil, India, Pakistan, Bangladesh, South Korea, Algeria, Egypt and Morocco. A substantial number of other countries each import more than 0.5 million tons of wheat, viz. Cuba, Chile, Peru, Venezuela, Iran, Iraq, Israel, Saudi Arabia, Indonesia, Phillipines, Sri Lanka, Taiwan, Vietnam, Libya, Morocco.15/ Thus LDC consumers of wheat have varying degrees of dependence on imports of wheat.

In the CPE's, on the other hand, wheat imports are more concentrated. The bulk of wheat imports are purchased by the Soviet Union. Other major importers are China and Poland.

In both LDC's and CPE's wheat imports are undertaken largely by national buying agencies. Imports are largely a result of the exigencies of domestic food grain supply, and evaluation of the behaviour of international wheat markets in many LDC cases is nonexistent. The CPE's have operated with relatively expert knowledge of world commodity markets.

D. Wheat Stocks

Data on world stocks of wheat are subject to substantial margins of error because of the difficulties of obtaining figures

15/ International Wheat Council, World Wheat Statistics, op. cit., p. 39.

TABLE V.8: WORLD WHEAT TRADE, 1951/52-1973/74

(thousand metric tons)

	WORLD		DEVELOPED COUNTRIES		CENTRALLY PLANNED ECONOMIES		LESS DEV. COUNTRIES	
	EXPORTS	IMPORTS	EXPORTS	IMPORTS	EXPORTS	IMPORTS	EXPORTS	IMPORTS
1951/52	28,510	28,760	25,836	15,846	n/a	n/a	n/a	n/a
1952/53	26,450	25,820	23,141	14,982	n/a	n/a	2,194	10,838
1953/54	23,320	23,370	17,604	12,684	925	265	4,791	10,421
1954/55	26,020	24,820	19,715	14,571	900	1,120	5,405	9,129
1955/56	28,220	26,260	23,557	14,415	485	1,675	4,178	10,170
1956/57	32,570	30,750	27,738	16,530	1,205	575	3,627	13,645
1957/58	29,310	28,725	25,380	13,161	855	1,190	3,075	14,374
1958/59	31,250	30,600	25,828	14,098	1,630	705	3,792	15,797
1959/60	31,940	31,150	28,076	11,762	1,060	1,120	2,804	18,268
1960/61	38,870	37,600	38,254	14,614	1,320	4,049	704	21,937
1961/62	43,480	42,320	39,424	15,825	1,350	5,670	2,706	23,136
1962/63	40,240	40,410	35,747	12,145	1,970	6,866	2,523	21,199
1963/64	55,170	53,820	50,732	12,196	620	18,488	3,818	23,136
1964/65	50,275	48,200	44,532	12,046	575	11,242	5,168	24,912
1965/66	59,640	58,645	50,680	13,237	30	18,433	8,930	26,957
1966/67	52,820	52,495	47,707	11,963	1,410	10,484	3,703	30,048
1967/68	49,170	48,260	44,120	10,971	3,045	6,599	2,005	30,690
1968/69	43,670	42,710	37,950	12,850	2,300	5,134	3,420	24,726
1969/70	48,045	47,425	43,900	12,965	1,491	8,027	2,644	26,433
1970/71	50,415	49,430	47,215	14,565	1,138	6,005	2,062	28,860
1971/72	50,720	50,550	48,051	12,551	942	7,977	1,727	30,022
1972/73	71,150	70,460	65,792	14,251	222	23,330	5,136	32,879
1973/74	64,725	63,695	60,926	13,950	2,590	12,138	1,209	37,607

1/ Excludes intra-CPE trade.

Source: United Nations, Food and Agriculture Organization, World Grain Trade Statistics (Rome), various issues. This publication was discontinued in 1973/74.

for the CPE's. Available data (Table V.9 below) show that the bulk of world stocks is held by the developed countries, and particularly by the major exporting countries--the United States, Canada and Australia.

TABLE V.9: WHEAT STOCKS

(thousand metric tons, beginnng of period)

	World	Developed Countries	Centrally Planned Economics	Less Developed Countries	USA+ Canada+ Australia
1960	74,252	63,823	4,270	6,159	54,042
1970	94,469	70,990	14,145	9,334	61,849
1973	60,185	37,306	9,837	13,042	26,814
1975	62,598	36,611	14,104	11,883	21,499

Source: U.S. Department of Agriculture, Foreign Agriculture Service, Foreign Agricultural Circular on Grains (Washington, D.C.) various issues.

E. Summary Evaluation of Prospects for Producer Group Action in Wheat Using Available Estimates of Price Elasticities of Demand and Supply

The review undertaken, so far, of the world wheat market indicates that an alliance of the three major producing countries--the United States, Canada and Australia--is possible. The prospects of the EEC joining such a group are uncertain--given its position as both an exporting and importing region (EEC wheat exports and imports comprise about 12 percent and 10 percent respectively of the world's

total trade in this community - See Table V.6). However, given the interest which the EEC has also shown in the maintenance of high farm prices under its Common Agricultural Policy (CAP), and the fact that its wheat trade balance is favourable, the possibility of it joining such a grouping cannot be ruled out. We will, therefore, investigate the chances of success of a producers' alliance of the three major exporting countries, as well as a a producers' group incorporating these countries and the European Economic Community.

A summary evaluation of producer-group supply management can be undertaken by the use of previous estimates of price elasticities of demand and supply for wheat (discussed in Chapter III). We have, on the basis of these data, made estimates of price elasticity of excess demand (E_{DG}) in the short term (one year) facing two alternative producer groupings (one encompassing the United States, Canada and Australia, and the other one comprising the same countries and the EEC). The two estimates are -0.9 and -0.7, respectively, which indicates that in both cases a supply cutback would increase total revenues. This assessment, however, assumes that wheat stocks would play a neutral or negligible role in this process. This is perhaps not an unrealistic assumption, given the fact that the producer group countries hold the bulk of the world wheat stocks and also the fact that a major consumer (the LDC's) holds barely minimum stocks necessary to meet normal processing requirements. However, to the extent that consumer countries can adjust stocks to meet the supply cut-back

(which is a distinct possibility in the short run), the gains accruing to a producer grouping are correspondingly reduced.

Table V.10 presents two alternative sets of price elasticity estimates for the long run for the two alternative groupings. Available elasticity estimates of supply and demand show significant variations. However, both sets of estimates indicate that, by and large, supply cutbacks would be detrimental to increasing total revenues over a longer period of time.

But, in the case of wheat-producer groupings of developed countries, a more legitimate aim would be to increase total profits rather than total revenues. This appears logical when one considers that most developed countries are operating at "full employment" levels; and, therefore, that in evaluating the benefit of any economic activity its opportunity cost has to be assessed. The choice between alternative economic activities would depend heavily upon the profitability of these alternatives. This can be contrasted with the case of a less developed country where, in the context of a labor surplus economy (with the opportunity cost of unskilled labor being negligible), it would be in the national interest to produce an agricultural product (involving a heavy unskilled labor input) at production levels which maximize total revenues rather than total profits. This would be the case particularly if the product is an exportable item and can therefore earn scarce foreign exchange (which is normally in short supply) for the less developed country. On the other

TABLE V.10: WHEAT, PRICE ELASTICITIES AND MARKET SHARES

	Price Elasticities			Quantity '000	Share of	
	Short Term	Long Term A	Long Term B	metric tons Average 72-75	Excess Demand 6/ Alt. 1	Alt. 2
A. Demand				358,712		
Developed Countries	-0.3 1/	-0.3 1/	-0.2 4/	86,195	1.18	0.65
Centrally Planned Economies	-0.1 3/	-0.2 4/	-0.2 4/	170,077	2.32	1.28
Less Dev. Countries	-0.1 2/	-0.5 2/	-0.3 4/	102,440	1.40	0.77
B. Supply				360,003		
United States	0.4 1/	1.0 1/	0.2 4/	50,410	0.69	0.38
Canada	0.4 5/	0.4 4/	0.4 4/	15,340	0.21	0.12
Australia	0.4 5/	0.4 4/	0.4 4/	8,850	0.12	0.07
Dev. Ec. excluding U.S., Australia and Canada	0.3 5/	0.3 4/	0.3 4/	59,420	0.81	0.45
Centrally Planned Economies	0.0 2/	1.0 2/	0.2 4/	150,319	2.05	1.13
Less-Dev. Countries	0.0 2/	0.6 2/	0.2 4/	75,664	1.03	0.57
C. Excess Demand						
Alt. 1 Facing U.S. Canada Australia Producers Group	-0.9	-4.4	-2.1	73,309		
Alt. 2 Facing U.S. Canada, Australia, Europe Producer's Group	-0.7	-2.4	-1.0	132,729		

1/ R.C. Hoyt, "A Dynamic Econometric Model of the Milling and Baking Industries," (PhD. Dissertation, University of Minnesota, 1972).

2/ F.G. Adams, and J.R. Behrman, Econometric Models of World Agricultural Commodity Markets (Cambridge, Mass.: Ballinger Publishing Company, 1976), pp. 42-48.

3/ Short-term price elasticity of demand for CPE's assumed to be similar to that of LDC's in the absence of alternative data.

4/ A.S. Rojko, F.S. Urban and J.J. Naive, World Demand Prospects for Grain in 1980 (Washington, D.C.: USDA Economic Research Service, 1971).

5/ Assumed to be similar to long-run elasticities in the absence of alternative data. This assumption lends a considerable element of conservatism to the results.

6/ Quantity demanded (A) and quantity supplied (B) as share of quantity of excess demand (C).

hand, total-revenue or export-value maximization is unlikely to be an objective of a developed country, since most of its products are potentially tradeable and foreign exchange shortage is unlikely to pose significant problems.

Thus, if profit maximization is the objective of a developed-country producer grouping, then the condition for profitable restriction $\frac{P}{MC} < \frac{EDG}{E_{DG} + 1}$ discussed earlier would imply that a producers' group comprising the United States, Canada and Australia, operating with marginal cost of about $94 metric ton (constant 1976 prices), would find that a profit maximizing price would be $179/metric ton (in 1976 prices) if the long run E_{DG} is -2.1 (elasticity estimates B). Actual world market prices have averaged about $140-170/metric ton (1976 prices) in the 1973-76 period; and recent efforts by the major producers to maintain world prices at about this level, through acreage cutbacks, indicate that they may well feel that this is a profit-maximizing price.

In view of the variations in price elasticity estimate made by other scholars and in pursuance of the methodology adopted in this thesis, we proceed to make our own complete estimates of the excess demand function likely to be faced by a group of producing countries comprising the United States, Australia and Canada, in order to examine some of the price setting alternatives available to this group.

F. Detailed Evaluation of Prospects for Producer Group Action in Wheat

1. Demand and Supply Functions in the Wheat Market - Estimation Methods: All demand and supply equations were formulated linearly - the simplest possible functional form which gives meaningful solutions[16/]. Variables were included strictly on the basis of justification in economic theory. However, in accordance with normal estimation procedures, where variables had no econometric significance, they were not included.

Demand. Separate demand equations were estimated for the developed countries, the centrally planned economies and the less developed countries. It is posited that wheat demand (D) is a linear function of wheat prices adjusted for inflation (PWR), per capita income (GDP/POP), wheat production (PRO) and a time trend (T). The choice of the first three variables is fairly obvious since we could expect demand to be influenced by price, per capita income and total domestic wheat availability. The time trend picks up the longer term secular movements (including population growth). The inclusion of price variables of substitutes in the estimating equation was rejected on the same grounds as discussed in the case of our copper model viz. that their inclusion would imply that it is necessary to interpret that the coefficient of the price variable in the demand equation represents the change in the demand for wheat as a result of

16/ Carl F. Christ, Econometric Models and Methods, op. cit. p. 57.

a change in the price of wheat holding the price of substitute constant; whereas, if the prices of substitutes are excluded from the estimating equation, the coefficient of the wheat price variable has to be interpreted as the change in demand from wheat as a result of a change in the price of wheat allowing substitute prices to find their equilibrium values[17/]. The level of stocks was also not included in the estimating equation, since as discussed in Appendix IV, the appropriate relationships are between inventory levels (as a proportion of demand or supply) and prices. The relationship between wheat price and inventory levels is displayed in Appendix VI of this thesis. The notable difference in formulating the equations compared to the copper model relates to the absence of the use of the Koyck distributed lag. The use of such a lag was deemed inappropriate in the wheat model since the rigidities in consumption and production prevalent in copper are not applicable in the case of wheat.

The data used were for the period 1960-75--the only period for which a consistent wheat consumption time series (Table V.7) was available. The values of the other variables used are shown in Table V.11. The price ratio utilized was the ratio of the UNCTAD export price index for the commodity to the OECD GNP deflator. While recognizing that the UNCTAD export price index was not immediately relevant to consumers in both CPE's AND LDC's, it is useful and

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17/ Fredrick C. Mills, "Statistical Methods," op. cit.

convenient to make the assumption that over time the internal price level in these countries moved to reflect world scarcity prices. The estimated demand and supply functions lends support to this hypothesis.

TABLE V.11: SELECTED VARIABLES AFFECTING WHEAT CONSUMPTION

Year	Population (1963=100) 1/ Dev.	CPE's	LDC's	GDP Index Numbers 2/ Dev.	CPE's	LDC's	OECD GNP Price Deflator 3/
1960	96	95	92	86	85	87	94
1961	97	97	94	89	92	93	96
1962	99	98	98	94	97	96	98
1963	100	100	100	100	100	100	100
1964	101	102	103	106	110	107	103
1965	102	103	106	111	115	110	106
1966	103	105	108	118	125	115	109
1967	104	106	111	122	134	122	113
1968	105	107	115	129	144	129	117
1969	106	109	118	135	1511	138	123
1970	107	110	120	139	164	147	130
1971	108	112	124	144	174	156	138
1972	109	114	127	151	182	163	144
1973	110	115	131	161	197	176	155
1974	111	117	134	161	210	188	173
1975	112	119	137	160	220	196	194

1/ Source: Derived from United Nations, Demographic Year Book (New York), various issues

2/ Source: United Nations, Statistical Year Book (New York), various issues.

3/ Source: National Accounts of OECD Countries, op. cit. for 1950-1973, and computed from International Financial Statistics, IMF and OECD data for 1974 and 1975.

The estimated equations are as follows:

(1) $DDC = 53{,}607 - 99.13\ PWR + 42{,}516\ GDPDC/POPDC - 599.8T$

$(-4.5)\qquad(2.0)\qquad(-0.7)$

$\bar{R}^2 = 0.92$ D.W. = 2.09 S.E. = 1,794 Years 1960-75

(2) $DCPE = 28{,}997 - 136.82\ PWR + 0.252\ PROCPE + 4314.2T$

$(-2.2)\qquad(2.2)\qquad(7.7)$

$\bar{R}^2 = 0.97$ D.W. = 2.56 S.E. = 5,117 Years 1960-75

(3) $DLDC = 12{,}242 - 95.9\ PWR_{-1}$

(-1.92)

$+ 118.4\ PWR_{-2} - 267.1\ PWR_{-3}$

$(1.5)\qquad(-1.8)$

$+ 50{,}820\ GDPLDC/POPLDC + 1446.7T$

$(2.1)\qquad(2.4)$

$\bar{R}^2 = 0.99$ D.W. = 2.56 S.E. = 1,696 Years 1960-75

Where:

DDC = Developed countries demand for wheat ('000 metric tons)

DCPE = Centrally planned economies demand for wheat ('000 metric tons)

DLDC = LDC demand for wheat ('000 metric tons)

PWR = UNCTAD export price index for wheat (1963=100) deflated by OECD GNP price index (1963=100)

GDPDC = Gross domestic product index, developed countries, services included, 1963=100 (United Nations)

GDPLDC = Gross domestic product index, LDC's, services included, 1963=100 (United Nations)

POPDC = Population, DC's 1963=100 (United Nations)

POPLDC = Population, LDC's, 1963=100 (United Nations)

PROCPE = Production of wheat by the Centrally Planned Economies ('000 metric tons)

T = Time trend, 1947=1 (chosen to reflect "normal" international economic conditions after the end of the Second World War in 1945).

Developed countries' per capita consumption of wheat was found to be relatively price-inelastic - both the short and long run price elasticity of demand being -0.11. This was to be expected, given the very small share of wheat consumption in family expenditure budgets. The wheat demand responses to per capita income or product were strongly positive - being higher than similar demand responses both in the CPE's and LDC's. Finally, a secular downward trend was also observed, confirming the findings of other economists of a long term shift away from wheat in favour of other products.

Consumption of wheat in the centrally planned economies was also found to be responsive to international prices - though less so compared to both developed countries and less developed countries (See below). This is similar to the findings of some analysts (e.g., Rojko, Urban and Naive) but different to that of Adams and Behrman.18/ Adams and Behrman argued that authorities in these

18/ F.G. Adams and J.R. Behrman, Econometric Models of World Agricultural Commodity Markets, op. cit.

economies do not alter either the quantities available for consumption or the domestic consumer price in response to international wheat price variations. On the other hand, our findings indicate that the centrally planned economies do alter availability both in response to domestic production as well as in response to current international prices (since they are substantial importers of wheat - see Table V.8).

Developing country consumption of wheat was found to be more responsive to international price changes than both the developed countries and the centrally planned economies - the short-run price elasticity of demand being estimated at -0.12, and the long-run elasticity at-0.22. Demand was strongly responsive to per capita income. However, the level of domestic production, as an explanatory variable in explaining wheat demand, did not prove to be significant. This reflects the fact that shortfalls in domestic production are invariably made up through imports.

Supply. Supply functions were estimated for the developed countries minus the United States, Canada and Australia; and for the centrally planned economies and the less developed countries. The general theory underlying the supply side was that of traditional supply response, viz. that supply is a function of actual and historical prices and actual weather conditions. Data were for the period 1954-75. Dummy variables were used to reflect the exceptionally bad weather conditions experienced in the CPE's in 1963, 1972,

1974 and 1975, and to reflect the exceptionally good conditions in the LDC's in 1966. The estimated equations are:

(4) $PRODC = 4.1627.639 + 100.211\ PWR\_1 + 3022.038T$

$(1.4) \qquad (11.9)$

$\bar{R}^2 = 0.89 \quad D.W. = 2.07 \quad S.E. = 6823.56 \quad Years\ 1954\text{-}75$

(5) $PROEUR = 3590.681 + 121.084\ PWR\_4 + 1692.972T$

$(1.4) \qquad (4.8)$

$\bar{R}^2 = 0.85 \quad D.W. = 2.44 \quad S.E. = 3512.963 \quad Years\ 1954\text{-}75$

(6) $PROCPE = -133587.677 + 329.497\ PWR\_5 + 684.660\ PWR\_6$

$(1.0) \qquad (2.2)$

$-18660.0009D63,72,74,75 + 7649.642T$

$(3.6) \qquad (8.3)$

$\bar{R}^2 = 0.89 \quad D.W. = 1.76 \quad S.E. = 8178.046 \quad Years\ 1956\text{-}75$

(7) $PROLDC = -56772.208 + 75.631\ PWR\_2 + 48.434\ PWR\_3$

$(1.0) \qquad (0.3)$

$+286.674\ PWR\_4 + 3625.810T + 15560.455D66$

$(2.0) \qquad (9.0) \qquad (4.0)$

$\bar{R}^2 = 0.95 \quad D.W. = 1.62 \quad S.E. = 3816.982 \quad Years\ 1954\text{-}75$

Where:

PRODC = Production of wheat by developed countries

PROEUR = Production of wheat by developed countries excluding the United States, Canada and Australia

PROCPE = Production of wheat by the centrally planned economies

PROLDC = Production of wheat by the less developed countries

Production in the developed countries as a whole (equation 4) proved to be substantially responsive to price prevalent in the immediately preceding period. This reflected the general openess of these economies. However, developed countries production excluding the United States, Canada and Australia (which leaves largely European production) proved not to be related to prices prevalent in the three preceding periods. This is explained by the fact that European prices are set under the "Common Agricultural Policy" of the European Economic Community and the European wheat market is protected. Over the longer term, however, it appears that European prices are adjusted to international prices. The price elasticity of European supply was estimated at 0.25 in the long run. In addition, European wheat production, like other developed countries' wheat production, showed a significant positive time trend reflecting primarily increases in productivity of European farmers.

Production of wheat in the centrally planned economies was found to be responsive - albeit with a substantial time lag - to international price movements. This reflected the fact that these economies initially try to shield themselves from what are initially perceived as temporary international price changes, but then adjust their own price levels to reflect the changed opportunity costs when

these international price levels look more permanent. The price elasticity of supply in the CPE's was found to be fairly high, being estimated at 0.80 in the long run.

Developing country supply response to international price changes was slow but significant in the long term (in accordance with historical experience). The long term price elasticity of supply was substantial - being estimated at 0.77. There was also a significant positive time trend reflecting productivity increases as a result of technical change in those economies.

G. Summary Implications of Price Elasticities of Estimated Demand and Supply Functions

Table V.12 presents our own estimate of short-and-long run price elasticities of demand and supply. Estimates by other scholars are included in this table for purposes of comparison. We note that, for the most part, our demand estimates (for both the short and long run) are lower than estimates made by others. These differences are partially attributable to our inclusion of the experience of recent years, and also to the fact that wheat-consumption data are continuously being revised as additional information, particularly on stock-holdings, becomes available (our wheat consumption data, incorporating the most recent estimates by the U.S. Department of Agriculture, were presented in Table V.7).

The derived 'elasticity of excess demand' (E_{DG}) indicates that in the short term a supply cutback by a producers' alliance comprising the United States, Canada and Australia would increase

revenues (E_{DG}< (minus) 1), but in the long-term this would result in reduced aggregate total revenues (EDG> (minus) 1). The addition of the other developed countries (i.e., Europe) to such an alliance would not affect this result. The reason for this, of course, is the large potential for increasing supply in both the CPE's and the LDC's which is reflected in their supply elasticities.

Table V.12: WHEAT PRICE ELASTICITIES

	Short Run 1/			Long Run 2/		
	'Own' Est.	Rojko et al	Adams et al	'Own' Est.	Rojko et al	Adams et al
Demand						
Developed Countries	-0.11	n.a.	-0.52	-0.11	-0.20	-0.52
Centrally Planned Economies	-0.09	n.a.	0.00	-0.09	-0.20	0.00
Less Developed Countries	-0.12	n.a.	-0.11	-0.22	-0.30	-0.51
Supply						
Developed Countries excluding U.S., Canada	0.00	n.a.	n.a.	0.25	-0.30	n.a.
Centrally Planned Economies	0.00	n.a.	0.00	0.80	-0.20	1.03
Less-Developed Countries	0.00	n.a.	0.77	0.77	-0.20	0.57
Excess Demand E_{DG} 5/						
Facing U.S., Canada, Australia Producers' Group	-0.51			-3.28		
Facing U.S., Canada, Australia and Europe Producers' Group	-0.28			-2.13		

1/ 1 year
2/ 3-6 years
3/ A.S. Rojko, F.S. Urban and J.J. Naive, World Demand Prospects for Grain in 1980, op. cit.
4/ F.G. Adams and J.R. Behrman, Econometric Models of World Agricultural Commodity Markets, op. cit.
5/ On the basis of 1972-75 market shares.

The appropriate long-term profit maximizing price, on the assumption that the marginal cost of producing wheat is $94 metric ton (1976 prices), has been calculated to be $135/metric ton (constant 1976 prices) for a producers' alliance comprising the United States, Canada and Australia, and $177/metric ton (constant 1976 prices) for a producers' group comprising the United States, Canada, Australia and Western Europe.

H. The Excess Demand Function Facing a Wheat Producers' Alliance Comprising the United States, Canada and Australia and a Possible Extension to Include EEC; Projected Future Prices and Their Implications

The "excess demand function" facing the producers' alliance comprising the United States, Canada and Australia is as follows:

(DDC + DCPE + DLDC) - (PROEUR - PROLDC)

This can again be manipulated to show the range of optional price movements.

The pricing alternatives available to the producers' group were examined under the following assumptions: (i) one wheat price would prevail in the whole market; (ii) GDP growth for the period 1977-80 would average 5 percent per annum in the LDC's, 4.5 percent per annum in the developed countries and 6 percent per annum in the CPE's (these assumptions are consistent with the OECD projections used in Chapter IV for our copper model); and (iii) population growth would follow the experience of the last decade (i.e., 0.09 percent per annum in the developed countries, 1.5 percent in the CPE's, and 2.6

percent in the LDC's). Finally, with regard to production response, it was assumed that (i) the unusual peak of about $200/metric ton reached in 1974 was due to "disorderly" market conditions and would be interpreted as such by producers and consumers, and (ii) neither the less-developed countries nor the CPE's would be able to increase production by more than 5 percent in any one year over the previous historical peak level of production.

Table V.13 shows the pricing alternatives available to a producer group comprising the United States, Canada and Australia. It indicates that the appropriate price for the group to establish would indeed be around $135/metric ton (constant 1976 prices). This would ensure the highest level of profits for producers.

More specifically, we note that if prices were set at the level they prevailed in 1972/73 viz. $115/metric ton (constant 1976 prices) as presented in Alternative I, then the total production for export by the group comprising the United States, Canada and Australia would be 227 million tons for the period 1976-80 (somewhat lower than the annual level of about 50 million tons which prevailed in the 1969/70 to 1972/73 period). Total revenues accruing to the group at this level of production would be about $24.7 billion and total profits about $5.3 billion (discounted present value, 1976 prices) for the period.

Alternative II in Table V.13 presents the results if prices were maintained at $135/metric ton (constant 1976 prices) which is the profit maximizing price according to our estimates when marginal cost

TABLE V.13: PRICING ALTERNATIVES AVAILABLE TO WHEAT PRODUCERS

GROUP COMPRISING THE UNITED STATES, CANADA AND AUSTRALIA

(Quantity in '000 metric tons, Revenue/Profit in US $ million - constant 1976 Prices)

	Actual	Estimated				Total Prod. for Excess Demand	Discounted (5%) Present
	1976	1977	1978	1979	1980	1976-80	Value 1976-80
Alternative I							
Price, U.S. $/metric ton (1976 price levels)	135	115	115	115	115	-	-
Excess Demand to be filled by Producers' Group	48,223	48,411	46,374	39,987	44,021	227,016	-
Total Revenue accruing to Producers' Group	6,510	5,567	5,333	4,599	5,062	-	24,744
Total Profits accruing to Producers' Group[1/]	1,977	1,017	941	840	924	-	5,312
Alternative II							
Price, U.S. $/metric ton (1976 price levels)	135	135	135	135	135	-	-
Excess Demand to be filled by Producers' Group	48,223	43,827	39,701	35,711	34,417	201,879	-
Total Revenue accruing to Producers' Group	6,510	5,916	5,360	4,821	4,645	-	24,990
Total Profits accruing to Producers' Group[1/]	1,977	1,797	1,628	1,464	1,411	-	7,587
Alternative III							
Price, U.S. $/metric ton (1976 price level)	135	156	156	156	156	-	-
Excess Demand to be filled by Producers' Group	48,223	34,037	24,689	19,600	14,239	140,788	-
Total Revenue accruing to Producers' Group	6,510	5,309	3,852	3,058	2,221	-	19,523
Total Profit accruing to Producers' Group[1/]	1,977	2,110	1,531	1,215	883	-	7,147

1/ At average cost of $94/metric ton

Note: Growth restrictions of wheat production of 3.5 percent per annum for LDC's and CPE's over last highest output were applied in Alternatives I and II. In Alternative III growth rate restrictions were somewhat relaxed to 5 percent per annum for LDC's and CPE's respectively. Historical experience shows an average annual increase of wheat output of 3.1 percent per annum for CPE's and 4.7 percent per annum for LDC's between 1960-70 and 2.5 percent and 3.5 percent per annum respectively for the period 1955-75.

of production is $94/metric ton. In this situation we find that total cumulative production for export by the producers' group would amount to 202 million tons for the period 1976-80, while total revenues would amount to about $25 billion and total profits to $7.6 billion (discounted present value, 1976 prices) for the period.

If prices were set and maintained at $156/metric ton, the high level which was reached in the 1974/75 period, then the total export quantity would decline to 141 million tons for the period 1976-80 (Alternative III). Total revenues would decline to $19.5 billion and total profits to $7.2 billion (discounted present value 1976 prices).

Table V.14 shows the pricing alternatives available to a wheat producers' group comprising the United States, Canada, Australia and the EEC. Here, as is again to be expected, much higher prices are sustainable. Three alternative price scenarios are examined. The first, $156/metric ton (the high level reached in the 1974/75 period), results in total demand faced by the enlarged group of about 472 million tons which brings about $65 billion in total revenues and about $25 billion in profits (discounted present value, 1976 prices). The profit maximizing price according to our estimates ($177/metric ton) presented in Alternative II gives the highest level of profits ($29 billion) and about the same level of total revenues ($67 billion). A 25 percent higher price level than optimal price results in a substantial drop in total revenues (Alternative III).

TABLE V.14: PRICING ALTERNATIVES AVAILABLE TO WHEAT PRODUCERS

GROUP COMPRISING THE UNITED STATES, CANADA, AUSTRALIA AND THE EEC

(Quantity in '000 metric tons, Revenue/Profit in US $ million - constant 1976 Prices)

	Actual	Estimated				Total Prod. for Excess Demand	Discounted (5%) Present
	1976	1977	1978	1979	1980	1976-80	Value 1976-80
Alternative I							
Price, U.S. $/metric ton (1976 price levels)	135	156	156	156	156	-	-
Excess Demand to be filled by Producers' Group	108,000	96,256	105,732	87,745	77,872	471,605	-
Total Revenue accruing to Producers' Group	14,580	15,016	16,494	13,688	12,148	-	65,633
Total Profits accruing to Producers' Group	4,428	5,968	6,555	5,440	4,828	-	24,717
Alternative II							
Price, U.S. $/metric ton (1976 price levels)	135	177	177	177	177	-	-
Excess Demand to be filled by Producers' Group	108,000	91,596	85,829	84,910	70,223	405,558	-
Total Revenue accruing to Producers' Group	14,580	16,212	15,192	15,029	12,429	-	66,973
Total Profits accruing to Producers' Group	4,428	7,602	7,124	7,048	5,829	-	29,000
Alternative III							
Price, U.S. $/metric ton (1976 price level)	135	221	221	221	221	-	-
Excess Demand to be filled by Producers' Group	108,000	75,940	60,020	57,736	21,506	323,202	-
Total Revenue accruing to Producers' Group	14,580	16,783	13,264	12,760	4,753	-	57,518
Total Profit accruing to Producers' Group	4,428	9,644	7,625	7,332	2,731	-	28,700

Note: Growth restrictions of wheat production of 5 percent per annum for LDC's and CPE's over last highest output were applied in Alternatives I and II. In Alternative III growth rate restrictions were somewhat relaxed to 7 percent per annum for both LDC's and CPE's. Historical experience shows an average annual increase of wheat output of 3.1 percent per annum for CPE's and 4.7 percent per annuam for LDC's between 1960-70 and 2.5 percent and 3.5 percent per annum respectively for the period 1955-75.

I. Assessment of Whether a Functional Producers' Alliance in Wheat Could be Formed, Taking into Account Individual Country Questions

A producers' alliance in wheat between the United States, Canada and Australia appears to be viable on the basis of our analysis. In fact, the behaviour of wheat prices since the dramatic increases in 1973-74, with no downward move to the levels experienced earlier, may well indicate fairly sensible supply management policies (whether by accident or design) aimed at maximizing profits to producers.

All three countries have appropriate supply management mechanisms. The bulk of world wheat stocks and stock holding capacity is in their hands. In addition, these countries did not suffer from acute shortages of foreign exchange over the period under study, and the logical objective is, therefore, to maximize profits (to farmers) rather than total export earnings. The countries concerned are allied by a community of interests including historical and cultural factors. The only other important interest group are the remaining developed countries (almost entirely in Europe), who already maintain prices at the higher levels and would consequently have no objection to the group's prices. On the other hand, it is unlikely that the EEC would wish to join a producers' group as an active member since it itself is a large consumer of wheat and there are likely to be domestic repercussions to higher price levels (if these increases go beyond domestic price levels, as they are likely to if the EEC joins the producer grouping).

On balance, it is our assessment that a producers' alliance is both likely and feasible in wheat if the United States, Canada and Australia decide to coordinate their wheat production policies in order to achieve profit maximizing objectives. Their recent pricing (in the neighbourhood of $140/ton constant 1976 prices), in fact, appears to indicate that some production "cooperation" may already be taking place.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This study has aimed primarily at investigating the possibility that, in the absence of a comprehensive international understanding on the appropriate new framework to govern international commodity prices producers of primary commodities would unilaterally attempt to form "groupings" to influence commodity prices. A methodology (centring around the "excess demand function") has developed for analyzing the effectiveness of proposed or existing individual commodity producer groupings. Econometric estimation of supply and demand relationships, in association with a broader-based commodity analysis, enables us not only to judge the possible success or failure of any particular grouping of commodity producers, but also to determine an "optimum" level of prices pertinent to such groupings (in the light of profit-or-revenue-maximizing objectives). The methodology, when applied specifically to two commodities, yields the following conclusions.

Copper lends itself (within limits) to an effective supply management program by existing members of CIPEC if they have the political will to do so. Given the particular demand and supply elasticities faced by a group of copper producers like CIPEC--our estimated price-elasticity of 'excess demand' being -0.88 in the short run and -1.90 in the long run--an appropriate objective for such a group would be to maximize profits rather than total

revenues. A profit-maximizing strategy for existing CIPEC members should be one aimed at establishing a floor price for copper between 96-100 cents per pound, rather than the present level of 50-65 cents, which barely covers the cost of production. A floor price of 96 cents per pound for the period 1976-80, according to our estimates, would have involved cumulative CIPEC production of 14.2 million tons and yielded $27 billion in revenues and $15.7 billion in profits. A floor price equivalent to the average of LME prices for the 1972-73 period (i.e., 78.5 cents per pound), on the other hand, would have involved much higher cumulative CIPEC production (20.4 million tons) and yielded only slightly higher revenues of ($28.9 billion) and much lower profits ($12.8 billion) over the period 1976-80.

If CIPEC was expanded to include all less-developed countries and Canada, the possibilities of effective supply management would be substantially enlarged. The price elasticity of "excess demand" for such a group is estimated by us to be -0.49 in the short run and -0.91 in the long run. This enables both revenue and profit maximizing objectives to be pursued without real conflict. Our estimates show that a floor price of about $1.25 per pound during the period 1976-80 would have involved cumulative group production of about 18.9 million tons and yielded $46.8 billion in revenues and $31.8 billion in profits. A floor price of 78.5 cents per pound, for the period, on the other hand, would have involved higher cumulative production (28.9 million tons) and much lower revenues and profits ($35.8 billion and $17.9 billion, respectively).

However, the actual ability of CIPEC to engage in active supply management is much more difficult to assess. The group, as presently constituted, is of manageable size (eight members) but has several members (Australia, Chile, and Zaire) highly vulnerable to consumer country pressures. It faces a relatively small number of very large international companies (11 in the United States, 8 in other industrialized countries) which dominate the world's copper smelting and fabricating facilities. In addition, all CIPEC members but Australia are less-developed countries and face foreign exchange shortages. CIPEC's ability to sustain organized supply management over a substantial period of time, therefore, appears to be limited. An enlarged CIPEC (to encompass all other LDC producers and Canada) would also appear to be burdened with the same problems.

Wheat leads us to the conclusion that supply management policies can be pursued to advantage by a group of producers comprising the United States, Canada and Australia if the objective of such a group is to maximize profits accruing to its members; the price elasticity of "excess demand" faced by the group being estimated by us at -0.51 in the short run and -3.28 for the long run. Such a profit maximizing strategy would involve setting the floor price for wheat sold by them at about $135 per metric ton. A floor price of $135 metric ton for the period 1976-80 would, according to our estimates, have meant the group producing about 202 million metric tons, which would have yielded $25 billion in revenues and $7.6 billion in profits. This

can be compared with the price of about $115 per metric ton which prevailed during 1972-73 (the year before wheat prices increased by almost 60 percent in real terms because of the failure of the Russian wheat crop) and which, if maintained during the period 1976-80, would have meant cumulative group production of about 227 million tons, $24.7 billion in revenues and only $5.3 billion in profits.

Actual experience during the post-1973 period has been that international wheat prices have moved in the range of about $140-$170 per metric ton and have averaged about $140 per metric ton (constant 1976 prices). Thus either by accident or design, wheat prices have fluctuated around a level which should have been the objective of a producers' group comprising the United States, Canada and Australia.

While it is tempting to speculate that such a group may already be in existence and undertaking active supply management, a more pertinent question from our point of view is whether such a group could formally be established. Our analysis indicates that, given the supply regulating facilities at the disposal of these countries (which, in fact, have been used to cut down wheat production during the last three years) and the general community of interests which they share, active supply management is both possible and viable.

A. Significance of the "Excess Demand Function" Approach and Usefulness of the Results

The "excess demand function" approach, in our view, appears to be a useful and practical way of analyzing the possibilities of supply management by any group of primary commodity producers. This

methodology has two special advantages. Through a summary examination of price elasticities of supply and demand for the commodity for a particular period of time, a judgement can be made as to the potential for a producers' group to pursue either revenue-maximizing or profit-maximizing objectives. Secondly, the derivation of a more complex "excess demand function" (incorporating a variety of other factors influencing supply and demand in a more "real world" situation--e.g., population growth, per capita income, the level of national production, etc.) permits a judgment to be made on the appropriateness of various price levels over a particular time period.

But the limitations of this approach also have to be recognized. The econometric techniques used have their shortcomings; the most significant one is that the price changes envisaged may be so large as not to be in the realm of historical experience, with the result that the estimated relationship may be less relevant in the changed circumstances. Other limitations relate to the fact that input-output links may be undergoing more (or less) rapid change than was historically the case, so that our derived relationships may not accurately reflect the situation being analyzed. Other constraining factors stem from the complexities of the real world, where a variety of considerations (political, sociological, economic, financial, etc.) inevitably affect decisions regarding producers' groupings and consumer reactions to them.

B. Welfare Implications of Supply Management

Assessment of the welfare implications of a supply management scheme depends on the basic assumptions used. Thus Harberger has urged the acceptance of "three basic postulates for applied welfare economics"[1]: (i) the competitive demand price for a given unit measures the value of that unit to the demander; (ii) the competitive supply price for a given unit measures the value of that unit to the supplier; and (iii) when evaluating the net benefits or costs of a given action, the costs and benefits accruing to each member of the relevant group would normally be added without regard to the individuals to whom they accrue. If these postulates are accepted, then a supply restriction *prima facie* causes a loss in world welfare--since under normal demand conditions, the loss in consumer surplus as a result of a price increase is always greater than the gain accruing to producers.[2] However, if different weights are assigned to different categories of producers and consumers (e.g., if it is assumed that the marginal utility of income accruing to the inhabitants of a poor country is greater than that accruing to the inhabitants of a rich country), then the welfare implications of a supply management scheme become much more complex.

1/ Arnold C. Harberger, "Three Basic Postulates for Applied Welfare Economics", *Journal of Economic Literature*, Vol. IX, No. 3 (September 1971), pp. 785-797.

2/ Charles River Associates Inc., A Frame-work for Analyzing Commodity Supply Restrictions, *op. cit.* pp. 62-64.

On a simpler level, however, the implications of increase in commodity prices as a result of supply restrictions include losses in consumer surplus and economic costs of shifting resources to previously uneconomic methods of production. This results in transfer of resources from consumers to producers (both domestic and foreign).

C. Prospects for Producer-Consumer Cooperation in International Commodity Markets

The emergence of "adversary" relationships between producers and consumers of primary commodities--where each group actively attempts to maximize its own gains without regard to the costs imposed on the other party--is not inevitable. Thus while intrinsic demand-supply relationships are bound to assert themselves in the long run (with scarce commodities commanding higher prices), a policy of co-operation between producers and consumers aimed at stabilizing prices while also taking into account market scarcity can be the pattern of the future. A major element in this regard, as pointed out earlier in Chapter I, is future agreement on the United Nations' proposed "integrated program for commodities." Recent developments indicate some limited progress. Negotiators from developed, less developed and centrally planned economies recently (March 1979) reached some agreement on a scaled-down version of the proposed "commodity fund" which is an integral part of the proposed "integrated program"3/. The preliminary agreement envisages a $750 million

3/ The New York Times, March 20, 1979, p. D-I.

"international commodity fund" which would serve as a central pool of finance for price-stabilization measures to be undertaken by international commodity organizations. The amounts presently agreed upon for the "commodity fund" ($400 million to finance buffer-stock activity and $350 million to diversify and improve productivity) are still, however, much less than the amount ($6 billion) which appears to be required. In addition, no substantial progress was made on the issue at the UNCTAD conference held in Manila in the spring of 1979. Thus while accepting the possibility that future international negotiations may lead to a more substantial "commodity fund" which could provide the framework for international producer-consumer cooperation in production and pricing of important primary commodities, our own prognosis must remain that for the immediate future the only viable tool available to primary producers in order to obtain higher incomes is a system of active supply management.

APPENDIX 1

SUMMARY OF ANALYSIS OF TWO MAJOR ECONOMETRIC STUDIES OF COPPER MARKETS

COPPER

The first major study of the world copper industry was done by Charles River Associates in 1970[1/]. The econometric model was composed of sixteen equations that simultaneously determined sixteen endogenous variables. Fourteen of the equations were estimated from time series data (1946-1969) while the remaining two were market clearing identities. The model had two demand sectors (United States and "foreign"), two primary supply sectors (United States and 'foreign'), three secondary supply sectors (United States new scrap, United States old scrap, and 'foreign' scrap) and three prices (United States producer price, United States scrap price, and the London Metal Exchange Price). The study pointed out that the five inventory equations, both individually and collectively, have little effect on the behaviour of the model in either simulations or forecasts[2/]. The equations were formulated in log-linear terms. Demand was influenced by price, the volume of industrial production and the price of the principal substitute - aluminium (the German aluminium price was used since both the United States price and United Kingdom price were deemed not to be "free market" prices but

1/ Charles River Associates, Inc., An Econometric Model of the Copper Industry, op. cit.

2/ Ibid. p. 58.

influenced by "discounting" in the case of the United States and by rationing in the case of the United Kingdom). Primary supply was deemed influenced by price and new scrap supply by current consumption. Estimates of both the short and the long run elasticities of demand with respect to the producers' price were quite low, -0.34 and -0.81, respectively.

The supply and demand equations estimated by Charles River Associates are presented below (note that in these and later equations the figures in parenthesis are t values and the figure represented as ρ is the first order autocorrelation coefficient of the disturbance in the equation):

(1) $$Q_T = -97.128 - \underset{(2.504)}{2.547\ RP^{EMJ}} + \underset{(2.011)}{0.579\ Q_T(-1)} + 0.759\ RP_{ALG} + 0.965\ I_D + 91.390 \Delta S_{MD} - 86.639 \Delta S_{MD}(-1)$$

$\bar{R}^2 = 0.904 \quad \rho = 11.55 \quad D.W. = 2.436 \quad$ Years 1949 - 1966

(2) $$X_T = -311.839 - \underset{(2.534)}{1.006\ RP^{LME}} + \underset{(0.837)}{0.287\ RP_{ALG}}$$

$\bar{R}^2 = 0.976 \quad \rho = 14.11 \quad D.W. = 2.4617 \quad$ Years 1950 - 1966

(3) $$\ln Q_M = -1.207 + \underset{(5.773)}{0.339 \ln P^{EMJ}} - \underset{(5.260)}{0.745 \ln E} + \underset{(9.844)}{0.962 \ln \bar{Q}_{PR}} - \underset{(6.966)}{0.390 \ln Q_M(-1)} + \underset{(15.651)}{0.072\ D_L} + \underset{(5.869)}{0.200\ D_C}$$

$\bar{R}^2 = 0.977 \quad \rho = 0.0266 \quad D.W. = 2.735 \quad$ Years 1949 - 1967

(4) $\ln Q_{OS} = 4.504 + 0.708 \ln PS/W_F + 0.176 \ln R$

(4.988) (1.391)

$-0.303 \ln Q_{OS}(-1) = 0.194 D_{12}$

(1.543) (3.192)

$\bar{R}^2 = 0.547$ $\rho = 0.0682$ D.W. = 1.241 Years 1948 - 1967

(5) $Q_{NS} = -18.118 + 0.302 Q_T$

(18.476)

$\bar{R}^2 = 0.951$ $\rho = 2.551$ D.W. = 1.911 Years 1949 - 1966

(6) $\ln X_M = 0.211 + 0.078 \ln RP^{LME} + 0.919 \ln X_M(-1)$

(1.279) (15.533)

$\bar{R}^2 = 0.953$ $\rho = 0.0508$ D.W. = 1.863 Years 1950 - 1966

(7) $X_S = 7.734 + 0.347 RP^{LME} + 0.373 X_T - 1.490t$

$\bar{R}^2 = 0.978$ $\rho = 4.268$ D.W. = 2.029 Years 1950 - 1966

Where:

Q_T = United States consumption of semi-fabricated copper products

X_T = Non-communist world (excluding United States) production of semi-fabricated copper products

Q_M = United States copper mine production

Q_{OS} = United States recovery of copper from old scrap

Q_{NS} = United States recovery of copper from new scrap

X_M = Non-communist world (excluding United States) recovery of copper mine production

X_S = Non-communist world (excluding United States) recovery of copper from old and new scrap

RP^{EMJ} = "Engineering and Mining Journal" copper price (weighted average of the United States producer price and the London Metal Exchange Price) deflated by the United States Bureau of Labor Statistics Wholesale price index of durable manufactures.

RP^{LME} = London Metal Exchange Price for refined copper deflated by the United States Bureau of Labor Statistics Wholesale price index of durable manufactuers

p^{EMJ} = "Engineering and Mining Journal" copper price

RP_{ALG} = Annual average German price of aluminum

I_D = United States Federal Reserve Board index of durable manufactures production

Y_{UK} = Index of Manufacturing production, United Kingdom

S_{MD} = Change in book value of inventories held by durable goods manufacturers, deflated by the United States Bureau of Labor Statistics Wholesale price index of durable manufactures

E = Index of principal mining expenses, United States open pit copper and iron mines

Q_{PR} = United States copper refinery capacity, end of period

D_L = Dummy variabe for strikes in the United States copper industry

D_C = Dummy variable for change in the definition of Q_{PR}

P_S = Dealers buying price for scrap

W_F = Average weekly earnings of copper rolling and drawing production workers

R = Estimated reservoir of United States semi-fabricated copper products in non-destructive uses

D_{12} = Dummy variable for change in the definition of P_S

A second major econometric model for the world copper industry was constructed by Fisher et.al. in 1972[3/]. Supply equations for primary (mine) copper production were estimated for four principal producing countries (United States, Chile, Canada and Zambia), and the "rest of the world" demand equations were estimated for the United States and the rest of the world as were price adjustment equations. The model was closed with a net input equation for the United States and various identities. The equations were formulated in terms of Koyck distributed lags (since the capital intensive nature of the industry was presumed to imply that crucial reactions in the industry take a great deal of time). The copper market was found to be characterized by low short run but high long run price

3/ F.M. Fisher, P.H. Cootner, and N.N. Baily, An Econometric Model of the World Copper Industry, op. cit.

elasticities. Thus for the United States the price elasticity of supply was estimated at 0.45 for the short run and 1.67 for the long run. Similarly, the price elasticity of demand for the United States was estimated at -0.2131 for the short run and -0.9002 for the long-run. The model, fitted to 1948-1968 data, has been used for forecasting and simulation purposes.

The supply and demand equations estimated by Fisher are presented below:

(1) $USMP_t = -160.04 + 14.27\ USP_{EMJt} + 0.7261\ USMP_{t-1}$

(2.996) (3.554)

$\rho = 0.5$ Years: 1949-58, 1962-1966

(2) $ChMP_t = 91.37 + 415.4\ Ch\ P_t + 0.7206\ Ch\ MP_{t-1}$

(2.520) (5.505)

$\rho = -0.1$ Years: 1948 - 1968

(3) $Can\ MP = -43.73 + 2.129\ Can\ P_{EMJt} + 0.9873\ Can\ MP_{t-1}$

(2.437) (25.11)

$\rho = -0.4$ Years: 1948 - 1967

(4) $ZMP_t = -69.19 + 0.1269\ ZP_{LMEt} + 1.103\ ZMP_{t-1}$

(0.283) (3.547)

$\rho = -0.3$ Years 1955-1957, 1961 - 1965

(5) $RWMP_t = -28.44 + 0.2222\ USP_{LMEt} + 0.8832\ RWMP_{t-1}$

(2.324) (9.199)

$\rho = 0.5$ Years 1948-68

(6) $$\log\left[\frac{USOS_t}{60{,}000 + K_t}\right] = -9.878 - 0.3731\ \log\left[\frac{USOS_{t-1}}{60{,}000 + K_{t-1}}\right] + 0.4222\ \log USP_{LMEt}$$

(2.960) (3.968)

$\rho = 0.9$ Years 1950-68

(7) $USNS_t = -275.2 + 0.3961\ USC_t$

(7.555)

$\rho = 0.2$ Years: 1947 - 1968

(8) $\log\left(\frac{RWS_t}{53{,}000 + K_t}\right) = -5.241 + 0.6278 \log\left(\frac{RWS_{t-1}}{53{,}000 + K_{t-1}}\right)$

(-1.328)

$+ 0.2546 \log USP_{LMEt} + 0.9534 \left(\frac{RWC_t}{53{,}000+K_t}\right)$

(2.557) (2.978)

$\rho = 0.2$ Years: 1952-1968

(9) $USC_t = 14.75 - 12.37\ USP_{EMIt-1} + 8.290\ USA1P_{t-1}$

(-7.060) (1.786)

$+ 5.078\ US1P_t + 60.49\ \Delta\ US1D_t$

(5.559) (9.431)

$-44.40\ \Delta\ USID_{t-1} + 0.71910\ USC_{t-1}$

(-6.251) (7.024)

$\rho = -0.8$ Years: 1950-1958, 1962-1966

(10) $EURC_t = -1220 - 0.2693\ EURP_{LMEt}$

(-1.373)

$+28.52 EURA1P_{t-1} + 9.045\ EURIP_t$

(1.144) (1.561)

$+0.5426\ EURC_{t-1}$

(1.598)

$\rho = -0.1$ Years: 1952-68

(11) $JC_t = 124.2 - 0.0002334\ JP_{LMEt-1} + 1.723\ JIP_t$

(-1.780) (24.06)

$\rho = 0.0$ Years: 1951 - 1968

(12) $RWC_t = 11.82 - 0.1212\ USP_{LMEt-1} + 0.8828 USA1P_{t-1}$

(0.237) (0.2929)

$+1.971\ RWIP_t + 0.7646\ RWC_{t-1}$

(2.426) (4.740)

$\rho = -0.3$ Years: 1951-1968

Where:

USMP = United States Mine Production

ChMP = Chilean Mine Production

CanMP = Canadian Mine Production

ZMPt = Zambian Mine Production

RWMP = World Mine Production excluding the United States, Chile, Canada and Zambia

USP_{EMJ} = Engineering and Mining Journal Price (weighted average of the US producer price and the LME price) deflated by the United States wholesale price index.

ChP_t = Chilean producer price deflated by the Chilean wholesale price index.

$CanP_{EMJ}$ = EMJ price deflated by the Canadian wholesale price index.

ZP_{LME} = LME price deflated by an index of the cost of living for Europeans in Zambia.

USP_{LME} = LME price deflated by the United States wholesale price index.

USOS = United States Old Scrap.

USNS = United States New Scrap

RWS = World (excluding the United States) supply of old and new scrap.

USC = United States demand for copper.

EURC = Europe demand for copper.

JC = Japan's demand for copper

RWC = World (excluding the United States, Europe, and Japan demand for copper)

USAl = German price of Aluminum deflated by the United States wholesale price index.

EURA1P = German price of aluminum deflated by a dollar-equivalent weighted wholesale price index.

USIP = United States Federal Reserve Board index of industrial production.

USID = United States inventories of durable goods, deflated by the United States wholesale price index.

EURIP = United Nations index of European industrial production.

JIP = United Nations index of Japanese industrial production.

RWIP = United Nations World (excluding the United States, Europe, Japan) index of industrial production.

APPENDIX II

SUMMARY ANALYSIS OF TWO MAJOR ECONOMETRIC STUDIES OF WHEAT MARKETS

An important set of wheat price elasticities of supply and demand were estimated as part of an elaborate "World Grain Model" by Messrs. Rojko, Urban and Naive[1/]. The simultaneous equation econometric model consisted of separate sets of demand and supply equations for three commodities (wheat, rice and coarse grain) in 22 separate regions, sets of price relationships to link commodities within and between regions, an objective function representing a matrix of transfer costs, and a set of constraining relations. Both demand and supply equations were formulated in linear forms. Demand was assumed to be influenced by price, population, income growth and trend. Supply was assumed to be influenced by price and trend. Data used related generally to the period 1955-56 to 1966/67. Estimated price elasticities of short term demand ranged between -0.2 to -0.4 for all regions. Price elasticity of short-term supply ranged between 0.1 to 0.2 for the less developed countries (LDC's) and centrally planned economies (CPE's), and between 0.3 to 0.4 for major exporters and developed country importer. The estimated equations were not presented in the publication.

1/ A.S. Rojko, F.S. Urban and J.J. Naive, World Demand Prospects for Grain in 1980, op. cit.

A second, more recent estimate of wheat price elasticities is available from Adams and Behrman[2/]. The wheat model (in similarity to the commodity models for cocoa, coffee, tea, wool, cotton, sugar and rice) had eight equations, viz. three supply relations (for the developed market economies, the developing economies and the centrally planned economies), demand relations for the same three country groups, a world inventory relation, and a world price determination relation. The general specification for supply posited that production is a log-linear function of historical relative prices and a time trend (dummy variables were also used to reflect bad weather conditions). The general specification for demand posited that per capita demand is a log-linear function of relative prices and per capita income or product. The price series used was the ratio of the UNCTAD export index for the commodity to the OECD GDP deflator. Data used related to the 1955 to 1971 period. The long term price elasticities of demand are estimated at -0.51 for the developed and developing countries and 0 for the CPE's. Long-term price elasticities of supply are estimated at 0.38 for the developed countries, 0.57 for the developing countries and 1.03 for the CPE's.

2/ F.G. Adams and J.R. Behrman, Econometric Models of World Agricultural Commodity Markets, op. cit.

The supply and demand equations estimated by Adams and Behrman are presented below:

(1) $\ln PRODC = 0.340 \ln PDF_{-0} + 0.152 \ln PDF_{-1} - 0.112 \ln PDF_{-2}$

(1.8) (1.4) (-0.7)

$+0.040T - 0.142\ DUM6170 + 4.005$

(4.5) (3.8)

$\bar{R}^2 = 0.93$ S.E. = 0.044 D.W. = 2.2 Years 1955 - 1971

(2) $\ln PROLDC = 0.117 \ln PDF_{-3} + 0.173 \ln PDF_{-4}$

(0.7) (1.6)

$+0.170 \ln PDF_{-5} + 0.111 \ln PDF_{-6}$

(1.6) (0.7)

$+0.053T - 0.140\ DUM66 + 2.934$

(6.2) (2.6)

$\bar{R}^2 = 0.94$ S.E. = 0.048 D.W. = 1.7 Years 1956 - 1971

(3) $\ln PROCPE = 0.052 \ln PDF_{-3} + 0.231 \ln PDF_{-4} + 0.384 \ln PDF_{-5}$

(0.4) (2.0) (3.9)

$+0.358 \ln PDF_{-6} + 0.064T - 0.218\ DUM63$

(3.4) (5.8) (3.3)

$+0.177\ DUM66 + 3.496$

(2.8)

$\bar{R}^2 = 0.93$ S.E. = 0.060 D.W. = 2.7 Years 1955 - 1971

(4) $\ln DDC/POP = -0.515 \ln PDF + 0.416 \ln GDPDC/POP$

$(-4.1) \qquad (1.9)$

$-0.031T + 0.288 \ln PRO/POP - 2.976$

$(-3.6) \quad (3.0)$

$\bar{R}^2 = 0.71$ S.E. = 0.022 D.W. = 2.5 Years 1955 - 1971

(5) $\ln DLDC/POP = -0.109 \ln PDF_{-0} - 0.157 \ln PDF_{-1}$

$(-1.2) \qquad (-2.1)$

$-0.151 \ln PDF_{-2} - 0.096 PDF_{-3}$

$(-3.3) \qquad (-1.6)$

$+0.028 \ln GDPLDC/POP - 3.324$

(0.1)

$\bar{R}^2 = 0.94$, S.E. = 0.025 D.W. = 2.8 Years 1955 - 1971

(6) $\ln DCPE/POP = 0.155 \ln GDPCPE/POP + 0.0630 \ln PRO/POP$

$(4.1) \qquad (7.8)$

-1.490

$\bar{R}^2 = 0.93$ S.E. = 0.036 D.W. = 1.2 Years 1955 - 1971

Where:

PRODC = Production of Wheat by Developed Countries

PROLDC = Production of Wheat by Less Developed Countries

PROCPE = Production of Wheat by Centrally Planned Economies

PDF = UNCTAD Export Price Index for Wheat Deflated by OECD GDP Deflator

T = Time Trend, 1947 = 1

DUM = Dummy Variable (1 for year/s in question, otherwise 0)

DDC/POP = Per Capita Wheat Consumption of Developed Countries

DLDC/POP = Per Capita Wheat Consumption of Less Developed Countries

DCPE/POP = Per Capita Wheat Consumption by Centrally Planned Economies

GDPDC/POP = Per Capita GDP (United Nations index 1963 = 100) Developed Countries

GDPLDC/POP = Per Capita GDP (united Nations index 1963 = 100)Less Developed Countries

GDPCPE/POP = Per Capita GDP (United Nations index 1963 = 100) Centrally Planned Economies

APPENDIX III

CHOICE OF PRICE DEFLATOR FOR COPPER MARKET ANALYSIS

An issue which had to be faced in our price analysis of the copper market was the choice of the appropriate deflator for examination of the behaviour of prices in real terms. For the United States and Canadian markets, the U.S. wholesale price index was used. For Europe, a dollar equivalent, industrial production weighted, wholesale price index was constructed. In addition, an appropriate general deflator, i.e., a dollar equivalent, GDP weighted, wholesale price for OECD countries was constructed for use in all other cases. With regard to these latter two indices, individual OECD country wholesale price indices were available comprehensively only for the period 1955-74. Consequently for the period 1947-54 we have used the U.S. wholesale price index, a defensible choice since the U.S. economy continued to occupy the dominant share of production in the OECD group in this period. For the period 1955-1974, we have estimated these two special indices which are presented in Appendix Table III.A on the following page.

Testing these indices in econometric work on copper provided better econometric results than alternative indices (e.g., the World Bank index of international inflation computed from developed countries "C.I.F." index of U.S. dollar prices of export of manufactures SITC 5-8 to all destinations, and the OECD Price Index of GDP at Market Prices).

APPENDIX TABLE III.A: Wholesale Price Index for OECD Countries

Year	WPI 1974 = 100		Year	WPI 1974 = 100	
	EUROPE	OECD		EUROPE	OECD
1955	41.9	47.5	1966	50.3	54.5
1956	43.3	49.1	1967	49.4	54.3
1957	43.9	50.3	1968	49.3	54.5
1958	43.1	50.0	1969	49.9	56.6
1959	39.7	49.1	1970	53.7	59.2
1960	43.1	49.9	1971	57.7	62.0
1961	44.1	50.1	1972	64.9	67.5
1962	44.7	50.3	1973	82.5	82.8
1963	46.2	51.0	1974	100.0	100.0
1964	48.5	52.0			
1965	49.4	53.0			

Source: Wholesale Price Index (WPI) 1955-74 computed from OECD Main Economic Indicators, various issues.

APPENDIX IV

COPPER PRICE AND INVENTORIES

Data available on copper stocks is seriously deficient in many respects. The most important of these deficiencies relates to the unavailability of data on stocks held by consumers (copper fabricators) as unfabricated metal or as copper metal products. Data on producers stocks is relatively more reliable, and is presented in Appendix Table IV.A together with data on the U.S. government stockpile which has been rapidly run down as a result of government policy.

Inventories are held by producers, traders, consumers and some governments for security reasons. Inventory levels by themselves have little economic meaning, but when related to demand or supply, they indicate the length of time for which reserves are available. The shorter the time period, the greater is the urgency to increase supply (or reduce consumption), and thus the stronger is the pressure on prices. One would expect, therefore, an inverse relationship between prices and the ratio of inventories to demand or supply. The results of the estimated price equations confirm this expectation. In interpreting the estimate price co-efficients of the price equation, it may be useful to view it as a price-dependent demand equation for copper stocks. The co-efficient associated with the ratio of stocks to world demand becomes then the price flexibility of the demand for stocks.

The following equations were estimated for the period 1960-74.

(IV.1) $$\ln PLME = 0.078 + \underset{(3.96)}{\ln 0.794}\ PLME_{t-1} - \underset{(3.30)}{\ln 0.150}\ \ln \frac{LMES}{CMW}$$

$\bar{R}^2 = 0.61$ D.W. = 1.89 SE = 0.20 Years 1960-74

(IV.2) $$\ln PLME = 3.192 + \underset{(0.35)}{\ln 0.108}\ PLME_{t-1} - \underset{(-2.24)}{\ln 0.348}\ \frac{TOTS}{CMW}$$

$\bar{R}^2 = 0.48$ D.W. = 13.7 SE = 0.23 Years 1960-74

(IV.3) $$\ln PLME = 3.587 - \underset{(-3.57)}{\ln 0.386}\ \frac{TOTS}{CMW}$$

$\bar{R}^2 = 0.48$ D.W. = 1.06 SE = 0.23 Years 1960-74

where:

PLME = Copper price (LME spot of wire bars); annual average in US¢/lb., 1974 prices

LMES = LME copper stocks (thousand metric tons)

TOTS = Total copper stocks (thousand metric tons)

CMW = World consumption of copper

Appendix Table IV.A: Copper Stocks, 1960-74
(Thousand metric tons)

Year	Producer Stocks Total	Producer Stocks (LME)	U.S. Govt. Stockpile	Total Stocks	Total Consumption	Total Stocks as Percent of Total Consumption
1960	311	(15)	1,040	1,351	5,423	25
1961	284	(17)	1,036	1,320	5,111	26
1962	335	(13)	1,029	1,364	6,155	22
1963	321	(14)	1,018	1,339	6,881	19
1964	293	(5)	993	1,286	7,132	18
1965	309	(8)	814	1,123	7,290	15
1966	326	(14)	410	736	6,831	11
1967	297	(12)	250	547	7,290	8
1968	338	(19)	237	575	8,093	7
1969	255	(19)	230	485	7,991	6
1970	435	(72)	230	665	7,955	8
1971	431	(140)	229	660	8,563	8
1972	515	(183)	229	744	9,549	8
1973	361	(35)	229	590	8,890	7
1974	713	(133)	-	713	7,440	10

Source: Gerhard Thiebeck and Ray Helterline, Copper: Situation and Short-Term Outlook, (Washington, D.C.: International Bank for Reconstruction and Development, May 1978), p. 15.

APENDIX V

RELATIONSHIP BETWEEN PRICES OF DIFFERENT VARIETIES OF WHEAT

As expected, there exists a close price relationship between different classes of wheat as can be seen from the estimated equations below:

(V-1) PWRARG = 12.96 + 0.80 PWRAUS

(10.0)

$\bar{R}^2$ = 0.87 D.W. = 1.68 S.E. = 2.65 Years 1956-73

(V-2) PWRAUS = -18.56 + 1.16 PWRCAN

(13.4)

$\bar{R}^2$ = 0.92 D.W. = 1.23 S.E. = 2.39 Years 1956-73

(V-3) PWRCAN = 4.29 + 0.95 PWRUSA

(13.4)

$\bar{R}^2$ = 0.92 D.W. = 2.28 S.E. = 1.97 Years 1956-73

(V-4) PWRARG = -0.37 + 0.92 PWRUSA

(7.9)

$\bar{R}^2$ = 0.92 D.W. = 2.17 S.E. 3.24 Years 1956-73

Where:

PWRARG = Argentina No. 2 Semi-hard, f.o.b. Buenos Aires (U.S. $/metric ton, current prices)

PWRAUS = Australia faq (fair average quality), f.o.b. Australian ports (U.S. $/metric ton, current prices)

PWRCAN = Canadian No. 1 CWRS (Canada Western Red Spring), f.o.b. Thunder Bay (U.S. $/metric ton, current prices)

PWRUSA = United States No. 2 Dark Northern Spring, f.o.b. Gulf ports (U.S. $/metric ton, current prices)

APPENDIX VI

WHEAT PRICE AND INVENTORIES

The general statement regarding the relationship between prices and the level of inventories in Appendix IV is also applicable here. It should also be noted that while overall data on wheat stocks is continuously being updated as additional information becomes available, the data relating to developed countries' stocks is of a much more comprehensive nature.

The following wheat price and wheat inventory equation was estimated for the period 1960-75.

$$(VI.1)\ \ln PWR = 1.262 + \underset{(3.47)}{0.71}\ \ln\ PWR_{-1} - \underset{(-0.9)}{0.19}\ \ln\ \frac{SW}{WD}$$

$\bar{R}^2 = 0.53$ D.W. = 1.21 S.E. = 0.16 Years 1960-75

Where:

PWR = UNCTAD export price index for wheat (1963=100) deflated by OECD GNP Price Index (1963=100)

SW = Known world stocks (thousand metric tons)

WD = World demand for wheat

Appendix Table V1.A: Wheat Stocks, 1960-75[1/]
(Thousand metric tons)

Year	Developed Market Econ. Stocks	Known World Stocks	Total Consumption	Developed Market Econ. Stocks As Percent of Total Consumption	Known World Stocks As Percent of Total Consumption
1960	63823	74252	234230	27	32
1961	66578	77359	237435	28	33
1962	57198	65511	247930	23	26
1963	59710	69985	243466	25	29
1964	49003	62763	260689	19	24
1965	50980	73598	282061	18	26
1966	43348	55443	281426	15	20
1967	43718	82278	288478	15	29
1968	48749	87495	303039	16	29
1969	68739	111514	323825	21	34
1970	70990	94469	338940	21	28
1971	55335	71118	342450	16	21
1972	56236	78177	362306	16	22
1973	37306	60185	358767	10	17
1974	33947	69183	359244	9	19
1975	36611	62598	354530	10	18

1/ Beginning Year Stocks

Source: U.S. Department of Agriculture, Foreign Agricultural Service. Foreign Agricultural Circular on Grains, (Washington, D.C.: Government Printing Office), various issues.

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