CIPEC AND THE COPPER EXPORT EARNINGS OF MEMBER COUNTRIES*

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I. BACKGROUND AND OBJECTIVES

THE INTERGOVERNMENTAL Council of Copper Exporting Countries (CIPEC)[1] with its secretariat in Paris, was formed in 1967 by four copper exporting developing countries—i.e., Chile, Zaire (formerly Democratic Republic of the Congo), Peru, and Zambia in order to coordinate their copper policies. Its Conference of Ministers held the first ordinary session in Lima, Peru in November 1969. This meeting closed with a number of resolutions concerning coordination of national policies with respect to the copper industries of the member countries. In view of the sharply falling world price of copper, the CIPEC held a series of meetings during 1970 which culminated in an extraordinary session of the Conference of Ministers toward the end of November. The conference agreed then on a number of possible measures intended "to halt the drift in copper prices to levels that would be injurious to the economies of copper exporting countries and would not be conducive to the orderly development of the world's copper market and industry." The conference delegated to a committee of experts the task of determining the most suitable measures and the means of their implementation. Following the conference, a number of statements were made by officials of the member countries regarding undisclosed plans to boost the price of copper, but it was not clear whether or not the four countries agreed on any secret, joint price-support plan.

Subsequently, another session of the Conference of Ministers was held in May 1971 in Kinshasa. The conference was attended not only by the delegations of the four member countries, but also by the Minister of Mines of Mauritania, observers from Canada, Iran, the Philippines as well as representatives of UNCTAD and

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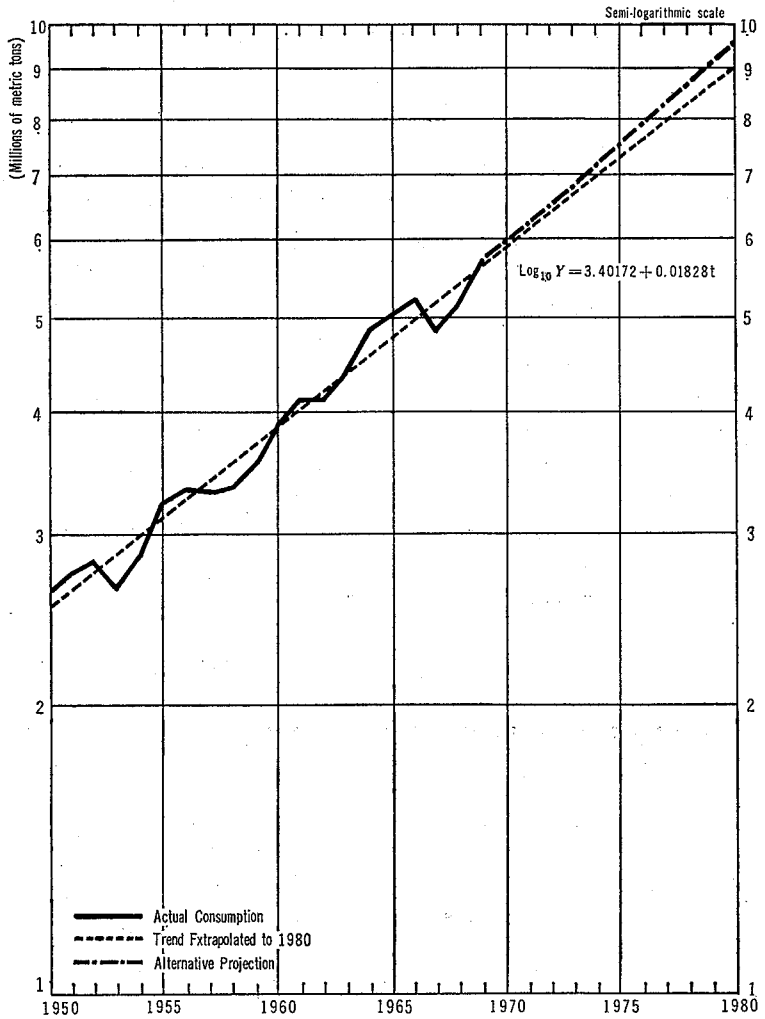
1 Conseil Intergouvernmental des Pays Exportateurs de Cuivre.

UNIDO. CIPEC reportedly is now studying possible long-term strategies for stabilization of copper prices, based on the results of the studies which it commissioned earlier.

It is the purpose of this paper to analyze the effects of possible concerted actions by the CIPEC on the copper export earnings of member countries.

The supply-demand balance on the world[2] copper market was extremely tight during the 1965–69 period, due to a series of abnormal circumstances. Among the significant factors that contributed to this situation are on the demand side, the

Fig. 1. World (excl. CPEs) Consumption of Refined Copper



Note: Refined copper includes primary and secondary copper.

[2] Excluding the centrally planned economies (CPEs) unless otherwise noted.

TABLE I

WORLD REFINED COPPER CONSUMPTION, 1950–70

(Thousand metric tons)

	Developed Countries									Developing Countries	Total
	United States	Canada	Western Europe				Japan	Other Developed Countries	Total Developed Countries		
			EEC	UK	Other W. Europe	Total W. Europe					
1950	1,292	97	442	410	154	1,006	60	51	2,506	104	2,610
1951	1,285	122	492	410	155	1,057	91	57	2,612	135	2,747
1952	1,342	118	480	429	171	1,080	96	55	2,691	116	2,807
1953	1,356	96	468	327	161	956	95	51	2,554	99	2,653
1954	1,138	93	689	455	203	1,347	98	55	2,731	128	2,859
1955	1,363	126	756	504	204	1,464	105	68	3,126	120	3,246
1956	1,380	132	756	510	226	1,492	147	64	3,215	108	3,323
1957	1,227	107	828	516	255	1,599	168	78	3,179	146	3,325
1958	1,135	111	875	543	265	1,683	147	86	3,162	186	3,348
1959	1,327	118	870	487	265	1,622	219	85	3,371	170	3,541
1960	1,225	107	1,062	560	309	1,931	304	98	3,664	180	3,844
1961	1,327	129	1,133	529	342	2,004	373	90	3,923	195	4,118
1962	1,451	138	1,070	526	332	1,928	301	107	3,925	205	4,130
1963	1,582	154	1,082	558	331	1,971	352	114	4,173	218	4,391
1964	1,656	184	1,187	633	347	2,167	457	133	4,597	255	4,852
1965	1,819	204	1,163	650	348	2,161	428	135	4,747	256	5,003
1966	2,141	238	1,089	593	347	2,029	483	138	5,029	200	5,229
1967	1,756	199	1,122	514	347	1,983	616	120	4,674	187	4,861
1968	1,698	230	1,282	539	353	2,174	695	103	4,900	233	5,133
1969	1,943	235	1,379	547	410	2,336	807	134	5,455	250	5,705
1970	1,842	229	1,447	548	414	2,409	832	148	5,460	243	5,703

Sources: [7]; 1969–70 based on [11, April 1971].

Notes: 1. Refined copper includes copper refined from old and scrap material.
2. Other Western Europe and Total Western Europe include Yugoslavia.
3. Other Developed Countries: Republic of South Africa, Australia, and Oceania.
4. Developing Countries: North and South America except United States and Canada; Africa except Republic of South Africa; and Asia (excluding Japan but including Turkey).

TABLE II

WORLD MINE PRODUCTION OF COPPER, 1950–70

(Thousand metric tons, copper content)

	United States	Canada	Western Europe	Japan	Other Developed	Developed Total	Chile	Peru	Zambia	Congo(K)	Other Developing	Developing Total	Grand Total
1950	825	240	125	39	49	1,278	363	30	297	176	143	1,009	2,287
1951	842	245	129	43	51	1,310	381	32	319	192	150	1,074	2,384
1952	840	234	137	54	56	1,321	409	30	330	206	147	1,122	2,443
1953	841	230	131	59	73	1,334	361	35	373	214	142	1,125	2,459
1954	758	275	130	66	84	1,313	364	38	398	224	148	1,172	2,485
1955	906	296	133	73	92	1,500	433	43	359	235	161	1,231	2,731
1956	1,002	322	142	78	101	1,645	488	46	404	251	197	1,386	3,031
1957	986	326	151	82	105	1,650	479	55	436	243	228	1,441	3,091
1958	888	313	160	82	127	1,570	465	52	400	238	232	1,387	2,957
1959	748	359	157	85	148	1,497	545	50	543	282	236	1,656	3,153
1960	980	399	157	89	160	1,785	532	184	576	302	238	1,832	3,617
1961	1,057	398	171	96	152	1,874	547	198	575	295	225	1,840	3,714
1962	1,114	415	181	104	157	1,971	586	165	562	297	230	1,840	3,811
1963	1,101	411	181	107	172	1,972	601	180	588	271	263	1,903	3,875
1964	1,131	442	191	106	168	2,038	622	176	632	277	252	1,959	3,997
1965	1,226	461	186	107	152	2,132	585	180	696	289	270	2,020	4,152
1966	1,296	459	178	112	236	2,281	637	176	623	317	281	2,034	4,315
1967	866	556	186	118	219	1,945	660	186	663	322	282	2,113	4,058
1968	1,093	575	200	120	234	2,222	658	214	685	326	313	2,196	4,418
1969	1,401	500	236	120	255	2,512	688	199	720	364	339	2,309	4,821
1970	1,548	613	242	117	284	2,804	686	203	684	386	365	2,324	5,128

Source: [7] for 1950–66; [11, April 1971] for 1967–70.

Notes: 1. Western Europe includes Turkey and Yugoslavia.
2. Other Developed Countries: Republic of South Africa, Australia, and Oceania.
3. Other Developing Countries: North and South America, excluding United States, Canada, Chile, and Peru; Africa, excluding Republic of South Africa, Zambia, and Congo, but including South West Africa; Asia excluding Japan.

TABLE III
WORLD TRADE IN COPPER, 1969
(Thousand metric tons, copper content)

	Exports of				
	Ores, Concentrates, etc.	Blister	Refined Copper	Gross Exports of Copper	Gross Imports of Copper
Developing countries: total	255	634	1,260	2,149	84
CIPEC:[a] total	101	612	1,260	1,974	—
Chile	40	188	428	657	—
Zaire	0	182	183	365	—
Peru	30	134	34	198	—
Zambia	31	108	615	754	—
Other developing: total[b]	154	23	0	175	84[c]
Philippines	131	0	0	131	—
Uganda	0	17	0	17	—
Developed countries: total	180	133	989	1,302	not available
Australia	10	9	33	52	—
Canada	143	0	191	334[d]	17[d]
South Africa (incl. S. W. Africa)	0	95	26	121	3
Western Europe: total[b]	26	25	529	580	2,250
Yugoslavia	0	0	18	18	32
Turkey	13	7	0	20	—
U.S.A.	1	4	195	200[d]	370[d]
Japan	—	—	15	15	613

Source: [11, December 1970].
Note: Centrally planned economies were not included in this table.
[a] Includes Chile, Zaire, Peru, and Zambia.
[b] Slightly underestimated because of incomplete coverage.
[c] Brazil and India are the significant net importers of copper among the developing countries—i.e., 50,000 tons and 34,000 tons in 1969 respectively.
[d] Includes trade in scrap.

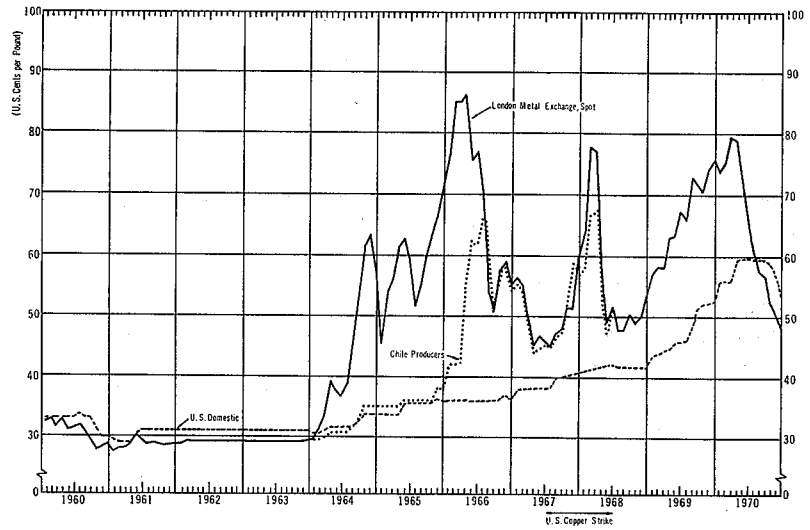
unexpectedly strong demand growth in the latter half of the 1960s which was sustained by a prolonged industrial boom throughout the world and reinforced by increased imports by mainland China and expanding military needs in the United States; and on the supply side, delays in carrying out expansion plans, considerable production losses due to labor strikes, and technical breakdowns.[3]

Consequently, copper prices on the London Metal Exchange (LME) remained at abnormally high levels, averaging around 60 U.S. cents per pound, during the 1965–69 period.[4]

Beginning with the second quarter of 1970, however, the demand for copper turned sluggish, mainly because of the U.S. recession and automobile strike, slower economic growth in some other OECD countries, and significant reductions both in mainland China's imports of copper and in U.S. military needs. In the mean-

[3] Figure 1 shows the long-term trend in world refined copper consumption. For the structure and trend of consumption, mine production and exports by area, see Tables I–III. "Copper" includes only unwrought copper.
[4] Figure 2 shows monthly copper prices since 1960.

Fig. 2. Copper Prices (London Metal Exchange, U.S. and Chilean Producers) 1960–70, by Months



time, on the supply side, there were substantial additions to the world productive capacity. It is estimated that world mine capacity increased by about 10 per cent in two years, rising from 4.98 million metric tons (annual capacity) at the beginning of 1969 to 5.48 million metric tons at the beginning of 1971.[5] This rapidly changing balance between demand and supply or capacity was reflected in the precipitate decline in the LME price in the latter half of 1970, i.e., from around 80 U.S. cents per pound in March–April 1970 to around 48 U.S. cents in November–December 1970.[6] In the first five and half months of 1971, the LME price fluctuated in the range of 45–58 U.S. cents per pound.

A tally of possible actions that theoretically could be taken by the CIPEC would be quite long if it were to include all conceivable alternatives. Examples of possible actions by the CIPEC are illustrated in a recent issue of the *Metals Week* [8, p. 20] which listed the following four as "possible methods of price support": (1) production cutbacks, (2) a move to a fixed price (to so-called producer pricing), (3) export controls, and (4) support-buying on the LME. The last method, of course, may be used in connection with a buffer-stock scheme. Another possible approach, discussed recently by the *Metal Bulletin*, is the suspension of capacity expansion programs by the member countries for one year.

Assuming that the CIPEC cannot influence the demand conditions outside the

[5] Tonnage data in this report are in metric units.

[6] There are basically two important prices in the copper market, the U.S. producers' price and the London Metal Exchange (LME) price. The former applies to copper which is mined and sold in the United States (about 30 per cent of world production), and moves in the classic manner of a "managed price," i.e., it is posted and changed only from time to time, with the role of price leader changing among various companies. Outside the United States most copper is sold on the basis of the LME price, which is essentially a daily auction price highly responsive to world, as well as United Kingdom, conditions.

CIPEC countries, possible action schemes may be sorted into two broad categories: (1) schemes that attempt to limit the copper supply to the world market by reducing the amount of production, and hence, *without* any accumulation of stocks, and (2) those that attempt to reduce the supply of copper being offered to the market by withholding sales but not production and *result in* an accumulation of stocks at the suppliers' end. The latter category could include an international buffer-stock scheme organized by the producer interests. It should be emphasized that, despite important differences among them, the various schemes in question are similar in that they all aim at reducing the effective supply of copper in the market with the hope of raising the price. This is also true of buying operations by an international buffer stock.

Needless to say, what is relevant for the governments concerned in the present context is not the price level of copper per se but the possible effects of a jacked-up price on (1) total export earnings from copper and (2) government revenues from copper in the member countries. It is important to note that actions intended to improve the situation on one account may not necessarily mean an improvement on the other account. In other words, there could be a conflict between the two objectives, namely, more export earnings and higher government revenues from copper.[7] Here, however, it is assumed that the total export earnings from copper are the overriding consideration from the viewpoint of the governments concerned. The question is then, under what conditions and to what extent the CIPEC countries as a group might be able through coordinated action to improve their export earnings from copper, as compared to what the earnings would be in the absence of such action. The key question seems to be whether or not and under what conditions the loss in export volume resulting from a concerted action by the CIPEC countries could be more than compensated for by the induced price increase.[8]

[7] Total export earnings from copper are equivalent to the volume of copper exported times the average price of copper and have no reference to costs of production or profits in the industry. On the other hand, government revenues from copper are based on the tax contributions from copper industry, and, in the case of Chile, Zaire, and Zambia, also on the dividends from the "nationalized" copper companies. Both of these are closely related to the profitability of copper mining (hence the cost of production as well as the price of copper) rather than the total receipts from copper sales overseas. Incidentally, it may be noted that total export earnings from copper are practically equal to total revenue of the copper industry in the CIPEC, as domestic consumption of copper in these countries is quite small.

[8] Another interesting question, which will not be covered here, concerns the cost-benefit consideration of those schemes involving building up of stocks. The sales-cutback scheme and the international buffer-stock scheme, for example, share a common aspect in that they both build up stocks which will "overhang" the market and be eventually "unloaded" on the market when the price climbs to higher levels. One question is whether the costs of financing or carrying these stocks can be more than compensated for by the "profits" yielded from the appreciation of the stocks—i.e, the "profit margin" between the price at which the stocks were bought and the price at which these stocks are eventually sold. Or, if there is to be a financial loss in carrying stocks but there is also to be a resulting net gain in the total export earnings in the long run, then the question will be whether the loss due to the carrying of stocks would be more than made up for by the gain on the export earnings front. Although these questions are interesting and worthwhile, they will not be probed in this paper.

Before we discuss this question, we must first touch on the important assumption underlying any scheme to restrict effective supplies, namely, that the exporting countries involved, in this case the four member countries of the CIPEC, will agree on and stick to a scheme that is believed to be beneficial to the group as a whole, although not necessarily equally beneficial to each member. The primary difficulty underlying any concerted action lies precisely in this point because the circumstances surrounding the copper industry vary from one country to another among the member countries and as a result the interests of each country tend to differ also, as illustrated below.

First of all, the relative importance of copper in the export earnings differs from one country to another. Copper accounts for 80 per cent or more of the export earnings of Chile and Zambia, but only 50–60 per cent and 30 per cent of those of Zaire and Peru, respectively. Second, copper mines in these countries are apparently operating on different costs. It is generally believed that under normal circumstances the average cost of copper production is relatively lower in Chile and Peru than in Zambia and Zaire [3, p. 42]. Third, there are differences among the CIPEC countries with respect to current and prospective scales of productive capacity also. Chile has been carrying out an ambitious capacity expansion program since 1967 to almost double the capacity by 1973, although there has been a substantial delay in the schedule since mid-1970. The expansion of capacity in the other CIPEC members, on the other hand, has been only gradual. This is especially true in the case of Zambia, due to the tragic accident at the Mufulira mine, which accounts for roughly one-fourth of the country's copper producing capacity, in September 1970. It is reported that the mine has not regained full capacity operation yet. Peru has not added any new capacity for a number of years and is not likely to add any for the next two or three years. She has a number of rich new mines ready for development, however, and could possibly add a substantial amount of capacity in the period after 1975 if investment decisions are made soon. These and other differences, combined with possible domestic political constraints in the individual member countries, tend to create ground for disagreement on concerted policy among the four countries. Consequently, it is not at all certain that the CIPEC countries would agree on any drastic measures, unless or until the world price of copper falls to levels well below those experienced in the recent past. This however, does not necessarily detract from the usefulness of the present investigation because, in the final analysis, what the member countries may choose to do might be influenced by their assessment of the potential benefits (and costs) of alternative courses of action or inaction.

II. SUMMARY AND CONCLUSIONS

As a rule, a necessary condition for an oligopolist (which is the role assumed for CIPEC in this analysis) to be able to increase his (export) earnings from a product (in this case, copper) by restricting his supply to the market is that the absolute value of the price elasticity of demand for his product (in this case, CIPEC's copper exports), which is normally negative, be less than unity. Also as a general rule, the

lower the absolute value of that elasticity is, the better the prospects are for the oligopolist (in this case, CIPEC) to greatly improve his (export) earnings from his product (copper) by a supply cutback.

The price elasticity of demand for CIPEC's copper in turn depends on, and has a definite algebraic relationship with the following three factors—i.e., (a) the price elasticity of demand for copper in the entire world market, (b) the price elasticity of supply in the countries outside CIPEC, and (c) the share of CIPEC in total world supply. The relationship among these variables is defined by the following equation:

$$E_{Dc} = \frac{1}{m} \cdot E_{Dw} - \frac{1}{m} \cdot (1 - m) \cdot E_{Sr} ,$$

where E_{Dc}: price elasticity of demand for the CIPEC's copper exports; E_{Dw}: price elasticity of world demand for all copper; E_{Sr}: price elasticity of supply outside the CIPEC; and m: CIPEC's share in total world supply.

In other words, for any given set of values for the elasticity of world demand for copper and the elasticity of supply outside CIPEC, the larger the share of CIPEC in world supply is, the lower will be the absolute value of the elasticity of demand[9] for CIPEC's copper. Similarly, for a given set of values for the CIPEC's share in world supply and the elasticity of supply outside CIPEC, the lower the world elasticity of demand for all copper is, the lower will be the elasticity of demand for CIPEC copper. It is also obvious that, for a given set of values for the CIPEC's share in world supply and the elasticity of world demand for all copper, the lower the elasticity of supply in the non-CIPEC area is, the lower will be the elasticity of demand for CIPEC copper.[10]

An important implication of the above relationship is that a successful supply cutback scheme requires that the absolute value of the price elasticity of demand in the entire world market be smaller than a critical value which is determined by the following inequality;

$$|E_{Dw}| < m - [(1 - m) \cdot E_{Sr}] .$$

This means that, if we know the empirically-estimated values of m and E_{Sr}, we could tell how small the absolute value of the price elasticity of demand in the world market must be in order that a coordinated supply cutback by CIPEC might lead to an improvement in the export earnings from copper.

One problem is that the share of CIPEC in total world supply of copper can have three alternative definitions; namely, (1) the share in world mine production, (2) the share in total world production including secondary refined copper, and (3) the share in world copper exports. Depending on the definition adopted, (1) $m = 0.4$, (2) $m = 0.33$, or (3) $m = 0.75$.[11] While the first definition is the most

[9] In this paper, "elasticity" means price elasticity unless otherwise noted. Although the price elasticity of demand is normally negative, reference will be made to the magnitude of the elasticity of demand often ignoring the negative sign.

[10] The expression CIPEC will often be used to stand for the CIPEC member countries as a group.

[11] The approximate value of m in each case is discussed later, together with the probable ranges of magnitudes of various elasticities.

relevant one in the context of the long run, the second and the third definitions are the more relevant in the short run.

In the context of the possible short-run effects of a supply cutback, the role of secondary refined copper is quite important. If secondary refined copper is included in the total supply in considering the CIPEC's share in world supply, a hypothetical supply cutback by CIPEC cannot increase the export earnings from copper so long as the price elasticity of supply outside CIPEC is higher than 0.5, no matter what the price elasticity of world demand for copper is.

In the short run, the price elasticity of supply outside CIPEC is fairly low. Available estimates of the price elasticities of supply for some major countries outside CIPEC and for the world as a whole differ rather widely depending on the countries chosen, and on the data and the estimation methods used. Nevertheless, on the basis of such available estimates, it is inferred that the short-run elasticity of supply outside CIPEC lies between 0.16 and 0.3, and most probably is around 0.2, if secondary copper supply is ignored. On the other hand, in the short run, the supply elasticity of secondary refined copper is fairly high (0.4 or higher) and should not be ignored. The price elasticity of supply (including secondary refined copper) outside CIPEC should probably lie in the range of 0.2 to 0.4.

Based on the available estimates of the short-run price elasticity of demand which again tend to show a wide range of results, it is inferred that the short-run elasticity of demand in the world as a whole lies in the range of (minus) 0.1 to 0.3 and is most probably around (minus) 0.2.

If only primary production of copper is considered, these probable values of supply and demand elasticities outside CIPEC, when applied to the fundamental inequality formula mentioned earlier, imply that the prospects for a successful supply cutback by CIPEC are fairly good. But, if secondary refined copper is included in the supply (as it should be in the short run), they imply that it would be rather difficult for CIPEC members to improve the export earnings from copper substantially, if at all, by cutting back their supply although there is no clear implication either that they will surely fail to do so in the short run.

If the share of CIPEC in world exports rather than that in total world supply is considered (which certainly is not inappropriate in studying the short-run effects), the concepts of demand and supply elasticities to be applied should also be changed for the sake of consistency. The elasticity of *import* demand of the net importing region (Western Europe, the United States, and Japan) should be used instead of the elasticity of total world demand. Also, the elasticity of *exportable* supply in the non-CIPEC exporting region should be used in place of the elasticity of total supply outside CIPEC.

The elasticity of *import* demand in the net importing region is considerably higher than the elasticity of overall demand. This is so for more than one reason. First, the net importing region has its own domestic supply—in fact, a very large domestic supply. Therefore, the demand which is satisfied by imports is only a part of the total demand in the region. So, even if the elasticity of domestic supply there is zero, the percentage change in the volume of imports in response to a given per-

centage change in price would be greater than the percentage change in total demand in that region. Second, if there is any elasticity to the domestic supply in the region at all, then the percentage change in import demand there induced by the given percentage change in price would be even greater than when the elasticity of domestic supply is zero. In the same vein, the elasticity of *exportable* supply in the non-CIPEC exporting region is significantly higher than the elasticity of overall supply in that region, for more or less similar reasons.

Both the elasticity of exportable supply in the non-CIPEC exporting region and the elasticity of import demand in the net importing region are reflections of, and can be derived from, the elasticities of overall supply and demand (assuming normal levels of production, consumption, and trade) in the respective regions. This is so because imports and exports can be considered, in the end, as reflections of the underlying demand and supply forces working in the entire market in each region concerned. Thus, our earlier conclusions regarding CIPEC's chances of success in a supply cutback scheme are not changed.

The possibilities of CIPEC being able to increase the export earnings by a supply cutback in the short run cannot be ruled out. But it must be remembered that whether it would be worthwhile for CIPEC to act on the short-run situation in this way depends also on the prospects for longer-run gains, as well as on the short-run financial costs if carrying stocks is involved.

Turning to the long-run effects of the hypothetical CIPEC action, it is noted that the long-run elasticities are always considerably higher than the corresponding short-run elasticities. A survey of the available estimates of the long-run elasticity of supply outside the CIPEC shows that the elasticity could take quite a wide range of values depending on what is included in the "supply" and what is meant by the "long run." Nevertheless, it is inferred that the long-run elasticity of supply outside the CIPEC today is at least 0.7 and possibly as high as 2.0 or even higher.

The long-run elasticity of demand for copper can be safely assumed to be considerably higher than the estimated short-run elasticity of (minus) 0.2, and scanty evidence suggests that it could be as high as (minus) 2.8 or even higher.

In the context of the long-run considerations, possible changes in the share of CIPEC in world supply are also relevant. If the hypothetical cutback in CIPEC's supply is done by delaying the scheduled capacity expansions intentionally, it would mean that, other things being equal, the CIPEC's share in future world supply will be smaller than otherwise. Furthermore, according to a recent survey of capacity expansions, the share of CIPEC in world capacity of mine production is projected to decrease from about 40 per cent as of the end of 1969 to about 36 per cent by the end of 1975.

In view of the estimated probable ranges of the long-run elasticities of supply and demand outside the CIPEC, it is clear, at least from the present analysis, that the CIPEC cannot increase their export earnings from copper on a long-term basis by cutting back their supply to the rest of the world.

An interesting corollary of the above conclusion is that the CIPEC countries should try their best to expand their copper-producing capacity if they want to

increase their export earnings from copper, although this advice may not necessarily be warranted on other counts such as profitability and government revenues (which obviously depend on cost conditions as well as on the price of copper).

One basic assumption underlying the entire analysis is that the hypothetical supply cutback is jointly undertaken only by the present members of the CIPEC. However, it is quite feasible that the CIPEC membership may be enlarged to include other developing, copper-exporting countries such as Uganda, the Philippines, and Mauritania (which will start exporting copper shortly). It is also conceivable that some developed, copper-producing countries might join the scheme. In any case, the more countries are included, the better will be the prospects for the success of such a scheme. One interesting limiting case, in fact, will be the case where all copper-producing countries participate in the scheme. Although these cases are not elaborated upon, the analysis can be easily extended to cover such cases.

Needless to say, the CIPEC countries, with or without other copper-producing countries, could get together with major copper consuming countries on a form of commodity agreement. Under such an arrangement, there is always a possibility for the exporting countries to be able to increase the total copper export earnings in the short run, by jacking up the price. However, as the analysis shows, they cannot necessarily improve their export earnings on a long-term basis unless the agreement includes most copper producers *and* the long-run elasticity of demand happens to be well below (minus) unity (which is not impossible but not very likely).

Finally, it should be emphasized that the analysis rests on the assumption that among other factors, the price is a key variable that affects demand and supply of copper both in the short run and in the long run. However, it is recognized that quite often supply of copper is limited in the medium term by the availability of capital for financing capacity expansions. Whether this factor will play even greater role in the future outside the CIPEC than in the past is an open question.

III. THE ANALYSIS

A. *The Theoretical Framework*

It is useful to begin the analysis by examining the theoretical conditions necessary for the CIPEC countries, acting as one oligopolistic supplier, to succeed in increasing their total export earnings from copper by cutting back their supply.[12]

The following notations will be used:

p : world copper price;
S_c : quantity of copper supplied by CIPEC;
S_r : quantity of copper supplied by the rest of the world;
S_w : $S_c + S_r$ = quantity of copper supplied by the entire world;

[12] In the analysis below, the CIPEC countries are assumed to act always as one oligopolistic entity, and will be referred to simply as CIPEC for the sake of brevity. In this paper, "copper" includes only unwrought copper, namely, copper content in ores, concentrates, mattes, blister, refined copper, and, depending on the context, copper in scrap.

D_c : demand for the copper supplied by CIPEC;

D_r : demand for the copper supplied by the rest of the world;

D_w : $D_c + D_r$ = total demand for copper in the world market;

E_{Dc} : $\dfrac{dD_c/D_c}{dp/p}$ = price elasticity of demand for the copper supplied by CIPEC;

E_{Dr} : $\dfrac{dD_r/D_r}{dp/p}$ = price elasticity of demand for the copper supplied by the rest of the world;

$E_{D:w}$ $\dfrac{dD_w/D_w}{dp/p}$ = price elasticity of demand for the copper supplied by the entire world;

E_{Sc} : $\dfrac{dS_c/S_c}{dp/p}$ = price elasticity of copper supply in the CIPEC countries;

E_{Sr} : $\dfrac{dS_r/S_r}{dp/p}$ = price elasticity of copper supply in the rest of the world;

E_{Sw} : $\dfrac{dS_w/S_w}{dp/p}$ = price elasticity of copper supply in the entire world;

m : S_c/S_w = CIPEC's share in total world supply.

We will assume for simplicity that there is only one price of copper in the world market. Among the various elasticities, there is the following relationship:[13]

$$E_{Dc} = \frac{1}{m} \cdot E_{Dw} - \frac{1}{m}(1 - m) \cdot E_{Sr} . \qquad (1)^{14}$$

13 This is not such a wild assumption as it may sound. As explained earlier, there are basically two important prices in the copper market—the U.S. producers' price and the LME price. In the period between early 1964 and mid-1970, there was extraordinary divergence between the two prices, as can be seen in Figure 2. This was due to the following circumstances. During the period in question, despite the chronic shortage of supply in world copper market, the U.S. producers' price was deliberately kept at low levels, partly because of government pressure and partly for the purpose of mitigating substitution of copper by other materials. The prolonged divergence between the two prices was possible, however, mainly because of the U.S. export controls on copper from 1965 to 1970. In the foreseeable future, however, the United States is not likely to apply any stringent export control measures on copper, and the U.S. producers' price is likely to follow the LME price much more closely than in the last few years.

14 Demand for copper in the world market is a function of the world copper price, while demand for the copper supplied by CIPEC is equal to total world demand minus what is supplied by the rest of the world. So,

$$D_c(p) = D_w(p) - S_r(p) . \qquad (i)$$

By differentiating both sides of the equation (i) with respect to p, we get

$$dD_c/dp = dD_w/dp - dS_r/dp . \qquad (ii)$$

Multiplying both sides of (ii) by p/D_c, we get

$$dD_c/dp \cdot p/D_c = (p \cdot dD_w)/(D_w \cdot dp) \cdot (D_w/D_c) - (dS_r/dp) \cdot (p/S_r) \cdot (S_r/D_c) ,$$

or

$$E_{Dc} = (D_w/D_c) \cdot E_{Dw} - (S_r/D_c) \cdot E_{Sr} . \qquad (iii)$$

On the other hand, at the equilibrium, $S_r = S_w - S_c = D_w - D_c$, $S_w = D_w$ and $S_c = D_c$. So,

$$S_r/D_c = (S_w - S_c)/S_c = (S_w/S_c) - 1 = (1/m) - 1 = (1/m) \cdot (1-m) .$$

Substituting this into (iii), we get $E_{Dc} = (1/m) \cdot E_{Dw} - (1/m) \cdot (1-m) \cdot E_{Sr}$, which is equation 1.

Now, other things being equal, the CIPEC can increase its earnings from copper sales by a supply cutback only if the absolute value of E_{Dc} is less than unity. Therefore, a necessary condition for any successful supply cutback scheme by CIPEC is represented by the following inequality:

$$\frac{1}{m} \cdot |E_{Dw}| + \frac{1}{m}(1 - m) \cdot E_{Sr} < 1.0 . \qquad (2)$$

Assuming $1 > m > 0$ and $E_{Sr} > 0$, the inequality (2) can be reduced to the following form:

$$|E_{Dw}| < m - (1 - m) \cdot E_{Sr} . \qquad (3)^{15}$$

Under normal circumstances, $E_{Sr} \geq 0$. Thus, by empirically estimating the values of m, E_{Sr}, and E_{Dw}, or the probable ranges thereof, we may be able to draw some conclusions as to the chances of success for a hypothetical supply cutback by the CIPEC countries acting together. We may begin with the size of m, i.e., the share of CIPEC[16] in world supply.

B. *The Share of CIPEC in World Supply*

Before discussing the empirical size of m, one point concerning the definition of world supply and demand needs to be brought out. Every year, there are some net exports of copper from the market economies to the centrally planned economies (CPEs). These were relatively small in the 1965–68 period, running at the rate of twenty to forty thousand tons per year, or equivalent of 0.4–0.8 per cent of annual world (excl. CPEs) production of refined copper.[17] Net exports of refined copper to the CPEs are estimated to have escalated to 83,000 tons in 1969 but receded somewhat in 1970, perhaps to sixty or sixty-five thousand tons. These tonnages are equivalent to a little over 1 per cent of annual world (excl. CPEs) production in 1969–70. There are reasons to believe that this part of the total demand is independent of the price level prevailing in the world copper market. Furthermore, very little is known about the demand and supply conditions of the copper market in the CPEs. For the sake of simplicity, thus, net exports to the CPEs will be ignored in the following analysis, and the "world" will exclude the CPEs unless otherwise noted.

As to the share of CIPEC in total world market, there are at least three different ways to look at it. The first approach is to look at the share of CIPEC in the world's total mine production. The share of CIPEC in world mine production has

15 $(1/m) \cdot |E_{Dw}| + (1/m) \cdot (1 - m) \cdot E_{Sr} < 1.0 .$
$(1/m) \cdot [|E_{Dw}| + (1 - m) \cdot E_{Sr}] < 1.0 .$
Since $m > 0$ by assumption,
$|E_{Dw}| + (1 - m) \cdot E_{Sr} < m .$
so,
$|E_{Dw}| < m - (1 - m) \cdot E_{Sr} .$

16 In what follows, "CIPEC" will mean the CIPEC countries acting as one oligopolistic supplier unless otherwise noted.

17 All data in the following paragraphs of this subsection are based on [11, May 1971].

recently fluctuated at around 40–42 per cent except for 1967 and 1968.[18] On the other hand, recent surveys of planned capacity increases indicate that the share of CIPEC in world mine capacity (hence production) might be expected to decline slightly in the next few years. For example, according to the latest survey of planned capacity increases, the share of CIPEC in world capacity of mine production is projected to decrease from about 40 per cent as of the end of 1969 to about 36 per cent by the end of 1975 [1, section 2, p. 6A]. On the other hand, the CIPEC membership may be enlarged to include some other developing exporters of copper such as Uganda, the Philippines, and Mauritania.[19] For the sake of the present analysis, however, it will be assumed that the share of CIPEC in world mine production is 40 per cent, or $m = 0.4$.

The above approach is sometimes objected to on the ground that it leaves out an important part of the total copper supply, namely, secondary copper recovered from scrap. Secondary copper is recovered from two principal classes of scrap, new and old.[20] New scrap refers to the scrap which is generated in the production processes of fabricators and copper using manufacturers. New scrap recycles without going through the refining stage. Old scrap is available from the accumulating reserve of secondary copper through reclamation of copper, brass, bronze, and other alloy products that have been used and then discarded. Only a part of secondary copper that is recovered from old scrap goes through the refining process.

Although available statistical data on secondary copper are notoriously incomplete, it is generally believed that secondary copper accounts for about 40 per cent of the world's annual copper supply.[21] It is also generally believed that for the world (excl. CPEs) as a whole total secondary supply is about equally shared by new and old scrap [5]. It has been estimated that secondary copper accounted for 15–20 per cent of the world's annual consumption of refined copper in the 1950–67 period, or on the average, for 17 per cent. Secondary copper, thus, is an important part of total supply of copper.

Ignoring the new scrap and that part of old scrap which is re-used without going through refining, one could consider the share of CIPEC in world supply to be represented by the ratio of the total mine production in CIPEC[22] to the total world production of refined copper (including secondary refined copper). The latter ratio is estimated to have been 33.5 per cent in 1969. For purposes of the analysis below, the value of m is assumed to be 0.33.

Yet another way to look at the position of the CIPEC in world copper supply is to consider the CIPEC's share in total world exports of copper. Total exports of copper by the world (excl. CPEs) in 1969 are estimated at 3.45 million tons. These

[18] There were large losses of production in the U.S. copper industry from mid-1967 to April 1968, due to the nine-month industry-wide strike. The United States normally accounts for about 30 per cent of world mine production.

[19] Uganda has been sending observers to the recent meetings of the CIPEC, while Mauritania is expected to begin to produce and export copper before the end of 1971.

[20] For further details, see [6, Chapter 4].

[21] For example, see various recent issues of [7]; also [3, p. 24].

[22] Production of secondary copper in the CIPEC countries is negligible.

include a great deal of "cross trade" within Europe as well as gross exports of some net importers such as Japan, the U.S., and India. Therefore, it is considered more meaningful to use the total exports of the "net exporters" only, which are estimated at 2.66 million tons in 1969 (Table III). The share of CIPEC in the total exports of the net exporters was 74.1 per cent in 1969, and, for the analytical purposes below it will be assumed to be 75 per cent, or $m = 0.75$.

Which of the three alternative concepts of the share of CIPEC in world copper supply is the most relevant one depends, in part, on whether one is considering the short-run effects or the long-run effects. In the short run, the second and third definitions seem more relevant than the first, while in the long-run context the first seems more relevant.

C. *The Short-Run Effects of a Supply Cutback—Secondary Copper Ignored*

Inequality (3) indicated that only when the absolute value of the price elasticity of world demand for copper, $|E_{Dw}|$, is smaller than $m-(1-m) \cdot E_{Sr}$, a hypothetical cutback in supply by CIPEC would increase the total export earnings from copper. Table IV shows the "critical values" of $|E_{Dw}|$ corresponding to various combinations of possible values of m and E_{Sr}.

TABLE IV

CRITICAL VALUES OF $|E_{Dw}|$ FOR DIFFERENT VALUES OF m AND E_{Sr}

m \ E_{Sr}	0.0	0.16	0.2	0.3	0.5	0.8	1.0	2.0	3.0
0.33	0.33	0.22	0.20	0.13	0	neg	neg	neg	neg
0.40	0.40	0.30	0.28	0.22	0.10	neg	neg	neg	neg
0.50	0.50	0.42	0.40	0.35	0.25	0.10	0.0	neg	neg
0.75	0.75	0.71	0.70	0.68	0.63	0.55	0.50	0.25	0

Notes: 1. The critical value of $|E_{Dw}|$, represented by $|E_{Dw}|^*$, has been derived by the following equation: $|E_{Dw}|^* = m - (1 - m) \cdot E_{Sr}$.
2. Neg = negative.
3. See text for notations and details of the theoretical basis for the relationship.

One interesting implication of the inequality (3) is that, when $m = 0.4$, *even if* the absolute value of the price elasticity of demand in the entire world market, E_{Dw}, is *zero*, the absolute value of the price elasticity of demand for the CIPEC's copper, $|E_{Dc}|$, will be greater than unity *so long as* the price elasticity of supply in the rest of the world, E_{Sr}, is greater than 0.67. Similarly, if $m = 0.33$, then the inequality implies that $|E_{Dc}|$ will be greater than unity *even if* $E_{Dw} = 0$, *so long as* E_{Sr} is greater than 0.50.

In the short run, the price elasticity of supply in the non-CIPEC world, E_{Sr}, is fairly low. Unfortunately, we have no reliable estimate of the short-run elasticity of supply relating to the non-CIPEC world as such. According to Newhouse and Sloan [10], the short-run elasticity of supply (mine production) in the *entire world (excluding CPEs)* was 0.2 in the 1949–63 period (see Table V). It was 0.3 in the United States in the 1947–65 period, while in Canada it was 0.16–0.23 in the period from the late-forties to 1963. According to the preliminary results of a study by

TABLE V

PRICE ELASTICITY OF COPPER SUPPLY ESTIMATED BY NEWHOUSE AND SLOAN

Geographical Area	Data Period	Method of Estimation[a]	R^2	Short-run Elasticity	Long-run Elasticity
World	1949–63	OLS	0.91	0.2	2.47
	1949–63	3PLS	0.91	0.2	6.18
United States	1922–39	OLS	0.88	1.0	1.9
	1924–39	3PLS	0.89	0.8	1.9
	1947–65	OLS	0.77	0.3	1.0
	1948–65	3PLS	0.77	0.3	1.3
Canada	1947–63	OLS	0.93	0.23	2.41
	1949–63	3PLS	0.93	0.16	3.03
Chile	1947–63	OLS	0.76	0.23	2.41
	1947–63	3PLS	0.83	0.36	8.91

Source: [10].

Notes: 1. Only selected results of their investigation are presented in this table. "Supply" refers to mine production. The measured elasticities are relevant in the price range of 28–40 U.S. cents per pound in 1965 constant dollar terms.

2. OLS: ordinary least squares estimation; 3PLS: three pass least squares estimation.

[a] Based on linear equations.

TABLE VI

PRICE ELASTICITY OF COPPER SUPPLY ESTIMATED BY FRED F. BANKS

	R^2	Durbin-Watson	Short-run[a] Elasticity	Long-run Elasticity
Mine production				
Chile	0.85	2.00	0.22	1.44
Peru	0.81	1.89	0.42	3.41
Zambia		completely unsatisfactory results		
Zaire	0.94	1.82	0.10	3.69
United States	0.74	1.63	0.25	0.71
Canada	0.95	1.95	0.18	42.24
Refined copper production				
Chile (a)[bc]	0.49	2.01	0.23	0.95
Chile (b)[b]	0.58	1.92	0.18	0.37
Peru[c]	0.70	2.61	0.15	0.71
Zambia[cd]	0.95	2.71	—	—
Zaire	0.77	2.04	0.07	0.18
United States	0.50	1.73	0.47	0.77
Canada	0.90	2.09	0.10	1.23

Source: [2].

Note: Annual data used are for 1950–67 period. The simple linear least-squares estimation method was used; with or without time lags; and mostly without dummies but, in some cases, with dummies.

[a] The "short-run" here is one year.

[b] Chile(a) has a lag of one year in the price term, while Chile(b) does not.

[c] The coefficient of the price term is not significantly different from zero.

[d] A very strong time trend is observed in the supply.

Fred E. Banks [2], the short-run elasticity of *mine* production is estimated to have been 0.25 in the United States and 0.18 in Canada in the 1950–67 period (see Table VI). Banks also estimated the short-run supply elasticity of *refined copper* in the United States and Canada at 0.47 and 0.10 respectively. On the basis of these estimates, then, it may be inferred that the short-run elasticity of supply in the non-CIPEC world lies between 0.16 and 0.3, and most probably is around 0.20.

Turning to the demand side, the question is what the short-run elasticity of demand in the world market is. Again reliable information needed to answer the question is scanty. However, results of econometric studies are available on some countries, e.g., the preliminary results of the study by Banks and a study by Charles River Associates [4].

On the basis of simple least squares regressions involving lags, and using quarterly data covering the period from 1955 (or 1957) to 1967, Banks studied the factors affecting consumption in the United States, Japan, and the major European countries. He estimated the implied price elasticities of demand (and the income elasticities as well) in those countries. Selected results of his study are summarized in Table VII. In some of the regression equations, the estimated regression coefficients for the price variable are only marginally significant. The U.K. equations indicate the short-run price elasticity ranging from (minus) 0.06 to (minus) 0.214. The U.S. equation implies an elasticity of (minus) 0.34, while the equation for France implies an elasticity of (minus) 0.08. Italy's elasticity ranges from (minus) 0.23 to (minus) 0.26.

The Charles River Associates study analyzes the U.S. copper market using a simultaneous equation model. It uses the two-stage least squares procedure with lags in several endogenous variables including the price of copper. The data used cover 1949–66. Among the alternative demand equations, the one which has yielded most satisfactory statistical results implies that the price elasticity of demand for copper in the United States relevant to the 1949–66 period is (minus) 0.21 in the short run and (minus) 2.86 in the long run.[23]

In the light of the estimates cited in the preceding two paragraphs it may be inferred that the short-run elasticity of demand for copper in the world market is in the range of (minus) 0.1 to 0.3, and most probably around (minus) 0.2.

According to Table IV, if secondary refined copper is excluded from the total supply of copper and only mine production is included ($m = 0.40$), the critical values of the absolute value of the price elasticity of demand, $|E_{Dw}|$, are:

0.30 when $E_{Sr} = 0.16$,
0.28 when $E_{Sr} = 0.20$, and
0.22 when $E_{Sr} = 0.30$.

[23] Incidentally, the same equation implies that the short-run elasticity of demand for copper with respect to the price of aluminum is (plus) 0.46, and that the long-run elasticity is 6.27.

TABLE VII

PRICE AND INCOME ELASTICITIES OF DEMAND FOR COPPER ESTIMATED BY F. E. BANKS

Country	Data	Period	Number of Observations	Form of Regression Equation[a]	R^2	Durbin-Watson	Price Elasticity			Income Elasticity (Ei)
							Short-run[b]		Long-run (Epl)	
							Eps	Ep		
United Kingdom										
(1)	1957–67	quarterly	44	arith., Pt-3	0.74	2.06	0.11	—	0.24	—
(2)	1957–67	quarterly	44	log, Pt-3, Pt-4	0.78	2.10	0.06	—	2.51	1.18
(3)	1957–67	quarterly	44	arith., Pt-4, inventory	0.71	1.11	—	0.214	—	0.98
(4)	1957–57	quarterly	44	log, Pt-4, inventory	0.63	1.06	—	2.214	—	0.94
(5)	1957–57	quarterly	44	arith., Pt-4	0.77	1.83	0.13	—	0.23	1.23
United States	1955–67	quarterly	44	log, Pt-2, Pt-3, inventory	0.80	1.85	—	0.34	—	0.84
Germany	1959–67	quarterly	32	log, Pt-1, Pt-2	0.60	1.71	—	—	0.22	0.67
Netherlands	1959–67	quarterly	36	no satisfactory results						
France	1959–67	quarterly	36	log, Pt-3, Pt-4	0.80	1.85	—	0.08	—	1.13
Italy										
(1)	1959–67	quarterly	36	arith., Pt	0.46	1.77	—	0.23	—	0.67
(2)	1959–67	quarterly	36	log, Pt, Pt-1	0.50	1.77	—	0.25	—	0.74
(3)	1959–67	quarterly	36	log, Pt	0.52	1.56	—	0.26	—	0.76
Japan	19 yearly observations			log, no price term	0.94	1.34	—	—	—	1.03

Source: [2].

Note: The method of estimation used is that of simple least-squares regression. Only the more significant results are presented.

[a] Forms of equation used for the regression exercises involve both arithmetic linear and log linear. Price terms as well as other independent variables involve lags. Lags in price terms are indicated by subscripts. Some equations include some forms of inventory.

[b] The "short-run" here is from one quarter to four quarters, depending on the lag structure of the regression equations.

It may be concluded then that prospects of a successful supply cutback are fairly good in the short run if only primary production is considered.[24]

D. *The Short-Run Effects When Secondary Copper Is Considered*

In the preceding section, secondary copper was totally ignored. In the short-run context, however, the existence of secondary copper supply is quite relevant as, after all, an important part of the supply of secondary copper is responsive to changes in the copper price. According to the Charles River Associates study, the price elasticity of supply of old scrap in the United States is estimated at 0.47 [4, p. 310]. Therefore, the probable range of the supply elasticity, E_{Sr}, must be higher than that indicated in the preceding section. It should probably be between 0.2 and 0.4. Moreover, the share of CIPEC in total supply of copper, m, should be reduced to 0.33. If secondary refined copper is included in the total "supply," thus, a supply cutback by CIPEC will be successful only if the absolute value of the price elasticity of demand for the world as a whole, $|E_{Dw}|$, is smaller than;

0.20 if $E_{Sr} = 0.2$,
0.13 if $E_{Sr} = 0.3$, and
0.06 if $E_{Sr} = 0.4$.

The short-run price elasticity of world demand was estimated at somewhere between (minus) 0.1 and (minus) 0.3, or probably around (minus) 0.2. Thus, the plausible ranges of the relevant elasticities as estimated above suggest the following conclusion. When account is taken of the supply of secondary refined copper, a supply cutback by CIPEC is not likely to result in any substantial increase, if at all, in export earnings from copper.

E. *The Short-Run Effects When Only Exports Are Considered*

As mentioned earlier, it is often argued that in the short run the relevant concept of the CIPEC's share in total world supply of copper is the share of CIPEC in the world exports of copper. If we accept the argument, the relevant measure of the CIPEC's share in world supply is 75 per cent ($m = 0.75$).

In this case, however, the relevant price elasticity of supply in the "rest of the world" would be the price elasticity of exportable supply of the non-CIPEC exporters, which may be represented by the symbol E_{Xs}. Since the exports are only a part of the total supply in the non-CIPEC copper-exporting countries, the elasticity of exportable supply there should be fairly high, although unfortunately no appropriate estimate is available for the value of E_{Xs}.

On the demand side, the relevant elasticity of demand outside the CIPEC in this case will be the price elasticity of *import demand* for copper in the net importing countries (Western Europe, the United States, and Japan). The price elasticity of import demand is always higher than the price elasticity of the total market demand

[24] A minor assumption underlying this conclusion is that we can ignore the possible effects of stock changes. To the extent that there are significant effects of changes in stocks on the short-run elasticity of supply the value of E_{Sr} tends to be higher than otherwise, thus lowering the critical value of $|E_{Dw}|$.

as a whole because generally demand for imports is only a part of total demand. Thus, the price elasticity of *import demand* for copper must be substantially higher than the price elasticity of *overall demand* for copper in the world as a whole. Unfortunately again, no reliable estimate of the price elasticity of import demand outside the CIPEC is available. The following analysis, however, will throw some light on this point.

First, the world may be divided into three regions: (1) the Net Importing Region (NIR), which include Western Europe, the United States, and Japan; (2) the CIPEC region (CIPEC); and (3) all other countries, or the non-CIPEC Net Exporting Region (NCP), including some small net importers as well as such net exporters as Canada, Australia, and the Philippines.

Next, based on the production, demand, and trade data for 1969, assume that the current levels of production, consumption, and net trade in the three regions are roughly as follows (in thousand tons per year):[25]

	NIR	NCP	CIPEC
Consumption	5,060	640	0
Domestic supply	2,620	1,100	1,980
Net exports	(−)2,440	460	1,980

Based on the earlier observations, it is assumed that the overall supply and demand elasticities outside the CIPEC are as follows:

$E_{Sr} = 0.2$ to 0.4, and

$E_{Dw} =$ (minus) 0.1 to (minus) 0.3.

By examining the effects of a hypothetical price increase of, say, 10 per cent on the export demand for the CIPEC's copper, one could derive the elasticity of demand for the CIPEC's copper exports, E_{Dc}, implied by each combination of various possible values of E_{Sr} and E_{Dw}.[26] The results of such exercises are shown in a matrix form in Table VIII. The results indicate that, if both elasticities of supply and demand happen to be close to the lower ends of the estimated probable ranges, then the elasticity of demand for CIPEC's copper exports, E_{Dc} could be less than (minus) unity. Considering the most probable values of E_{Sr} and E_{Dw} as estimated earlier, however, it does not seem very likely that the elasticity of demand for the CIPEC's copper exports is very much lower, if lower at all, than (minus) unity.

[25] All figures have been adjusted slightly to simplify the picture. For example, consumption in the CIPEC is assumed to be zero, although there is domestic consumption in the CIPEC countries.

[26] For example, assume $E_{Sr} = 0.2$ and $E_{Dw} = (-)\ 0.2$. A 10 per cent rise in price will cause the consumption in NIR to decrease from the current 5,060 to 4,959, while it will cause the domestic supply in NIR to increase from 2,620 to 2,672, resulting in the reduction of net imports from 2,440 to 2,287. Similiarly, the 10 per cent price rise will cause the domestic consumption in NCP to decrease from 640 to 627, while it will increase the domestic supply from 1,100 to 1,122, resulting in an increase in exportable supply from 460 to 495. All this means a decrease of demand for the CIPEC's exports—i.e., from 1,980 to 1,792. This implies the elasticity of demand for the CIPEC's copper exports of (minus) 0.95.

TABLE VIII

PRICE ELASTICITY OF DEMAND FOR CIPEC'S COPPER EXPORTS (E_{Dc}), AS IMPLIED BY VARIOUS ASSUMED VALUES OF ELASTICITIES OF SUPPLY AND DEMAND OUTSIDE CIPEC

E_{Dw}† \ E_{Sr}*	0.2	0.25	0.3	0.4
−0.10	−0.66	−0.76	−0.85	−1.04
−0.20	−0.95	−1.046	−1.142	−1.328
−0.25	−1.094	−1.19	−1.284	−1.472
−0.30	−1.239	−1.335	−1.428	−1.617

Source: Trade Policies & Export Projections Division, Economics Department, IBRD.
Note: See text for details of the underlying relationships between various elasticities involved.

* E_{Sr}: price elasticity of supply in all areas outside the CIPEC, assumed to be uniform in all non-CIPEC copper producers.

† E_{Dw}: price elasticity of demand in all areas outside the CIPEC. It is assumed to be the same for the non-CIPEC exporters as for the net importers.

TABLE IX

ELASTICITY OF IMPORT DEMAND IN THE NET IMPORTING REGION (E_{Md}), AND ELASTICITY OF EXPORTABLE SUPPLY IN THE NON-CIPEC EXPORTING REGION (E_{Xs}) AS IMPLIED BY DIFFERENT ASSUMED VALUES OF ELASTICITIES OF SUPPLY AND DEMAND OUTSIDE THE CIPEC (E_{Sr} and E_{Dw})

E_{Dw} \ E_{Sr}	0.2	0.3	0.4
−1.0	E_{Md}=−0.42 E_{Xs}=0.62	E_{Md}=−0.53 E_{Xs}=0.86	E_{Md}=−0.64 E_{Xs}=1.10
−0.2	E_{Md}=−0.63 E_{Xs}=0.76	E_{Md}=−0.74 E_{Xs}=1.00	E_{Md}=−0.84 E_{Xs}=1.24
−0.30	E_{Md}=−0.84 E_{Xs}=0.90	E_{Md}=−0.95 E_{Xs}=1.13	E_{Md}=−1.053 E_{Xs}=1.37

Source: Trade Policies & Export Projections Division, Economics Department, IBRD.
Note: Net Importing Region: Western Europe, the United States, and Japan. Non-CIPEC Exporting Region: World (excl. CPEs) minus CIPEC minus Net Importing Region.

Table IX tabulates the implied elasticity of import demand in the Net Importing Region (NIR) and the implied elasticity of exportable supply in the Non-CIPEC Exporting Region (NCP) when various values are assumed for the elasticities of overall supply and demand outside the CIPEC. It clearly shows the links between the elasticities of overall supply and demand outside the CIPEC, on the one hand, and the elasticity of import demand in NIR and the elasticity of exportable supply in NCP, on the other. It is also clear that the elasticities of *import* demand and *exportable* supply are always larger than the corresponding elasticities of overall demand and supply.

The results above indicate that concentrating one's attention on the trade flows of copper does not change the basic picture in any way. Trade flows of copper are, after all, mere reflections of the more fundamental workings of overall supply and demand in various regions of the world.

The conclusions that can be drawn from the preceding analysis are not clear-cut. If in the short run the elasticities of demand and supply outside the CIPEC are (although not very likely) both close to the lower ends of the estimated probable ranges, CIPEC may be able to improve the export earnings from copper by cutting back its supply to the rest of the world. But, on the whole, it does not seem very likely that CIPEC could increase, if at all, its export earnings from copper by a very substantial margin. Furthermore, whether it would be worthwhile for CIPEC to act on the short-run situation depends not only on the possible short-run gains but also on the prospects for longer-run gains, as well as on the short-run financial costs if carrying stocks is involved.

F. *The Long-Run Effects of a Supply Cutback by the CIPEC*

What would be the probable effects of a supply cutback by CIPEC in the long run? Are they likely to be different from those in the short run? In discussing these questions, it will be assumed that the cutback will be rather substantial, say, by 10 per cent. It is also assumed that the cutback will continue for a fairly long period, at least for one year.

The first question that must be answered in considering the long-run effects of a possible cutback of copper supply by CIPEC is: Which of the three concepts of the CIPEC's share in the world supply is the most relevant one in the context of the long run? The short answer to this question is that the most relevant concept seems to be the share of CIPEC in world mine production. The share of CIPEC in the world production of refined copper *including secondary refined copper* is not so relevant as in the case of short run because the supply of scrap *in the long run* depends on past consumption of primary copper [4, p. 210], and can be presumed to be price-inelastic in the long run. The concept of the CIPEC's share in world mine production is preferred to other alternative concepts of the share of CIPEC in world supply, because, in the long run, supply must ultimately come from mine production. Therefore, $m = 0.4$.

It may be recalled that a successful supply cutback by CIPEC requires the absolute value of E_{Dc} to be less than unity. This in turn requires the condition expressed by inequality (3), which is: $|E_{Dw}| < m-(1-m) \cdot E_{Sr}$. Since $m = 0.4$, unless E_{Sr} is less than 0.67, the value of $m-(1-m) \cdot E_{Sr}$ cannot be positive.

Then, the next logical question would be: What is the probable value of E_{Sr} in the long run? First of all, as a general rule, the price elasticity of supply in general is higher in the medium and long run than in the short run. So, the price elasticity of supply in the "rest of the world," namely E_{Sr} in our notation, would be a priori higher in the medium to long run than in the short run. Other things being equal, this works against the CIPEC.

No reliable estimates of the "long-run elasticity of supply in the non-CIPEC world" per se, E_{Sr}, are available. Furthermore, available estimates of the long-run elasticity of supply in various regions of the world tend to differ widely from one study to another, and from one country to another. The estimates made by Newhouse and Sloan are presented in Table V, and the estimates by Banks are shown in Table VI.

The Newhouse-Sloan study reports the long-run elasticity of supply in the United States ranging from 1.0 to 1.3, that in Canada ranging from 2.41 to 3.03, and that in the entire world (excl. CPEs) ranging from 2.47 to 6.18. Banks estimates the long-run elasticity of supply in the United States at 0.71, and that in Canada at 42.24 (!) None of these results should be taken too seriously. But one thing seems to be clear: The long-run elasticity of supply outside the CIPEC is fairly high—at least 0.7 and most probably above 1.0.

Table X shows estimates of a kind of price elasticity of supply in the entire world including CIPEC in various cost ranges as of 1968. The basic data used are taken from Sir Ronald Prain's estimates of the cumulative total productive capacity of the copper mining industry outside the CPEs, which is available at specified cost intervals.[27] The costs reflect the *average* cost of production of individual mines, including cost of delivering to Europe. It is true that, in the short run, what is relevant is the marginal cost schedule of each mine rather than the average cost. In the long run, however, it is the average cost which becomes more relevant. The elasticity of supply seems to vary according to different cost ranges as presented in Table X: It is close to unity within the cost range of 30–35 U.S. cents per pound; less than unity in the cost range of 35–42 U.S. cents per pound; and well above unity in the 45–47.5 U.S. cents per pound range.

TABLE X

PRICE ELASTICITIES OF WORLD SUPPLY OF COPPER IN VARIOUS COST RANGES, 1968

Cost Range U.S. ¢/lb.	% Change in Cost	% Change in Cumulative Total Capacity	Elasticity of Supply[a]
20.0–22.5	12.5	25.2	2.02
22.5–25.0	11.1	10.0	0.99
25.0–27.5	10.0	7.2	0.72
27.5–30.0	9.1	13.0	1.43
30.0–32.5	8.3	8.3	0.99
32.5–35.0	7.7	7.3	0.95
35.0–37.5	7.1	1.8	0.25
37.5–40.0	6.7	4.6	0.69
40.0–42.5	6.5	4.4	0.68
42.5–45.0	5.9	6.4	1.08
45.0–47.5	5.6	12.1	2.17
47.5–50.0	5.3	0	0

Source: Based on Sir Ronald L. Prain's data.

Notes: 1. Average cost of production at each individual mine, including cost of delivering in Europe.

2. CPEs are excluded in this table.

[a] As pointed out in the text, account has been taken only of those mines in operation in 1968. There should be many potential mines in the high cost brackets which would assure higher elasticities than indicated here.

[27] The cost data used refer to the costs in 1968. The inflationary pressures and other factors may have changed the costs subsequently. But, if it can be assumed that the costs have risen more or less proportionately at all mines, the derived elasticities might still be relevant if all the cost ranges were slided slightly upwards.

The estimates presented in Table X have two serious limitations. First of all, the data include only those mines that were in operation in 1968. Since the interest here lies in the possible long-run effects of a "high" price resulting from the CIPEC's hypothetical supply cutback, the relevant concept of supply elasticity should take into account potential mines as well as those already in operation. Second, the data include those mines in CIPEC countries, and therefore, the estimated elasticities refer to the elasticities of supply in the entire world *including the CIPEC*. On the other hand, for the purposes at hand, what is needed is the elasticity of supply *outside the CIPEC*. If the mines in the CIPEC countries are excluded, which cannot be done here unless more detailed data are available, the configuration of the "supply curve" and the price elasticity of supply might turn out to be quite different. Despite such serious limitations as mentioned above, Table X tends to confirm the impression that the long-run elasticity of supply ouside the CIPEC is at least 0.7 in most of the historically relevant price range.

Table XI shows the estimated reserves of copper recoverable in different areas of

TABLE XI

COPPER RESERVES RECOVERABLE AT VARIOUS PRICES

(Millions of metric tons)

	50 ¢/lb.	60 ¢/lb.	70 ¢/lb.	80 ¢/lb.
World (excluding CPEs)	268	301	329	365
Centrally planned economies	42	43	45	48
World (excluding CPEs)	226	258	284	317
CIPEC total	107	122	138	156
Chile	54	62	69	76
Peru	14	19	24	29
Zambia	20	21	23	25
Zaire	19	20	22	25
Non-CIPEC	119	136	146	161
of which, U.S.	73	85	85	90

Source: U.S. Department of the Interior.

the world at various assumed levels of the copper price, based on the estimates made by the U.S. Department of the Interior early in 1970. The quantities of copper which would be recoverable from known resources of the United States and twenty-four other countries were estimated at ten-cent incremental price increases starting from fifty cents per pound. On the basis of these data, price elasticities of supply of a sort[28] can be estimated for various price ranges for different areas. The price elasticities of supply of economic reserves in the non-CIPEC countries thus estimated are (price range in parentheses):

0.72 (50–60 ¢/lb.), 0.41 (60–70 ¢/lb.), and 0.70 (70–80 ¢/lb.).

[28] "Supply" here refers to economically exploitable reserves. This is a stock concept, not a flow concept. Therefore, the elasticity of "supply" in this case is not the elasticity of supply in the usual sense.

The pieces of evidence presented so far give the impression that the long-run elasticity of supply could take quite a divergent range of values depending on the definition of supply and what is meant by the long run. Nevertheless, it seems fairly safe to assume that the long-run elasticity of supply outside the CIPEC today is at least 0.7 and possibly as high as 2.0 or even higher.

Turning to the demand side of the picture, the question is: What is the long-run elasticity of world demand for copper? It is generally believed that the long-run elasticity of demand for copper is significantly higher than its short-run counterpart. One of the factors responsible for this tendency is the role played by investment decisions in substitution of other materials for copper.[29] The situation is illustrated by the following statement:

> Substitution is largely a question of the long term comparative costs of materials that technically can replace copper. The dilemma that the manufacture often finds himself in is that he does not want to scrap his existing investment in copper fabricating facilities but at the same time he knows that he would be correct in doing so if he knew that the price of copper was going to remain at uncompetitive levels in the long term. [9, p. 269]

Available evidence for the plausible magnitude of the long-run elasticity of demand is scanty, and what is available seems to be of uncertain reliability. For instance, the study by Banks shows the estimates ranging from (minus) 0.23 to (minus) 2.51 for the United Kingdom, and the estimate for Germany of (minus) 0.22 (see Table VII). The "best" demand equation in the Charles River Associates study, on the other hand, implies a long-run price elasticity of demand for the United States of (minus) 2.86.[30] It is not justifiable to try to narrow down the likely range of the long-run elasticity of world demand on the basis of such scanty and divergent evidence. On the other hand, it is reasonable to assume that the long-run elasticity of demand is substantially higher than the short-run elasticity, which earlier was found to be around (minus) 0.2.

Table IV shows that when the elasticity of supply outside the CIPEC is higher than 0.5, the critical value of the demand elasticity is less than (minus) 0.10. Since we are fairly certain of the fact that E_{Sr} is higher than 0.7 in the long run and that E_{Dw} is "substantially" higher than (minus) 0.2, it follows that the elasticity of demand for the CIPEC's copper must be considerably higher than (minus) unity. Therefore, the CIPEC countries must lose in the long run if they attempt to jack up the price of copper by cutting back their supply on a long-term basis.

[29] The problem of substitution for copper by other materials is far more complicated than can be dealt with here. For a recent account of this problem, see [4, Chapter 2].

[30] The Charles River Associates study, cited earlier, is a much more carefully executed study than the study by Banks in so far as the estimation of the *long-run* demand elasticity is concerned. Nevertheless, we are somewhat suspicious of the validity of the estimate given by the Charles River study. According to the study, the estimated lag coefficient is such that only 54 per cent of the effects of an assumed change in price today will be felt within ten years. This certainly runs counter to our "common sense," because the result of that study in effect implies that 46 per cent of the full effects of a price change today will come only after 1981!

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