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Abstract

The issue at stake at the Third United Nations Conference on the Law of the Sea was a new international distribution of ocean wealth along the lines of the so-called New International Economic Order. The best example of interventionism on the international mineral markets is the Convention's regime to govern seabed mining.

This paper presents empirical estimates in an attempt to identify net winners and net losers resulting from ocean mining both under the Convention and under open access, and to contrast these outcomes with widely held beliefs concerning the distributional impact of seabed mining. Furthermore, it discusses the desirability and feasibility of loser compensation by the Seabed Authority.

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I. Introduction

The Third United Nations Conference on the Law of the Sea (UNCLOS) will probably be remembered as one of the longest diplomatic battles between DCs and LDCs fought in the twentieth century. The issue at stake was nothing less than a redistribution of ocean wealth, i. e. of future income flows arising from the different uses of the world's marine resources. On the basis of majority voting (one country, one vote), UNCLOS produced a Convention which, should it pass ratification, can be regarded as a major step of the international community towards the so-called New International Economic Order (NIEO).

It is the Convention's régime to govern deep-sea mining that best embodies the NIEO-spirit, apparently on the ground that the "common heritage of mankind" (the polymetallic nodules) should be managed by an international bureaucratic body rather than by market forces, in order to guarantee a "just" distribution of the potential economic rent among the countries of the world. Although it can be hardly denied that the pressure on metal prices resulting from minerals production from the ocean bed could impose an additional burden on some mineral-exporting LDCs already facing serious balance of payments problems, it is not at all clear a priori to whom the potential net gains from deep-sea mining will accrue, nor which of the land-based producers will suffer the highest losses. Furthermore, it is neither obvious whether the creation of another international bureaucracy could assist the world in coping with seabed mining without totally dissipating the mineral rents involved.

This paper intends to give an answer to these questions at a time when an increasing number of countries is pushing for a review of the Convention while others are already pleading for similar régimes to govern future resource utilization in Antarctica and outer space. In the next section direct income effects from seabed mining are identified, the quantitative estimates of which are presented in Section III. The last section deals with the central policy issues in seabed mining: First, whether a redistribution of gains from deep-sea mining is necessary, and second, whether the Seabed Authority could contribute to compensate the losers in case it should be desirable.

II. The Potential Income Effects of Metals Production From the Ocean Bed: Some General Considerations

Additional minerals supply from the ocean bed are expected to have essentially two major direct income effects. One of these is the short-run impact of a supply-curve shift to the right on prices, land-based production and consumption as reflected by changes in the level and distribution of producer and consumer surpluses. The other income effect is the revenue of the Seabed Authority generated by fees and royalties paid by firms receiving mining contracts[1]. Indirect income effects related to deep-sea mining should also be considered, though unfortunately, they are extremely difficult to identify and more difficult still to measure. At any rate, they can be thought of as the effects on other sectors of the economy (including the government) through interindustry linkages, technological externalities (spillover) and the savings resulting from lower strategic inventory holdings by Western DCs. In this paper, however, the analysis will focus on direct effects only[2].

1. The Impact of Seabed Mining on Producer and Consumer Surpluses

Changes in producer and consumer surpluses following the beginning of deep-sea mining can be easily demonstrated applying elementary microeconomic market theory to the minerals markets in question. Unfortunately, the two most important metals to be recovered from manganese nodules, cobalt and nickel, cannot be said to be supplied under competitive conditions [Rafati, a; b]. However, if several international consortia bring their seabed mining operations onstream simultaneously, the cobalt and nickel markets will automatically become more competitive. In fact, the threat alone that they could start production any time should already have a considerable impact on the dominant land-based producer, considering the long-term decisions typically taken in this industry.

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[1] For simplicity, it is assumed that the "Enterprise", the Authority's arm envisaged to actively engage in seabed mining, will not operate during the period studied.

[2] For an attempt to quantify some of the indirect income effects of deep-sea mining see Dick [1982].

Figure 1 shows the long-term supply and demand curves, for example, on the world manganese market. The market is in equilibrium at the outset if the land-based producers sell the quantity q_0 for the price p_0. The additional supply from the ocean bed shifts the supply curve SS' to the right into the position S*S*'. Now the price falls to p_1, Op_1 being the cost of seabed mining, and the quantity supplied by land-based producers is reduced from q_0 to q_L; the amount $q_0 - q_L$ is being replaced by cheaper manganese from deep-sea mining. Total manganese production from the ocean bed amounts to $q_1 - q_L$. The resulting gain in consumers' surplus is represented by the area $p_0p_1$da and the loss in producers' surplus by $p_0p_1$ba; the difference between these two areas, the triangle bda, is the net gain accruing to market participants[1]. Such an outcome, however, heavily depends on the cost of seabed mining, which is very unlikely to be so much lower than the cost of land-based production, at least for the first generation of deep-sea mining operations [Dick, 1981]. For if, irrespective of long-run profitability considerations, first-generation costs are higher than the new equilibrium price p_1 in Figure 1, deep-sea miners will have to bear a self-induced loss. On the other hand, if first-generation costs are lower than p_1, deep-sea miners will enjoy a gain in producer surplus.

Similarly, the changes in consumer and producer surpluses can be determined for cobalt, copper and nickel[2]. Alternatively, Figure 1 can be interpreted as representing the aggregated supply and demand curves for all four metals [Wijkman, 1981]. Further, it might also be of interest to focus on the trade effects of seabed mining for a particular country [Tilton, 1983]. The results derived above, however, can be readily carried over to any of the alternative approaches.

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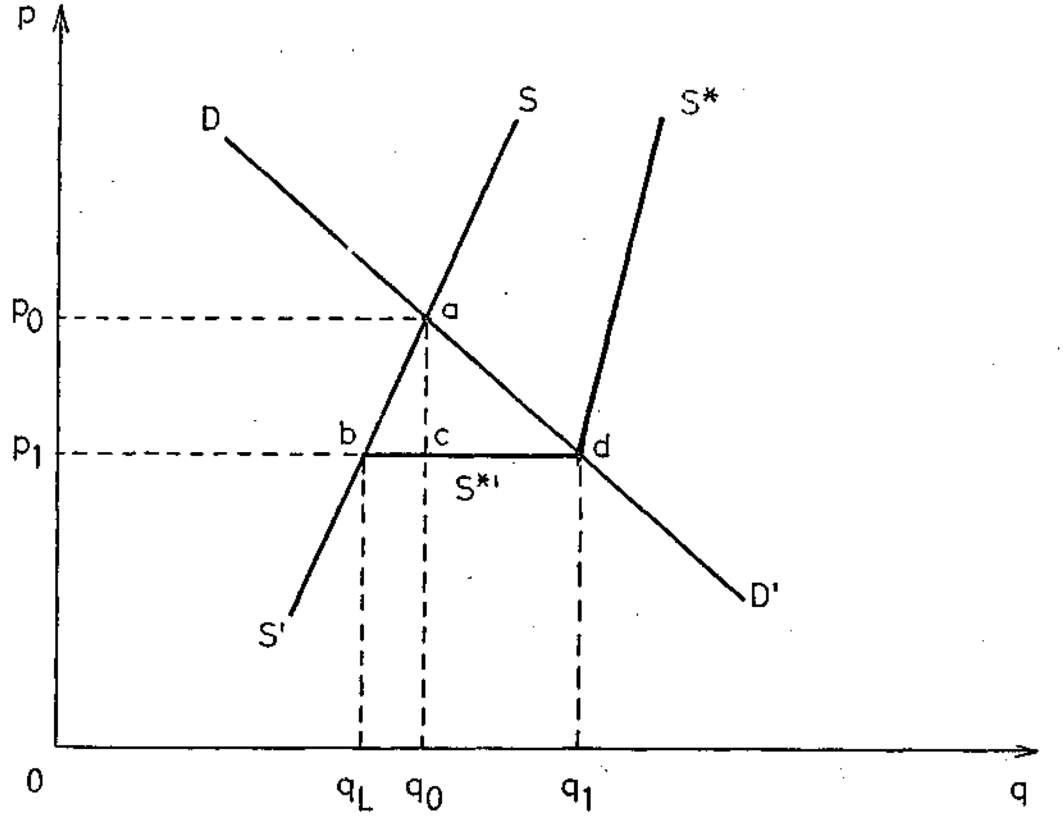
1 It should be noted that most of the land-based producers of manganese are at the same time consumers and that countries active in seabed mining also play on both sides of the market.

2 Only one point should be borne in mind when analyzing the cobalt and nickel markets. The transition from monopolistic competition prevailing on both markets to a more competitive situation implies a reduction of monopoly benefits accruing to the dominant land-based producers. In fact the bulk of producer surplus on the cobalt and nickel markets arises from monopoly. There is, thus, a qualitative distinction to be drawn between losses of producer surplus in competitive and in uncompetitive markets.

Figure 1 - Hypothetical Demand and Supply Curves on the World Manganese Market



2. Economic Rents and International Common Property Resources

The above analysis showed the simple economics of deep-sea mining when only direct effects are taken into account. For certain purposes, though, it could be convenient to discriminate between the producer and the resource owner. The reason for this is that they each expect a different kind of income from mining. Mining firms will try to make a profit on their production, whereas the resource owner will try to capture a part of the potential economic rent associated with a particular mining site. While the ownership issue seems straightforward on a country level, where usually the government is the legal proprietor, international common property resources like manganese nodules lying on the ocean bed beyond national jurisdiction have been declared by the Convention to constitute the "common heritage of mankind", whatever it means.

Traditionally, ocean resources have been simultaneously considered to be res nullius, res communes and res publicae [Clarkson, 1974], i. e. owned by no one, by everyone and by the nation states. Under such a régime of open access ocean resources were used on a first-come, first-served basis. This rule obviously works efficiently as long as the resources are so plentiful that congestion does not occur. With increasing scarcity, resource management becomes necessary, the optimal degree of control depending on whether the resource in question is of the renewable or non-renewable kind and divisible or not. Contrary to fisheries, manganese nodules can be efficiently utilized if exclusive, universal and transferable property rights are assigned to interested firms endowed with appropriate technology and risk capital, because they could be enforced on a relatively low-cost basis[1]. With such a slightly restricted access, firms holding property rights on resources located beyond national jurisdiction do not share economic rent with any state, the only exception being the country of registration which might feel entitled to tax away at least some part of the mineral rent[2].

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1 An optimal regime to manage seabed mining under a restricted access also implies further legal-institutional features which are discussed in Foders [1984]. Here we concentrate only on the ownership aspect of such a regime.

2 The debate in the literature on whether or not nation states are entitled to tax income arising from commercial activities carried out beyond national jurisdiction still goes on. On this see Delespaul [1982].

Fearing that only a minor group of DCs would benefit from seabed mining, thereby fundamentally changing the world pattern of minerals production and trade, some UNCLOS participants succeeded in incorporating the creation of an International Seabed Authority with ownership over the "common heritage of mankind" into the Convention[1]. Whatever the rationale for these fears and the remedy suggested for them, this means that if the Convention should pass ratification and, thus, someday become effective as international law, deep-sea mining is expected to generate a direct rent income for the Seabed Authority. This will probably be the case, to the extent that both the fiscal burden on the interested firms and the additional conditions stipulated in the contracts[2] do not work as a disincentive for mining operations under the Convention's regime[3]. The Authority's budget will albeit not only include revenue from firms holding seabed mining contracts but also funds from other sources, as determined by Article 171 [UN, 1982, a]. Besides covering the administrative expenses of such an organization, these funds are supposed to be used to compensate developing countries for potential reductions in export earnings caused by market reactions to seabed mining [UN, 1982, a, Art 173, § 2 (c)]. Thus, the Seabed Authority has been devised to redistribute gains and losses resulting from the recovery of manganese nodules among countries active in seabed mining and land-based producers of the affected metals.

III. The World Distribution of Gains and Losses From Deep-Sea Mining: Some Estimates

The empirical assessment of changes in producer and consumer surpluses following seabed mining calls for the estimation of long run sup-

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1 "All rights in the resources of the Area are vested in mankind as a whole, on whose behalf the Authority shall act." [UN, 1982, a, Art. 137, § 2].

2 The impact of royalties and other payments on the firm's investment and production behaviour is analyzed in Foders [1984, b]. One of the regulations included in the Convention expected to substantially obstruct firm participation is the compulsory technology transfer regime. On this see Dick and Gutberlet [1983].

3 It is, of course, always possible that some countries decide to mine the ocean bed on the basis of softer terms resulting from bilateral or multilateral agreements, ignoring the Convention. On institutional choice in this context see Foders [1984, c].

ply and demand curves on the metal markets in question. The available data base, though, precludes such estimates on a world scale and even for the most important producer and consumer countries[1]. Alternatively, changes in production and consumption value can be used as a rough but nevertheless meaningful indicator of the level and distribution of gains and losses associated with ocean mining. Estimation of losses in production value instead of producer surplus has the advantage of approximating the potential shortfalls in export earnings of LDCs which, in turn, could be used to discuss the viability of loser compensation by the Seabed Authority.

In this study changes in production and consumption value are computed on the basis of simulation results for cobalt, copper, manganese and nickel presented elsewhere[2]. For this purpose, it is assumed that five private international consortia [UN, 1982, b] have been assigned fictitious contracts by the Seabed Authority as of January, 1985. Commercial production is hypothesized to begin 1988, i. e. three years later. Although it can be expected, that these contracts will have a life of at least 20 - 25 years, simulation results for years after 1995 have been considered to be extremely unreliable. The latter follows from the fact that the econometric models used in the simulations do not endogenize seabed mining. The beginning of ocean mining will probably exert some influence on the world pattern of minerals production and trade, particularly on supply elasticities, and structural simulation models, thus, cannot be expected to adequately catch the full impacts. On the other hand, this is the best one can do at this stage, since one could hardly estimate such structural changes from historical data today without making heroic assumptions. Therefore, it was convenient to confine the analysis to the first eight years of metals production from the ocean bed.

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1 "Econometric studies at best provide a reliable picture of the nature of these curves and the elasticities around the range of prices and outputs that have actually occured in the past" [Tilton, 1983, p. 23].

2 See Foders and Kim [1983], Rafati [1982, a, b,] and Wagenhals [1983]. The simulated prices and quantities of seabed minerals used to calculate production and consumption values and their changes are included in Appendix B.

1. The Seabed Authority's Revenue From Seabed Mining Contracts

The financial terms of the contracts to be assigned by the Seabed Authority are included in Article 13 in Annex III to the Convention [UN, 1982, a]. Firms operating under one of these contracts are expected to pay (a) an application fee of US-$ 500 000,-- and (b) an annual fixed fee of US-$ 1 million or a production charge, whichever is greater.

Further, the contractor is free to choose between a production charge only (= royalty) and a combination of production charge and a share of net proceeds. For data reasons, in this study we shall assume that the five consortia each signed a contract stipulating the payments of royalties only. Moreover, Article 13 sets the royalty at 5 percent of the production value in the years 1 to 10 and at 12 percent from the eleventh year onwards, till the end of the production period.

Based on the amounts of cobalt, copper, manganese and nickel recovered from seabed mining assumed in the said simulation runs, Table 1 shows the total estimated value of mineral output from the ocean bed, together with the resulting royalties. Although in some simulations more than two scenarios were considered, here we just focus on the "low" and the "high" scenarios[1]. In Table 2 the total revenue of the Seabed Authority is presented, including the application fees and the annual fixed fees to be paid from 1985 to 1987, i. e. till the beginning of commercial production in 1988. Thus, in the period under analysis, the Authority's income amounts to about 6 percent of the total value of output in the low case and to 5.86 percent in the high case. If output were restricted to the low case, the revenue per contract would be only 61.3 percent of the one that could be achieved in the high case.

The relevant issues about the Authority's revenue are (a) whether it has any important impact on the level and distribution of net gains (losses) from seabed mining and (b) whether it could be used to compensate the losers. Both topics will be discussed in the next sections.

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1 The high scenario is reported (a) to contrast the outcome under the Convention, i. e. with production ceilings, with a situation where no restrictions are imposed and (b) to analyze the sensitivity of the distributional impact of seabed mining with respect to the level of seabed production. It is, however, unlikely that such a high case should materialize under the Convention.

Table 1 - Projected Royalty Income of the Seabed Authority From Deep-Sea Mining Contracts 1988 - 1995, (millions of 1981 US-$)

Year	Value of Output from Deep-Sea Mining				The Authority's Royalty Revenue from Deep-Sea Mining			
	Current Value		Discounted Value[b]		Current Value		Discounted Value[b]	
	Low	High	Low	High	Low	High	Low	High
1988	930.7	1664.3	846.1	1513.0	46.5	83.2	42.3	75.6
1989	989.0	1637.8	817.4	1353.6	49.5	81.9	40.9	67.7
1990	1030.1	1706.8	773.9	1282.3	51.5	85.3	38.7	64.1
1991	1043.0	1713.0	712.4	1170.1	52.2	85.7	35.7	58.5
1992	1059.6	1752.5	657.7	1087.8	53.0	87.6	32.9	54.4
1993	1115.4	1800.5	629.5	1016.1	55.8	90.0	31.5	50.8
1994	1098.6	1834.6	563.7	941.3	54.9	91.7	28.2	47.0
1995	1100.0	1825.5	513.1	851.5	132.0	219.1	61.6	102.2
Total	8366.4	13935.0	5513.8	9215.7	495.4	824.5	311.8	520.3

[a] For 1988 - 1994 (years 4 to 10) the royalty is 5 % of the production value, whereas for 1995 (the eleventh year) it increases to 12 %.

[b] Discount rate: 10 %; base year: 1988.

<u>Source</u>: Own calculations.

Table 2 - Projected Total Seabed Authority Revenue From Deep-Sea Mining Contracts, 1985 - 1995, (millions of 1981 US-$)

	Current value		Discounted or compounded value[a]	
	Low	High	Low	High
Application fee 1985	2.5		3.3	
Fixed fee 1985	5.0		6.1	
Fixed fee 1986	5.0		5.5	
Fixed fee 1987	5.0		5.0	
Royalties 1988 - 1995	495.0	824.5	311.8	520.3
Total revenue	512.5	842.0	331.7	540.2
Revenue per contract	102.5	168.4	66.3	108.1

[a] Rate: 10 %; base year: 1988; commercial production is assumed to begin 1988, three years after the assignment of fictitious contracts to five international consortia.

Source: Own calculations.

Table 3 - Projected Decrease in Consumption Value in Major Consumer Countries[a] (millions of 1981 US-$)

Metal / Country/Region	Cobalt[b]		Copper		Manganese[d]		Nickel	
	Low	High	Low	High	Low	High	Low	High
COMECON	486.6	560.9	1.3	4.3	114.8	275.2	862.3	2014.0
Japan[c]	951.4	1102.7	0.7	2.2	34.5	82.9	631.1	1473.0
United States	1453.3	1645.2	1.2	3.7	.	.	181.9	373.6
Western Europe	1072.8	1243.5	1.8	5.5	64.0	154.6	753.6	980.3

[a] Compared to base case; discounted value; discount rate: 10 %; base year: 1988.

[b] Apparent consumption (production + imports - exports).

[c] Japan's cobalt consumption is included in the value estimated for Western Europe's in our simulation calculations. In order to assess the potential gains in consumption value for Japan a share of 13 % in world cobalt consumption was assumed for this country.

[d] Imports; US imports of manganese ore can be neglected. In this study they are assumed to cease at the latest by 1990.

<u>Source</u>: Own calculations.

2. Net Gains From Deep-Sea Mining for Major Producers and Consumers

Before discussing the world distribution of net gains (losses) associated with seabed mining, it might be useful to take a glance at the level and distribution of absolute decreases in both consumption value (= gains) and production value (= losses) for major consumer and producer countries[1].

The major consumers of seabed minerals can be identified as Japan, the US, Western Europe[2] and the COMECON-countries. Each of these countries or regions holds a share between 20 and 30 percent of the total decrease in consumption value enjoyed by them (Table 3). Although the overall absolute gain appears to be almost equally distributed, the consumption structure differs from country (region) to country (region). The US extracts most of her gains from cobalt and the COMECON-countries from nickel, while Japan and Western Europe equally benefit from both cobalt and nickel. Manganese accounts for a share between 2.1 and 7.8 percent in the low case and between 3.1 and 9.6 percent in the high case; the contribution of copper is only marginal.

The predominance of cobalt and nickel on the demand side carries over to the supply side too. It becomes clear from the decreases in production value shown in Table 4 that the lowest value reductions will be borne by the copper-producing countries (Chile, Peru and the Philippines). Zaire, Canada, Australia[3] and the COMECON-countries are the great losers with a share of 41.2 (28.0), 20.2 (28.3), 10.7 (12.8) and 18.7 (21.8) percent, respectively[4], in the total value decrease suffered by the major mineral producers included in Table 4. The rest of the losses will be due to lower values of minerals production in the US (2.0 percent in both scenarios) and in Zambia (3.8 percent in the low case

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[1] Decreases in value are computed as difference between the base case value (without seabed mining) and the values resulting from the low and high scenarios of seabed mining. These differences are then discounted with a rate of 10 percent to the year 1988 (beginning of production) and cumulated to calculate their present value in constant 1981 US-$.

[2] Belgium, France, Germany (F. R. of), Italy, Netherlands, and the United Kingdom.

[3] Including New Caledonia.

[4] The shares in parenthesis belong to the high seabed mining scenario.

Table 4 - Projected Decrease in Value of Land-Based Production of Major Producer Countries[a] (millions of 1981 US-$)

Metal / Country/Region	Cobalt		Copper[b]		Manganese		Nickel		Total	
	Low	High	Low	High	Low	High	Low	High	Low	High
Australia	205.6	237.7	.	.	38.4	88.8	.	.	244.0	326.5
Canada	.	.	0.9	2.9	.	.	1685.5	3982.3	1686.4	3985.2
Chile	.	.	0.8	2.5	.	.	.	.	0.8	2.5
COMECON	486.6	560.9	1.1	3.3	114.8	275.2	956.9	2238.2	1559.4	3077.9
New Caledonia	.	.	.	.	.	.	651.2	1484.5	651.2	1484.5
Peru	.	.	0.4	1.2	.	.	.	.	0.4	1.2
Philippines	.	.	0.4	1.3	.	.	.	.	0.4	1.3
South Africa	.	.	0.2	0.6	58.2	186.3	206.6	423.2	265.0	610.1
Zaire	3440.7	3941.4	0.3	0.9	.	.	.	.	3441.0	3942.3
Zambia	307.5	352.5	0.4	1.2	.	.	.	.	307.9	353.7
United States	.	.	0.9	2.9	.	.	155.0	275.9	155.9	278.8

[a] Compared to base case; discounted value; discount rate: 10 %; base year: 1988.
[b] Primary production only.

Source: Own calculations.

Table 5 - Projected Self-Induced Decrease in Production Value of First-Generation Deep-Sea Mining Output[a] (millions of 1981 US-$)

Country/Region \ Metal	Cobalt Low	Cobalt High	Copper Low	Copper High	Manganese Low	Manganese High	Nickel Low	Nickel High	Total Low	Total High
Canada	127.2	227.0	.[c]	.	2.9	20.7	25.2	109.3	155.3	357.0
Japan	127.2	227.0	.	.	2.9	20.7	25.2	109.3	155.3	357.0
United States	593.7	1059.4	.	.	13.5	96.4	117.8	510.0	725.0	1665.8
Western Europe[b]	848.1	1513.5	.	.	6.8	137.8	168.3	728.5	1035.7	2379.7
Total	1696.2	3026.9	.	.	38.5	275.5	336.6	1457.0	2071.3	4759.4

[a] Compared to base case prices; discount rate: 10 %; base year: 1988.
[b] Belgium, France, Germany (F. R. of), Italy, Netherlands, United Kingdom.
[c] Decrease in value is either zero or neglectable.

Source: Own Calculations.

and 2.6 percent in the high case). In sum, the major land-based producers of cobalt and nickel show the highest losses.

First-generation recovery of metals from manganese nodules could, though, not only exert pressure on land-based producers of these metals but also on the seabed miners themselves, to extent that production costs should result higher than the new equilibrium price p_1 in Figure 1 during the first eight years, irrespective of long-run profit expectations. Production of seabed minerals can be attributed to four countries or regions, considering the shares of the firms registered in these countries (regions) in the five international consortia assumed to be active in deep-sea mining (Appendix A). Table 5 shows the corresponding distribution of production value losses by country and metal[1]. According to the composition of the said consortia in the year 1982, firms based in Western Europe will be responsible for half of the production value generated by seabed mining. Thus, this region will have to bear the major losses, together with the US, whose share is about 35 percent; Canada and Japan hold a share of only 7.5 percent each. In contrast to the losses of the land-based metal producers, which may be attributed to both cobalt and nickel production, the value losses suffered by seabed miners are due mainly to cobalt production alone. Two conclusions can be drawn from this. First, the cobalt market is the worst hit by deep-sea mining, and second, that future joint production of metals from the ocean bed might thus be restricted not by developments on the world nickel market, as is widely believed[2], but rather by conditions prevailing on the cobalt market.

How will the distribution of absolute gains and losses influence the distribution of net gains? Net gains from seabed mining, presented in Table 7a for the low-cost scenario (costs equal to p_1 in Figure 1), were calculated as decrease in consumption value minus decrease in value of

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1 For the computation of such self-induced losses in the high-cost scenario it is assumed that the costs of seabed mining are constant and equal to P_0 in Figure 1.

2 Production ceilings set in the Convention, for example, are expressed in terms of nickel production [UN, 1982, a, Art. 151, § 4] and not of cobalt production. Under conditions of joint production, the failure to incorporate the cobalt market could have serious consequences.

Table 6 - Projected Payments to the Seabed Authority by Countries (millions of 1981 US-$)

Country/Region \ Payments[a]	Royalties		Fees[b]	Total	
	Low	High		Low	High
Canada	23.39	39.00	1.49	24.90	40.50
Japan	23.39	39.00	1.49	24.90	40.50
United States	109.10	182.10	6.96	116.10	189.10
Western Europe	155.90	260.20	9.94	165.80	270.10
Total	311.80	520.30	19.88	331.70	540.20

[a] Discounted value of payments due from 1985 to 1995; rate: 10 %; base year: 1988.
[b] Application and annual fixed fees.

Source: Own Calculations.

Table 7a - Projected World Distribution of Net Gains (+) and Losses (-) from Deep-Sea Mining Under Open Access and Under the Convention (Cost Scenario I[a]) (millions of 1981 US-$)

Metal	Cobalt		Copper[b]		Manganese		Nickel		Total Under Open Access		Total Under the Convention[d]	
Country/ Region	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Developed Countries												
Australia[c]	-205.6	-237.7	-	-	-38.4	-88.8	-651.2	-1484.5	-895.2	-1811.0	-	-
Canada	0	0	-0.9	-2.9	0	0	-1685.5	-3982.3	-1686.4	-3985.2	-1711.3	-4025.7
Japan	951.4	1102.7	0.6	1.9	34.5	82.9	631.2	1473.0	1617.7	2660.5	1592.8	2620.0
South Africa	-	-	-0.2	-0.6	-58.2	-186.3	-206.6	-423.2	-265.0	-610.1	-	-
United States	1453.3	1645.2	0.4	-0.7	0	0	26.9	97.7	1480.6	1742.2	1364.5	1553.1
Western Europe	1072.8	1243.5	1.4	4.2	64.0	154.6	753.6	980.3	1904.3	2382.5	1738.5	2112.4
Comecon	0	0	0.2	0.7	0	0	-94.6	-224.2	-94.4	-223.5	-	-
Developing Countries												
Zaire	-3440.7	-3941.4	-0.3	-0.9	-	-	-	-	-3441.0	-3942.3	-	-
Zambia	-307.5	-352.5	-0.4	-1.2	-	-	-	-	-307.9	-353.7	-	-

[a] First-generation costs of seabed mining are assumed to be constant and equal to the new equilibrium price.
[b] Including secondary production.
[c] Including New Caledonia.
[d] Including payments to the Seabed Authrority.

Source: Own calculations.

Table 7b - Projected World Distribution of Net Gains (+) and Losses (-) from Deep-Sea Mining Under Open Access and Under the Convention (Cost Scenario II[a]) (millions of 1981 US-$)

Metal	Cobalt		Copper[b]		Manganese		Nickel		Total			
									Under Open Access		Under the Convention[d]	
Country/ Region	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
<u>Developed Countries</u>												
Australia[c]	-205.6	-237.7	-	-	-38.4	-88.8	-651.2	-1484.5	-895.2	-1811.0	-	-
Canada	-127.2	-227.0	-0.9	-2.9	-2.9	-20.7	-1710.7	-4091.6	-1841.7	-4342.2	-1866.6	-4382.7
Japan	824.2	875.7	0.6	1.9	31.6	62.2	606.0	1363.7	1462.4	2303.5	1437.5	2263.0
South Africa	-	-	-0.2	-0.6	-58.2	-186.3	-206.6	-423.2	-265.0	-610.1	-	-
United States	859.6	585.8	0.4	-0.7	-13.5	-96.4	-90.9	-412.3	755.6	76.4	639.5	-112.7
Western Europe	224.7	-270.0	1.4	4.2	57.2	16.8	585.3	251.8	868.6	2.8	702.8	-267.3
Comecon	0	0	0.2	0.7	0	0	-94.6	-224.2	-94.4	-223.5	-	-
<u>Developing Countries</u>												
Zaire	-3440.7	-3941.4	-0.3	-0.9	-	-	-	-	-3441.0	-3942.3	-	-
Zambia	-307.5	-352.5	-0.4	-1.2	-	-	-	-	-307.9	-353.7	-	-

[a] First-generation costs of seabed mining are assumed to be constant and equal to base case equilibrium price.
[b] Including secondary production.
[c] Including New Caledonia.
[d] Including payments to the Seabed Authrority.

<u>Source</u>: Own calculations.

land-based production. Net gains presented in Table 7b correspond to the high-cost scenario (costs equal to p_0 in Figure 1) and include the decrease in value of seabed production. For the scenario under the Convention, the payments to the Seabed Authority (Table 6) were also taken into account. The assumption of relatively low deep-sea mining costs results in net gains for Japan, the United States and Western Europe in all output and institutional scenarios studied (Table 7a). The United States is shown to enjoy the highest share in total net gains in the low-output case under both institutional settings, whereas the highest share corresponding to the high-output cases is achieved by Japan. Differences in net gains due to output level variation (measured as a percentage of low-output net gains) amount to 64 % for Japan, 25 % for Western Europe and 18 % for the United States under the open access regime. Payments to the Seabed Authority reduce such differences for both the United States and Western Europe by almost 3 percentage points. Moreover, payments under the Convention also depress the level of net gains by about 2 % for Japan in both output scenarios and by 8 % (low-output case) and 11 % (high-output case) for the United States and Western Europe.

In contrast, under the high-cost assumption (Table 7b), Japan turns out to be the only net winner in every scenario, holding a share of 47.4 percent in total net gains estimated for the low seabed mining case and one of 96.8 percent in the high case, excluding payments to the Authority. If fees and royalties paid to the Authority are considered, Japan's share in net gains is 51.7 percent and 100 percent in the low and high cases, respectively. Western Europe and the US are the other two net winners, with the exception of the high scenario including payments to the Seabed Autority, where both countries suffer net losses. Interestingly, the US presents net losses for manganese and nickel in all cases and for copper in the high case only, the source of her gains being cobalt. In contrast, the only net loss registered for Western Europe is due to the high cobalt scenario.

Canada and Zaire have to bear the heaviest losses in net terms, with the former country losing on copper and nickel in the low-cost case and on every metal in the high-cost case, and the latter country losing on cobalt and copper. Australia (including New Caledonia) also suffers substantial losses from cobalt, manganese and nickel. Minor losers are South Africa, Zambia and the COMECON-countries.

IV. Redistributing Income From Deep-Sea Mining

The beginning of seabed mining is expected to change the existing international pattern of mining activity, inducing a reallocation of capital and labour away from inefficient onshore mining sites and, thus, a redistribution of income arising from this industry. The regime to govern seabed mining included in the Convention on the Law of the Sea has been apparently devised to obstruct such potential shifts in income distribution brought about by market forces reacting to cheaper minerals supply from the ocean bed. Besides erecting barriers to entry to ocean mining and allowing for production ceilings, the Convention provides for compensatory payments to land-based producers "which suffer serious adverse effects on their export earnings or economies resulting from a reduction in the price of an affected mineral or in the volume of exports of that mineral" [UN, 1982, (a), Art. 151, § 10].

On the basis of the empirical results presented in Chapter III, where the level and distribution of losses in production value incurred by traditional mineral-exporting countries were analyzed, the next sections will discuss the desirability and the feasibility of compensatory payments, drawing on international experience with the IMF's Compensatory Finance Facility scheme and the EEC's STABEX system.

1. Compensatory Payments to Mineral-Exporting LDCs

The simple microeconomics of Figure 1 clearly show the effects of a supply shock on prices and quantities of the minerals in question. In the short run, at least, mineral prices are bound to fall subject to the relevant elasticities. In the long run, however, adjustments on both sides of the market could possibly quite well absorb the additional supply of metals from the ocean bed, assuming seabed mining should in fact turn out to be competitive, and contribute to a recovery of prices. Since we are dealing with natural resources, increasing scarcity should, following the Hotelling-rule, make such an outcome plausible. What does this mean for mineral-exporting LDCs?

In the short term, lower metal prices could have both a direct demand-effect and a substitution-effect in favour of cheaper metals. Although mineral exports should only slowly return to the levels recorded before the supply shock, lower prices could have the advantage of being more stable than higher ones, allowing for a stabilization of export earnings. Of course, lower prices usually render those mining ventures unprofitable which are run by firms that fail to improve efficiency and to hold down costs accordingly. In many cases, mines would have to be closed, at least until the market offers new profitable opportunities. The capital and labour released should be efficently used for other mineral projects or for projects in other sectors of the economy, as far as they are non-specific factors.

The availability of compensatory payments to mineral-exporting LDCs as stipulated in the Convention would undoubtedly interfere with the process of optimal allocation of factors of production in these countries by smoothing out the impact of lower metal prices and/or lower quantities exported, independently of who receives the subsidies, the firms themselves or the government. Land-based producers are isolated from market signals, and worse still, efficient and inefficient miners are given equal treatment. In spite of the fact that the most efficient land-based producers will have to bear the greatest losses from the impact of ocean minerals, their past performance indicates that it is not certain a priori whether or not they can successfully meet the challenge from the sea. Therefore, compensatory payments are also likely to obstruct internal adjustment of efficient firms engaged in onshore mining.

To the extent that marketing boards and similar institutions in LDCs already isolate domestic producers from the world markets, reductions in export earnings due to deep-sea mining could have macroeconomic effects in the sense that a country's total foreign exchange revenue could fall short of the expected level and consequently diminish its import capacity. Normally, lower export proceeds would induce such institutions to refrain from less profitable "development projects" originally planned under the assumption of higher foreign exchange availability. Compensatory payments to these countries would obviously create an automatical supply of foreign exchange loans to finance projects, the profitability and viability of which is unknown to the creditor[1]. Thus, optimal allocation of financial resources in this context seems to be a matter of chance, especially considering that neither the past financial record nor the potential future exports of these countries could influence eligibility for receiving compensatory payments.

The above arguments against compensatory finance to developing countries which are exporters of minerals affected by seabed mining are fully supported by the available evidence on the performance of similar schemes offered by the EEC and the IMF to stabilize exports of both mineral and non-mineral commodities from LDCs[2]. Interestingly, the EEC's compensatory payment system for minerals, Minex, which has so far already generated transfers to Zambia and Zaire, also includes cobalt, copper and manganese, i. e. three of the four seabed minerals[3]. Under this system, Zambia received 55 million European Currency Units and Zaire 40 million [Kibola, 1984, p. 45]. The financial terms were as follows: 1 percent interest to be repaid over 40 years with a grace period of 10 years, at a time when international interest rates were at record levels (1983). These figures speak for themselves.

2. The Role of the Seabed Authority in International Income Redistribution

At any rate, it should be useful to compute the costs of compensatory payments for the hypothetical situation presented in this study. The sum of the value losses incurred by the major mineral-exporting LDCs[4]

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[1] In fact these funds could be arbitrarily used by the debtor countries.

[2] See, for example, Cuddy [1979] for a comparative evaluation of the EEC's Stabex and the IMF's Compensatory Finance Facility schemes. Experience with Stabex is reported by Kibola [1984]; Faber [1984] offers a thorough economic analysis of the Stabex system.

[3] One could, therefore, argue that these existing schemes could suffice to deal with unstable export earnings, since it should be very difficult to discriminate between shortfalls due to seabed mining and those due to other causes.

[4] Chile, Peru, Philippines, Zaire and Zambia. The losses computed for these countries pertain to their production value. Since domestic consumption is neglectable, it is plausible to assume that total production is being exported. For simplicity, inventories are assumed to be zero.

included in Table 4 amount to 3.8 billion US-$ in the low scenario and to 4.3 billion US-$ in the high scenario; about 91 percent of these losses are borne by Zaire alone. Confronting these figures with the Seabed Authority's revenue in the same period (Table 2) leads to the conclusion that the latter would only cover 8.8 percent of the losses in the low scenario and 12.5 percent in the high case[1], in the event that full compensation should be desired. Thus, at least 85 percent of the funds needed for compensatory payments would have to come from other sources, if the financial terms of the seabed mining contracts remain unchanged. Alternatively, the Seabed Authority could consider a revision of, say, the royalty charged. In the situation under study the royalty would have to amount to 54 percent of production value in the high scenario and to 90 percent in the low case, if the target revenue is to be set at 5 billion US-$ in order to meet the losses quoted above. Such royalties would, however, probably render deep-sea mining unprofitable. None of the countries included in Table 7 and making net gains under the terms stipulated in the Convention could do so with increased royalties. From this can be inferred that the Authority would be obliged to receive loans from other international organizations to fully compensate the losers, i. e. the Authority would have to be run virtually like an international financial institution, very much like the IMF.

Compensatory finance schemes for losers from deep-sea mining are not only inefficient, too costly and associated with undesirable distributive effects, but also uneconomic on other grounds. The market potentially worst hit by seabed mining is the cobalt market; about 90 percent of the losses due to ocean mining suffered by LDCs are incurred by Zaire, the dominant cobalt producer. Thus, compensatory payments to Zaire could turn out to protect or subsidize the monopoly benefit enjoyed by the price setter on this uncompetitive market. Could it be reasonable to subsidize monopolies with royalty revenues and/or loans from an Authority designed to manage the "common heritage of mankind"?

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[1] The administrative costs of operating the Authority are not included in these figures.

V. Conclusions

This paper is an attempt to quantitatively and qualitatively assess direct short-run income effects of ocean mining under the assumption that manganese nodules are recovered under the regime included in the Convention on the Law of the Sea. Subject to the limitations of the analysis, widely held beliefs concerning the distributional impact of deep-sea mining have been shown to be entirely groundless.

First, it can not be maintained that the LDCs are going to be the big losers. There will be, though, also a few LDCs among the losers. Canada and Zaire have been identified as the land-based producers who will have to suffer the highest reductions in production values. The great majority of the losers are industrialized countries.

Second, Japan, the United States and Wester Europe will be able to enjoy net gains of seabed mining over the different scenarios studied, if first-generation costs of seabed mining are in line with lower metal prices prevailing after the supply shock.

Third, the fees and royalties to be paid to the Seabed Authority will not be neutral; they can significantly influence the pattern of gains and losses.

Fourth, compensatory payments to LDCs bearing losses from seabed mining result in an inefficient allocation of resources. This is suggested by available international evidence on the IMF's and the EEC's compensatory finance schemes.

Fifth, under the financial terms stipulated in the Convention, the potential revenue of the Seabed Authority could at most be used to finance about 12 percent of the losses incurred by LDCs. The rest would have to be provided through higher royalties and/or loans from other institutions. Higher royalties could, however, render ocean mining unprofitable, and loans could be too costly.

Sixth, 90 percent of LDCs' losses from seabed mining will be suffered by Zaire, the dominant cobalt producer and price setter on the world market. Any kind of compensation payments to this country would subsidize the monopoly benefits enjoyed by Zaire with funds belonging to the international community.

Finally, one could turn around the main argument set out in this paper, and ask what would happen, if seabed mining does not occur at all in spite of the ratification of the Convention by the required number of countries, due either to zero production ceilings set by the Authority or to general abstention. In this case, the estimated losses turn out to be gains in the sense of "saved" losses and, similarly, the estimated gains could be interpreted as losses in the sense of foregone gains. The former would accrue to the land-based producers and the latter would be suffered by the major consumer countries. Because such an outcome could be directly associated with protection of land-based mineral producers by barriers to entry, production ceilings and other obstacles to a profitable seabed mining stipulated in the Convention, the said gains would essentially be monopoly benefits from cartelization backed by international law.

On the other hand, such a hypothetical pattern of income effects could be successfully impeded if countries interested in manganese nodules yet opposing the Convention were to recover them ignoring the Convention. Then the expected international distribution of gains and losses would again be very much like the one presented in this paper for the scenario under open access.

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Appendix A

Country of Origin and Shares of Firms Participating in International Seabed-Mining Consortia[a], 1982

Country/Region	Share (%)	Consortium
Canada	25	Ocean Management Inc.
	12	Kennecott
Japan	25	Ocean Management Inc.
	12	Kennecott
United States	61.4	Ocean Minerals Co.
	50	Ocean Mining Associates
	40	Kennecott
	25	Ocean Management Inc.
Western Europe[b]	50	Ocean Mining Associates
	38.6	Ocean Minerals Co.
	36	Kennecott
	25	Ocean Management Inc.

[a] Excluding the Japanese Consortium DOMA as well as state-owned enterprises from China, India and the USSR.

[b] Belgium, France, Germany (F. R. of), Italy, Netherlands, United Kingdom.

Source: UN [b, 1982].

Appendix B

Table B 1 - Hypothetical Scenarios of Minerals Production From Manganese Nodules, 1988-1995 (1000 tons)

Year	Cobalt		Copper		Manganese		Nickel	
	Low	High	Low	High	Low	High	Low	High
1988	13.6	22.7	9.0	27.0	2950.0	8850.0	100.0	185.0
1989	13.6	22.7	9.0	27.0	2950.0	8850.0	100.0	185.0
1990	13.6	22.7	9.0	27.0	2950.0	8850.0	100.0	185.0
1991	13.6	22.7	9.0	27.0	2950.0	8850.0	100.0	185.0
1992	13.6	22.7	9.0	27.0	2950.0	8850.0	100.0	185.0
1993	13.6	22.7	9.0	27.0	2950.0	8850.0	100.0	185.0
1994	13.6	22.7	9.0	27.0	2950.0	8850.0	100.0	185.0
1995	13.6	22.7	9.0	27.0	2950.0	8850.0	100.0	185.0

Source: Foders and Kim [1983]; Rafati [1982, a, b]; Wagenhals [1983].

Table B 2 - Potential Impact of Deep-Sea Mining on Metal Prices, 1988-1995 (1981 US-Dollars per ton)

Year	Prices											
	Cobalt			Copper			Manganese			Nickel		
	Base Case[a]	Low	High	Base Case[a]	Low	High	Base Case[a]	Low	High	Base Case[a]	Low	High
1988	31525.8	8818.4	6834.3	2358.22	2358.22	2358.22	34.08	34.08	34.08	7830	6890.4	6185.7
1989	34832.7	11023.0	8157.0	2363.93	2363.79	2566.32	32.48	29.40	24.99	7940	7304.8	6312.3
1990	38801.0	13448.1	10141.2	2371.36	2371.25	2370.98	30.85	27.72	23.37	8045	7441.6	6516.5
1991	36596.4	13668.5	9479.8	2375.59	2375.46	2375.24	29.25	26.31	22.25	8155	7584.2	6687.1
1992	36816.8	14109.4	10361.6	2379.23	2379.12	2378.90	27.69	24.83	20.83	8265	7727.8	6860.0
1993	38801.0	17636.8	11904.8	2381.45	2381.34	2381.14	26.22	23.39	19.46	8375	7847.4	6993.1
1994	40785.1	15673.1	12125.3	2388.13	2388.04	2387.87	24.85	22.06	18.20	8485	7958.9	7212.3
1995	38801.0	15432.2	11023.0	2393.86	2393.78	2393.60	23.58	20.84	17.05	8595	8070.7	7348.7

[a] Base case without seabed mining. Quantities of minerals produced from ocean mining assumed in the simulations are included in Table B 1.

Source: Foders and Kim [1983]; Rafati [1982, a, b]; Wagenhals [1983].

Table B 3a - Potential Impact of Deep-Sea Mining on Cobalt Consumption, 1988 - 1995 (1000 tons)

Year	United States			Western Europe[a] and Japan			COMECON		
	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High
1988	12.6	13.1	13.2	18.8	19.7	19.9	3.9	3.9	3.9
1989	13.0	14.3	14.9	19.3	22.2	23.3	3.9	3.9	3.9
1990	13.4	15.1	15.9	19.9	24.7	26.9	3.9	3.9	3.9
1991	13.8	17.0	19.1	20.8	27.2	33.1	3.9	3.9	3.9
1992	14.3	20.0	23.6	21.7	31.8	38.6	3.9	3.9	3.9
1993	14.8	21.7	27.7	22.2	36.3	43.5	3.9	3.9	3.9
1994	15.3	21.8	27.8	23.1	36.7	44.5	3.9	3.9	3.9
1995	15.7	21.9	27.8	24.0	37.2	44.9	3.9	3.9	3.9

[a] Belgium, France, Germany (F. R. of), Italy, Netherlands, United Kingdom.

Source: Rafati [1982,b].

Table B 3b - Potential Impact of Deep-Sea Mining on Copper Consumption, 1988 - 1995 (1000 tons)

Year	Japan			United States			Western Europe[a]			COMECON		
	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High
1988	1829.0	1829.0	1829.0	2400.0	2400.0	2400.0	4490.4	4526.4	4476.4	2808.2	2808.2	2808.2
1989	1913.9	1913.9	1913.9	2444.0	2444.0	2444.0	4657.9	4657.8	4657.8	2864.6	2864.7	2864.7
1990	2028.7	2028.8	2028.9	2491.1	2491.1	2491.1	4783.4	4783.5	4783.7	2921.1	2921.1	2921.1
1991	2151.8	2151.8	2151.9	2536.9	2536.9	2537.0	4901.3	4901.4	4901.6	2979.4	2979.4	2979.4
1992	2252.6	2252.6	2252.7	2579.7	2579.7	2579.7	5013.5	5013.7	5013.9	3039.5	3039.6	3039.6
1993	2348.2	2348.2	2348.3	2620.1	2620.1	2620.1	5136.7	5136.8	5137.1	3100.3	3100.4	3100.4
1994	2497.5	2497.5	2497.6	2661.2	2661.2	2661.2	5284.1	5284.1	5284.3	3162.6	3162.6	3162.6
1995	2652.6	2652.6	2652.7	2705.6	2704.6	2704.6	5448.0	5448.0	5448.3	3225.5	3225.5	3225.5

[a] Belgium, France, Germany (F. R. of), Italy, Netherlands, United Kingdom.

Source: Wagenhals [1983].

Table B 3c - Potential Impact of Deep-Sea Mining on Manganese Consumption[a], 1988 - 1995 (1000 tons)

Year	Japan			United States			Western Europe[a]			COMECON		
	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High
1988	2645	2645	2645	239	239	239	5260	5260	5260	9294	9294	9294
1989	2720	2719	2720	195	195	196	5353	5353	5354	9325	9325	9325
1990	2802	2815	2835	148	170	201	5445	5489	5552	9374	9374	9374
1991	2890	2903	2923	100	130	174	5538	5583	5645	9438	9438	9438
1992	2977	2990	3008	51	84	131	5630	5672	5730	9516	9516	9516
1993	3077	3089	3107	2	36	83	5722	5763	5820	9605	9605	9605
1994	3181	3193	3211	-	-	32	5812	5853	5909	9704	9704	9704
1995	3286	3297	3315	-	-	-	5901	5941	5996	9813	9813	9813

[a] Imports of Manganese Ore for Japan, United States and Western Europe; domestic production for the COMECON-countries

[b] Belgium, France, Germany (F. R. of), Italy, Netherlands, United Kingdom.

Source: Foders and Kim [1983].

Table B 3d - Potential Impact of Deep-Sea Mining on Nickel Consumption, 1988 - 1995 (1000 tons)

Year	Japan			United States			Western Europe[a]			COMECON		
	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High
1988	173.2	173.2	173.2	285.2	288.6	297.6	250.5	250.9	276.0	240.3	240.3	240.3
1989	184.3	184.3	184.3	292.2	295.6	300.9	259.9	268.5	288.1	246.0	246.0	246.0
1990	186.0	186.0	186.0	302.1	304.8	306.6	268.8	283.5	299.5	251.2	251.2	251.2
1991	188.1	188.1	188.1	313.9	319.3	323.0	279.8	300.0	318.0	256.7	256.7	256.7
1992	190.0	190.0	190.0	326.6	333.8	340.2	289.7	317.5	336.5	261.0	261.0	261.0
1993	192.0	192.0	192.0	339.3	349.3	358.3	298.4	335.5	356.1	265.1	265.1	265.1
1994	194.2	194.2	194.2	351.1	362.0	372.9	307.4	354.0	375.5	270.0	270.0	270.0
1995	196.0	196.0	196.0	374.7	376.5	387.4	316.0	373.1	395.9	274.0	274.0	274.0

[a] Belgium, France, Germany (F. R. of), Italy, Netherlands, United Kingdom.

Source: Rafati [1982, a].

Table B 4a - Potential Impact of Deep-Sea Mining on Land-Based Cobalt Production, 1988 - 1995 (1000 tons)

Year	Australia			Zaire			Zambia			COMECON		
	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High
1988	1.3	1.1	1.0	20.9	14.8	11.9	2.1	1.8	1.6	3.9	3.9	3.9
1989	1.4	1.1	1.0	22.1	16.1	13.3	2.2	1.7	1.5	3.9	3.9	3.9
1990	1.5	1.3	1.2	24.0	18.0	15.3	2.2	1.7	1.4	3.9	3.9	3.9
1991	1.5	1.4	1.2	24.4	18.5	15.7	2.2	1.7	1.5	3.9	3.9	3.9
1992	1.5	1.4	1.3	25.3	19.4	16.6	2.2	1.7	1.5	3.9	3.9	3.9
1993	1.7	1.5	1.4	26.2	20.3	17.6	2.2	1.8	1.6	3.9	3.9	3.9
1994	1.8	1.6	1.5	27.1	21.2	18.5	2.3	1.8	1.5	3.9	3.9	3.9
1995	1.9	1.6	1.5	27.4	21.5	18.8	2.3	1.8	1.6	3.9	3.9	3.9

Source: Rafati [1983, b].

Table B 4b - Potential Impact of Deep Sea Mining in Land-Based Copper Production, 1988 - 1995 (1000 tons)

Year	Canada			Chile			Peru			Philippines			South Africa[a]		
	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High
1988	943.6	943.6	943.6	1348.6	1348.6	1348.6	421.0	421.0	421.0	494.0	494.0	494.0	276.4	276.4	276.4
1989	968.3	968.3	968.3	1356.7	1356.7	1356.7	463.9	463.9	463.9	519.9	519.8	519.8	280.5	280.5	280.4
1990	993.7	993.7	993.6	1365.0	1365.0	1365.0	507.9	507.9	507.8	547.3	547.3	547.2	284.7	284.7	284.7
1991	1021.6	1021.6	1021.5	1372.7	1372.7	1372.7	519.6	519.6	519.6	576.0	576.0	576.0	289.0	289.0	289.0
1992	1049.8	1049.8	1049.7	1380.4	1380.3	1380.3	531.1	531.2	531.1	606.4	606.4	606.4	293.4	293.4	293.4
1993	1078.9	1078.9	1078.8	1387.8	1387.8	1387.7	542.7	542.6	542.6	638.3	638.3	638.3	297.9	297.9	297.9
1994	1109.0	1108.9	1108.8	1395.7	1395.7	1395.7	554.7	554.7	554.6	672.3	672.2	672.2	302.6	302.6	302.6
1995	1139.9	1139.8	1139.7	1403.8	1403.8	1403.7	566.7	566.7	566.7	708.2	708.2	708.1	307.5	307.5	307.4

[a] Including Namibia

Table B 4b (continued)

Year	United States			Zaire			Zambia			COMECON		
	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High
1988	1389.9	1389.9	1389.9	423.6	423.6	423.6	647.2	647.2	647.2	2331.5	2331.5	2331.5
1989	1390.6	1390.6	1390.6	423.9	423.9	423.9	648.1	648.0	648.0	2388.6	2388.6	2388.6
1990	1391.8	1391.8	1391.7	424.3	424.3	424.2	649.1	649.1	649.1	2445.7	2445.7	2445.7
1991	1392.8	1392.8	1392.7	424.5	424.5	424.5	649.9	649.9	649.9	2502.9	2502.9	2502.9
1992	1393.8	1393.8	1393.7	424.8	424.8	424.8	650.7	650.7	650.7	2560.4	2560.4	2560.4
1993	1394.8	1394.7	1394.7	424.9	424.9	424.9	651.2	651.2	651.2	2617.8	2617.8	2617.8
1994	1396.4	1396.4	1396.4	425.2	425.2	425.2	652.2	652.2	652.1	2675.5	2675.5	2675.5
1995	1398.2	1398.2	1398.1	425.5	425.5	425.5	653.1	653.1	653.1	2733.1	2733.1	2733.1

Source: Wagenhals [1983].

Table B 4c - Potential Impact of Deep-Sea Mining in Land-Based Manganese Production, 1988 - 1995 (1000 tons)

Year	Australia			South Africa			COMECON		
	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High
1988	2570	2570	2570	6239	6354	6354	9655	9294	9294
1989	2691	2691	2691	6440	6636	6637	9542	9325	9325
1990	2815	2788	2750	6684	6921	6896	9450	9374	9374
1991	2940	2913	2875	6962	7230	7186	9378	9438	9438
1992	3068	3042	3007	7265	7558	7505	9327	9516	9516
1993	3198	3174	3139	7590	7904	7845	9295	9605	9605
1994	3332	3307	3273	7933	8266	8203	9284	9704	9704
1995	3468	3445	3411	8293	8643	8579	9294	9813	9813

Source: Foders and Kim [1983].

Table B 4d - Potential Impact of Deep-Sea Mining on Land-Based Nickel Production, 1988 - 1995 (1000 tons)

Year	Canada			New Caledonia			South Africa			United States			COMECON		
	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High	Base Case	Low	High
1988	225.0	182.3	148.5	97.6	95.0	93.0	35.0	34.5	34.1	11.9	11.2	10.6	264.4	264.4	264.4
1989	230.0	204.7	163.3	104.0	102.9	98.0	37.8	36.9	35.9	12.0	11.1	9.8	272.2	272.2	272.2
1990	241.3	211.0	172.9	110.7	109.8	108.0	40.8	38.8	37.7	12.7	10.0	9.0	279.0	279.0	279.0
1991	241.3	218.1	180.0	116.1	111.6	106.1	42.6	40.7	39.6	12.7	9.8	8.1	285.0	285.0	285.0
1992	241.3	225.0	187.0	121.6	113.4	103.4	44.5	42.6	41.8	12.7	9.6	7.1	291.1	291.1	291.1
1993	241.3	230.0	194.1	127.9	116.1	100.7	46.3	44.5	43.5	12.7	9.4	6.0	297.0	297.0	297.0
1994	241.3	234.0	198.0	134.3	119.7	98.9	48.1	46.9	45.4	13.6	9.2	5.2	303.0	303.0	303.0
1995	241.3	237.0	200.0	140.6	125.2	99.8	50.0	47.8	46.9	13.6	9.0	5.0	308.1	308.1	308.1

Source: Rafati [1982, a].