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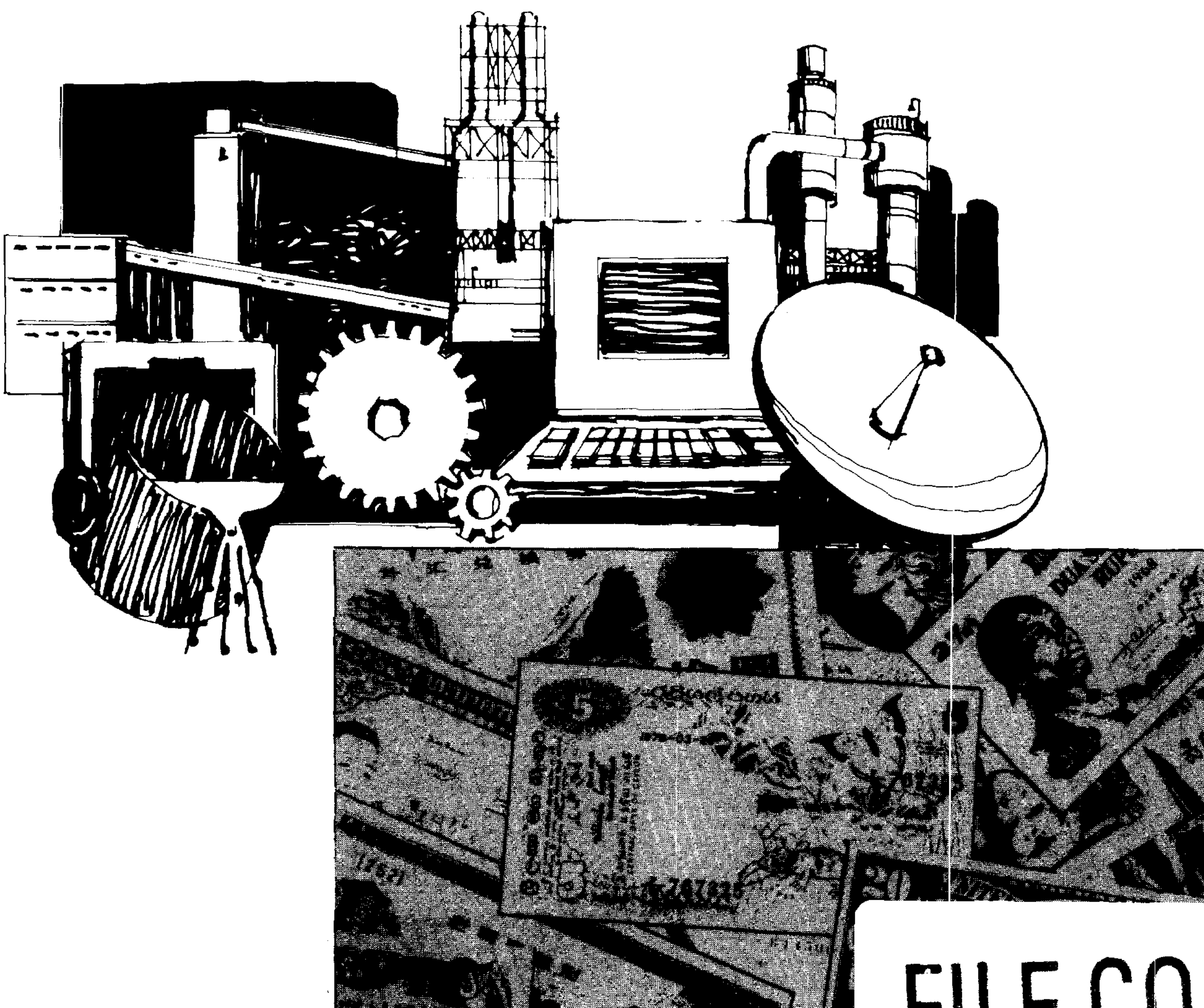
Iron Ore

Global Prospects for the Industry, 1985–95

Juergen Franz, Bo Stenberg, and John Strongman



Iron Ore

Global Prospects for the Industry, 1985–95

<u>Industry and Finance Series</u>

<u>Volume 12</u>

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ABSTRACT

The paper examines some deep-rooted changes which have taken place during the past 20 years in the world's steel industry and presents projections of future steel production and demand. Based on the expected trends in world steel the paper analyzes the prospects for iron ore. It provides an in-depth evaluation of the world seaborne iron ore market potential to 1995; examines the comparative cost structure and competitiveness of existing major producing areas in different regional markets; and determines if future international iron ore market conditions will justify investment considerations for new iron ore production facilities. It addresses future trends in international iron ore trade and examines three separate scenarios -- base case, low case and high case. Potential new iron ore production capacity is detailed as expansions, replacements, and greenfield projects. Under the projected base case conditions, a need for about 15 million tpy new iron ore production capacity is indicated by the mid 1990s. Potential projects total about 200 million tpy, indicating that only the lowest cost, most competitive projects with assured markets will be suitable for implementation in the next decade.

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LIST OF ACRONYMS AND ABBREVIATIONS

BOF	Basic oxygen furnace
CPEs	Centrally planned economies
EAF	Electric arc furnace
EC-9	European Economic Community (Belgium, Denmark, Federal Republic of Germany, France, Ireland, Italy, Luxembourg, Netherlands, United Kingdom)
GDP	Gross Domestic Product
IDC	Industrialized countries
ITC	International Trade Commission
LDC	Less-developed countries
mtpy	million tons per year
OECD	Organization for Economic Co-operation and Development
OHF	Open hearth furnace
tpy	tons per year

UNITS

1 ton = 1,000 kilograms or 2,205 pounds

SUMMARY AND CONCLUSIONS

1. The character of the international steel market has changed markedly in the past two decades. During the 1960s world steel consumption grew strongly at an average rate of 5.5% per year. In the 1970s, steel growth declined to 1.9% annual average growth rate. From 1980 to 1983 the world steel market experienced the severest reversal in decades, with consumption declining from 712 million tons 1/ in 1980 to 668 million tons in 1983. The changes were greatest in the industrialized countries. Intensity of steel use has peaked and is now declining for most industrialized countries. Steel consumption in such countries averaged only 315 million tons in 1980-83 compared with 411 million tons in 1973, the year of peak consumption. Steel production for industrialized countries has followed a similar trend peaking at 444 million tons in 1974 compared with an average production of 356 million tons from 1980-83. Three groups of producers are dominant--Japan, European Economic Community (EC-9) and US producers--accounting for 87% of industrialized production in 1980-83. By contrast, consumption for developing countries (LDCs) increased steadily at an average annual growth rate of 5.6% and 6.2% per year respectively in the 1960s and 1970s/early 1980s to reach 171 million tons in 1983. Steel production in developing countries was 125 million tons in 1983--the gap between supply and demand being met by exports from industrialized countries. European Centrally Planned Economies (CPEs) produced and consumed about 210 million tons of steel in 1983 with minimal net trade with market economies.

2. Steel consumption in industrialized countries (IDCs) is expected to show only minor growth in the next decade or so. However, for developing countries substantial steel consumption growth especially in the larger LDCs is expected in the next decade because they are in the process of developing their basic industries and infrastructure, as well as improving their housing and capital stock. Base case, low case and high case steel consumption and production estimates have been prepared based on assump- tions regarding future economic growth, intensity of steel use and steel income elasticity of demand. The projections indicate a wide range of possible future steel demand for 1995. Specifically, they indicate world steel production and consumption would increase from just over 710 million tons in 1980 to somewhere in the range 765-876 tons by 1995 with a most likely estimate of 823 million tons. For industrialized and developing countries, production and consumption would increase from 505 million tons in 1980 to 542-635 million tons by 1995--with a most likely estimate of 587 million tons. Net exports from industrialized countries to developing countries would be in the order of 40-50 million tons in 1995 compared with 50 million tons in 1980.

3. Iron ore production and consumption is inextricably linked to steelmaking and the international iron ore market has contracted severely in the face of the steel market collapse. An estimated 98% of iron ore goes to steel industry blast furnaces to produce pig iron for steel

1/ All data in this report are in metric tons (i.e. 1 ton contains 2,205 lbs); the abbreviation mtpy is used for million tons per year.

making. World production of iron ore peaked at 903 million tons in 1975 and fluctuated between 850 and 900 million tons from 1976 to 1981. In 1982 and 1983, production collapsed to 777 and 746 million tons respectively in the face of large inventory overhangs and sharp cutbacks in offtake by steel mills of a previously unprecedented nature. Major producing regions are USA (Minnesota), Canada (Quebec-Labrador), Australia (Northwest), Brazil and West Africa (Mauritania-Liberia) who account for about two thirds of market economy production. Cutbacks have been most severe in industrialized countries where 1983 production was at 190 million tons compared to 337 million tons in 1975. However, developing country producers have also faced cutbacks from 324 million tons in 1975 to 305 million tons in 1983.

4. Steel mills have important relationships with iron ore mines in terms of ownership and long term purchase arrangements. Steel companies have traditionally viewed security of supply and stable prices of their raw materials as a critical requirement for their long term viability. In particular, US steel mills have always had substantial interests in terms of ownership, loans and long term sales contracts in Canadian iron ore mines, Japanese mills in Australian mines and European steel mills in Brazilian and West African mines. More recently, Japanese mills also have developed major interests in Brazilian iron ore operations. In addition, different mines produce different products, namely, lumpy ore, sinter feed and pellets (from fines) and long term sales arrangements also reflect a matching of steel mill requirements with particular grades and types of ore available at specific mines.

5. Brazil and Australia are the lowest cost iron ore producers with average production costs (on an fob basis) about 20% below West African producers and 50% below North American producers. Specifically, the cost for sinter feed delivered to the point of export on an fob basis are presently estimated at US$14-15 per ton (Brazil and Australia), US$18 per ton (West Africa) and US$24-28 per ton (USA and Canada) in 1984 terms. It should be noted, however, that costs can range widely between different producers in the same country or region. The cost estimates reflect, in particular, differences in labor, energy and supplies costs due to differences in ore grades, mining conditions, labor productivity, technical capabilities and to a lesser extent shifts in exchange rates and inflation in prior years. Production costs for pellets show a similar pattern--though differentials are larger. Brazil is the lowest cost supplier at US$22 per ton (on an fob basis in 1984) followed by Australia at US$24 per ton, with a substantial differential to Canada at US$35 per ton and USA at US$40 per ton. West Africa has no significant pellet production and estimates are not available. The large differences between the sinter fines price and the pellet price reflects the beneficiation and processing costs of transforming fine particles into a pellet of uniform size and consistency.

6. Most iron ore is marketed internationally using long term sales contracts which were designed to provide security of supply and sales to buyers and sellers alike. This follows from industry developments in the

1950s and 1960s, when many new iron ore mines were implemented around the world to meet the growth in inputs required by steel mills. In most cases, sales contracts were signed providing for long term (10 years or more) purchase commitments but annual price negotiations. While this provided for relatively stable market circumstances for many years, the collapse of steel demand and hence iron ore requirements in the past ten years has undermined the previous stability of purchaser-supplier arrangements. Almost all mines have suffered large production cutbacks. Steel mills have tended to give priority to supplies from mines in which they have some ownership or financial participation. The iron ore market slump has been especially severe in 1982 and 1983 and some steel mills have decided not to renew long term sales contracts which recently expired with some independent mines. In order to maintain operations, these mines have resorted to selling at below contract prices and a spot market in iron ore, in volume terms, is emerging as a new feature of international, seaborne iron ore trade.

7. International trade in iron ore reached a peak of about 400 million tons in 1979 and declined to about 301 million in 1983. Japan is the largest importer accounting for 109 million tons in 1983, followed by the nine European Economic Community countries with 98 million tons. The leading exporters are Australia and Brazil (about 70-80 million tpy each). The major international seaborne trade in iron ore is from Brazil and Australia to Japanese and European steelmakers. Smaller but significant exporters include India (about 25 million tpy) and South Africa, Liberia, Canada, Sweden and Venezuela (about 10-20 million tpy each). There are also important exports from Canada across the Great Lakes to the United States (about 10-15 million tpy).

8. On a delivered basis, Brazil is the lowest cost supplier to Europe, and Australia the lowest cost supplier to the Far East, including Japan. The delivered cost of Brazilian sinter feed to Rotterdam was about US$19 per ton in 1983--about $2 per ton less than West Africa and Australia and $8 per ton less than Canada. For Japanese mills, Australian sinter feed and pellet feed are US$3 and US$1 per ton respectively less than Brazilian. The cost advantages of Brazil, Australia and West Africa vis-a-vis US and Canadian mines raise the question of whether offshore suppliers can penetrate the US market--especially the Great Lakes market which accounts for 75% of US iron ore consumption. Although cost estimates indicate that offshore suppliers could be competitive with domestic mines, little penetration of foreign ores in the Great Lakes market is expected because most US iron ore mines are owned by steel companies who would not switch unless imported costs were well below direct cash operating costs of captive operations. At the same time, lack of coastal plants with deep water ports restricts foreign suppliers from making in-roads into the US iron ore market.

9. The North American market has remained somewhat isolated from world market forces and North American iron ore prices presently show a large premium over iron ore prices in Europe and Japan. Most iron ore mines in North America are captive mines with some type of steel mill

financial interest or ownership. As a result iron ore prices in North America are generally determined by production costs. Elsewhere, iron ore prices are determined by market forces. In major markets such as Japan and Europe, prices are compared on a cif basis and in almost all cases, mines receive the market price less ocean freight and other handling and transportation costs. From 1960 to 1984, cif Europe prices increased (in current terms) from US$17 per ton to US$22 per ton. When measured in real (1980) terms, this was equivalent to a decline from US$65 per ton to US$23 per ton reflecting falling long run industry production costs resulting from implementation of a succession of large scale low cost mines. In the past two years, however, iron ore prices have weakened in the face of very depressed market conditions. In contrast, US prices (cif Chicago) are estimated to be up to 50% higher than European prices indicating that North American steel mills face considerably higher costs for their iron ore feed than competing mills in Europe and Japan.

10. For the future, growth in iron ore requirements will come from steel mills in developing countries. Iron ore requirements of steel producers in industrialized countries are expected to remain below the level of the early 1980s. Future base case, high case and low case international, seaborne iron ore supply and demand projections have been prepared to 1995 based on the world steel market projections. The iron ore estimates take into account various changes expected in technical coefficients which will result in the iron ore requirements per ton of crude steel equivalent declining by 5-10% from 1985 to 1995. The estimates indicate poor market prospects for iron ore requirements in industrialized countries which are estimated in the range of 352-421 million tons in 1995 compared with an average of 385 million tons from 1980-83. For developing countries, however, iron ore market prospects are more promising and requirements will increase from 177 million tons average in 1980-83 to 248 to 292 million tons in 1995. European CPEs will also show small growth with requirements increasing to 296 to 316 million tons in 1995 from 263 million tons average 1980-83.

11. There is presently substantial excess world iron ore production capacity. Current market economy production potential is estimated at 556 million tpy compared with a production of about 415 million tpy in 1983. About 100 million tpy of idle capacity presently exists in five producing regions namely United States, Australia, Canada, Brazil and South Africa. From 1985 to 1990, production capacity is expected to increase by about 15 million tpy allowing for certain capacity additions from new projects in Brazil, India and Iran and closures in USA, France and Liberia. From 1990 to 1995, further closures of about 20 million tpy capacity are expected as other mines are depleted in Australia, US, Canada and Liberia.

12. Future market projections indicate poor growth prospects for seaborne iron ore trade with total requirements expected to increase from about 294 million tons in 1985 to 304 to 385 million tons in 1995. For industrialized countries, growth in requirements will be minimal. Estimated requirements in 1995 range from 228 to 280 million tons compared

with about 239 million tons expected for 1985. Thus in the low case, requirements will decrease and in the high case they will grow by at most 1-2% per year. For developing countries the picture is different although the quantities are smaller. Even in the low case iron ore requirements are expected to increase from 37 million tons in 1985 to 55 million tons in 1995 and in the high case they more than double to 83 million tons. The Republic of Korea accounts for 28% of the incremental requirements and China for 17%. European CPE seaborne requirements are expected to be about 18 million tons in 1985 and 18-22 million tons in 1995.

13. Under the base case and low case scenarios there will be a supply capacity surplus for seaborne iron ore through 1990; under the high case there will be a small deficit by 1990. For 1995 the base case projects a small supply capacity deficit (15 million tons), whereas the high case indicates a somewhat larger deficit (over 79 million tons) and the low case indicates excess production capacity persists at 27 million tons. Thus, new production capacity for seaborne iron ore is hardly justified if start up is before 1990 at the very earliest, and is generally not required before 1995. The factors which will most influence in practice how quickly the surplus oversupply is reduced are considered to be, first, the economic performance of the industrialized countries since a ±10% change in industrialized countries steel demand impacts international iron ore shipments by about ± 40 million tpy and secondly, the rate of growth of steel production over the next decade in The Republic of Korea and China because of their importance for incremental developing country iron ore requirements. In the meantime, faced by persistent supply surpluses steel companies using imported ores are expected to emphasize supplies from existing captive mines with close ownership/financial ties and from the lowest cost producers.

14. There are about twenty potential new iron ore projects identified for export markets with total capacity of over 200 million tpy by 1995 of which about 40 million tpy would be expansion, about 30 million tpy would be replacement projects in the vicinity of depleted deposits and about 130 million tpy would be greenfield projects. Potential new capacity totals about 85 million tpy in Australia, 63 million tpy in West Africa, 25 million tpy in Brazil, 10 million tpy each in Saudi Arabia and India, and 5 million tpy each in South Africa and Sweden. Capital costs for these projects can be as low as US$20 per ton for expansions, US$25-75 per ton for replacement projects and US$100 per ton and above for greenfield projects. Compared with the estimated requirements for new production capacity of about 15 million tpy under the base case only one or perhaps two projects have a realistic chance to be implemented in the next decade out of the twenty projects identified.

15. It is too speculative, at this time, to predict which iron ore export projects will be implemented first. However, given the adverse seaborne iron ore market circumstances, only projects with highly favorable cost structures and with strong and competent private project sponsors able to underwrite the project risk in the event of persistent oversupply in the 1990s, will be able to emerge as front runners. In the final analysis,

only projects with firm support from steel mills including some type of financial participation as well as long term purchase commitments are likely to be able to put together and finalize the necessary financing for construction to take place. To the extent that high rates of economic growth are sustained through the early 1990s, project timetables may be accelerated. However, if economic growth turns down and steel production slackens, even the most attractive projects may have to wait until well into the 1990s before the market outlook improves sufficiently to support implementation activities.

I. INTRODUCTION

1.01 The most recent price outlook for the world iron ore market was given in the World Bank Report 814/84, Price Prospects for Major Primary Commodities, Volume IV, Metals and Minerals, September 1984. That report focused on the price prospects for iron ore and provided a brief account of the most likely future trends in iron ore production and consumption and steel production and consumption. This paper provides a more detailed, updated analysis of expected trends in world steel and iron ore supply-demand situation in order to: (a) provide an in-depth evaluation of the world seaborne iron ore market potential to 1995; (b) examine the comparative cost structure and competitiveness of existing major producing areas in different regional markets and (c) determine if future international iron ore market conditions will justify investment considerations for new iron ore production facilities. As such the paper does not directly address world iron ore price prospects. Instead, it addresses in greater detail future trends in international iron ore trade and examines three separate scenarios--base case, low case and high case. The paper also examines the different products in world iron ore trade, production costs in different regions and ocean freight differentials between major producing regions and different markets. The cutoff date for most of the data upon which the study is based is December 31, 1983; however iron ore prices and some of the comparative production costs reflect 1984 developments. Major new iron ore production capacity is detailed as expansions, replacements, and greenfield projects. Under the projected base case conditions, a need for about 15 million tpy new iron ore production capacity is indicated by the mid 1990s. Potential projects total about 200 million tpy, indicating that only the lowest cost, most competitive projects with assured markets will be suitable for implementation in the next decade.

II. WORLD STEEL TRENDS

2.01 This chapter examines some deep-rooted changes which have taken place during the past 20 years in the world's steel industry and presents future projections of steel production and demand. The intensity of use of steel has peaked and declined sharply in most industrialized countries (IDCs) in the past two decades with the result that steel consumption and production in IDCs peaked in the mid 1970s and has declined since. In contrast, developing countries (LDCs) have shown steady annual increases in steel consumption and have also increased steel production by taking advantage of lower labor costs and changing technology which has brought new and more efficient methods of producing steel. From 1970 to 1983 the LDC share of world steel production increased from 10% to 19% while the IDC share declined from 65% to 49%, the balance being production by European Centrally Planned Economies (CPEs). For the future, steel consumption for the IDCs is forecast to show only minor growth. However, for LDCs, substantial steel market growth is to be expected especially in the larger LDCs over the coming decades, because they are in the process of developing their basic industries and infrastructure, as well as improving their housing and other physical capital stock.

Past Trends in Production and Consumption

Production

2.02 During the 1960s world steel production grew at 5.6% per year as shown in Table 2.1 overleaf. In absolute terms, growth was strongest in Japan, where production increased by over 70 mtpy, and to a lesser extent, USA and European Economic Community (EC-9) where production increased by over 30 mtpy each. By 1970, these three producers accounted for 80% of the combined steel production of IDCs and LDCs. During the early 1970s, an economic boom resulted in peak steel consumption in 1973-74 which brought the world steel industry to the limits of its production capability. At that time, many steel producers embarked on ambitious expansion plans based on optimistic expectations of future steel demand. The expansion program included investment in less capital-intensive mini-mills, and in the rapid application of new technologies directed to improving productivity and yields, and increasing energy efficiency (e.g., ultra-high-power electric steelmaking, continuous casting and direct rolling). However, at the same time new capacity was being added, economic growth slowed and economic downturns were much more severe than previously. In the mid 1970s steel consumption in IDCs peaked and declined and steel industry capacity utilization rates which had generally ranged from 80-90% in the 1960s and early 1970s fell to 70-80% in the mid to late 1970s. As economic conditions worsened in the early 1980s, operating rates fell to about 64% in industrialized market economies as a whole in 1982 (50% in the USA, 67% in the EC-9, and 70% in Japan). 1/

1/ In late 1982 operating rates in the USA fell below 40%, but have since recovered and averaged 50-60% in 1984.

Table 2.1: World Steel Production 1960-83
(in million tons crude steel equivalent)

	1960	1970	1980	1981	1982	1983	Annual Average Growth Rate (%) 1960-70	1970-83
IDCs								
USA	90	122	104	112	67	76	3.1	(3.5)
EC-9 a/	98	138	126	125	110	109	3.5	(1.8)
Japan	22	93	111	102	100	97	15.5	0.3
Other IDCs	16	38	50	48	44	44	8.7	1.1
Subtotal IDCs	226	391	391	387	321	326	5.6	(1.3)
LDCs								
China	18	18	37	36	37	40	(0.2)	6.3
Brazil	2	5	15	13	13	15	8.9	8.0
Korea, Rep. of	0 b/	1	9	11	12	12	-	27.6
India	3	6	10	11	11	10	6.7	3.9
Mexico	2	4	7	8	7	7	7.0	4.5
S. Africa	2	5	9	9	8	7	8.1	2.9
Yugoslavia	1	2	4	4	4	4	4.6	4.9
Argentina	0 b/	2	3	3	3	3	19.6	3.7
Other LDCs	4	8	21	23	25	27	9.0	9.8
Subtotal LDCs	33	51	115	117	121	125	4.5	7.1
Subtotal IDCs and LDCs	259	442	505	504	442	451	5.5	0.2
European CPEs	87	156	209	206	204	212	6.0	2.4
Grand Total	346	598	714	710	645	663	5.6	0.8

a/ United Kingdom (UK), Federal Republic of Germany (FRG), France, Italy, Netherlands, Belgium, Luxembourg, Denmark, Ireland.
b/ Less than 0.5 MT.

Note: Totals may not add due to rounding; annual average growth rates derived from originally unrounded data.

Source: World Bank, Economic Analysis and Projections Department.

2.03 Governments of major industrialized steel producing countries have reacted in various ways to alleviate the problems of their domestic steel industries. Examples of the steps taken include the US trigger price mechanism, introduced in 1978, but subsequently superseded by negotiated limits on imports from the EC and Japan, and accelerated depreciation allowances in the USA; a European Coal and Steel Community (ECSC) rationalization plan combined with the closure of obsolete facilities and the imposition of individual country production quotas; and the Japanese administrative guidance system for reduction of scrap-based steel production capacity. Additionally, the industry's own response has led to the closure of many obsolete facilities and a shift in investment strategy from capacity expansion to cost reduction. As a result, effective capacity in the industrialized market economies has remained flat since the late 1970s after the investment boom in the early part of the decade had run its course. It is expected that IDC steel production capacity will decline somewhat further through at least the mid-1980s. In particular, it is generally accepted that there is substantial obsolete capacity which will be closed permanently (approximately 15% of stated capacity) especially in the USA and the EC-9, 2/ but also, to a lesser extent, in Japan.

2.04 While steel production for IDCs as a group declined from 1970 to 1983, it more than doubled for LDCs notwithstanding the financial difficulties for many LDCs in the mid-1970s and early 1980s. The largest production increases were achieved in China, Brazil and the Republic of Korea, all of which have large domestic requirements for steel and presently produce in excess of 10 mtpy. These 3 countries, together with India, accounted for over 60% of LDC steel production in 1983. Another 17% is provided by Mexico; S. Africa; Yugoslavia; and Argentina and the balance by minor amounts of production in about 20 other LDCs. For the most part, LDCs have been steadily increasing investment in their domestic steel production facilities in order to reduce dependence on foreign imports and save foreign exchange. Consumption of steel has increased in the LDCs with an average annual growth rate of 6.2% between 1970-83. Consequently, most part of their domestic steel production is consumed internally, although The Republic of Korea and Brazil have steel in surplus for exports. Newer and more efficient steel production technology, together with lower labor costs have resulted in lower overall production costs for the LDCs. This has enhanced their competitive advantage vis a vis many of the older IDC steel producing units. While IDC producers have suffered from excess capacity in the past decade, LDCs have remained close to their sustainable production capability.

Consumption

2.05 The importance of steel in the economic growth process derives from its comparatively low cost as a basic material suitable for multiple uses especially in capital intensive industries (construction, engineering and capital goods industries) as well as for transportation (automobiles and ships) and consumer durables. Through the 1960s world steel consumption grew at an annual rate of around 5.5%, with almost identical average annual growth rates for IDCs as a group, LDCs as a group and CPEs as shown in Table 2.2 overleaf. The 1974 oil crisis, however, represents a

2/ The objective of the EC Commission in Brussels is to reduce steelmaking capacity in each of its member countries on average by 20% by 1985. The Steel Restructuring Plan stipulates two principles: (a) public aid is not to be granted to steel companies unless they reduce their capacities; and (b) no further subsidies will be permitted to steel companies beyond 1985. It is thus expected that the industry by then will have come back to profitable operations. It is also estimated that losses in (primarily state-owned) steel companies in the EC amounted to approximately US$4.4 billion in 1981.

turning point in steel consumption for the different groups of countries. The peak level of steel consumption for IDCs was reached in 1973 (411 million tons),[3] immediately prior to the first sharp increase in oil prices. The ensuing energy crisis contributed to a major slowing in GDP growth especially in industrialized economies. Perhaps more importantly, it brought to the fore major structural and technological changes in the industrialized economies. These combined changes have resulted in a relative decline in the share of investments in capital intensive sectors (which traditionally have accounted for between 30-40% of steel consumption), substitution of lighter materials, such as aluminum and plastics, for steel, and increased efficiency by steel-consuming industries.

Table 2.2: World Steel Consumption 1960-83
(in million tons crude steel equivalent)

	1960	1970	1980	1981	1982	1983	Average Annual Growth Rate (%) 1960-70	1970-83
IDCs								
USA	90	127	118	128	92	96	3.5	(2.1)
EC-9	82	124	106	97	90	88	4.2	(2.6)
Japan	20	70	79	72	70	66	13.6	(0.5)
Others	21	42	43	43	38	37	7.1	(1.0)
Subtotal IDCs	213	363	346	340	290	287	5.5	(1.8)
LDCs								
China	19	23	42	38	40	48	1.6	5.8
Brazil	3	6	15	12	11	9	8.5	3.2
Korea Rep. of	0 a/	1	6	8	8	9	-	18.4
India	5	6	11	12	12	12	3.4	5.5
Mexico	2	4	11	13	9	6	7.0	3.2
S. Africa	2	5	6	7	6	5	8.1	0
Yugoslavia	2	3	6	6	5	5	7.2	4.0
Argentina	2	3	4	2	3	3	7.5	0
Others	10	27	59	64	66	74	10.4	8.1
Subtotal LDCs	45	78	170	168	163	171	5.6	6.2
Subtotal IDCs and LDCs	258	441	502	511	460	458	5.5	0.3
European CPEs	88	152	210	206	205	210	5.6	2.5
Grand Total	346	593	712	717	665	668	5.5	0.9

a/ Less than 0.5 mtpy.

Note: Totals may not add due to rounding; annual average growth rates derived from originally unrounded data.

Source: World Bank, Economic Analysis and Projections Department.

3/ Unless otherwise specified steel production and consumption refer to crude steel equivalent.

2.06 From 1970 to 1983, average annual steel consumption growth in the IDCs was negative. During this period, business cycles have tended to accentuate the decline in the steel market and troughs have become more severe and peaks less pronounced. The trough in 1982 and 1983 was particularly severe. IDC steel consumption in 1982 and 1983 was around 290 million tons (versus 346 million tons in 1980 and 363 million tons in 1970). The decline was especially severe in the USA where consumption was close to the level for 1960. However, consumption experienced a strong recovery in 1984 when consumption trends in the steel using sectors (construction, automobiles, and industrial equipment) were substantially higher compared with the previous year especially in the USA and also in Japan.

2.07 Underlying the decline in steel consumption in IDCs is a sharp reduction in intensity of use in the USA, EC and Japan. Intensity of use peaked and started declining in the EC-9 and USA in the early and late 1960s respectively. The rate of decline increased noticeably in the 1970s. In Japan, steel intensity of use did not decline until the early 1970s. But in all three cases, the change has been relatively drastic during the past decade. Estimates of the reduction in intensity of steel given in Table 2.3 below indicate a decline of about one third over the past 10 years:

Table 2.3: Intensity of Use of Steel in Industrialized Countries 1960-82
(in grams of steel per $ of GDP in real 1980 terms) a/

	USA	EC	Japan
1960-64	68.3	57.8	84.5
1965-69	73.1	55.2	94.8
1970-74	65.7	54.4	101.4
1975-80	53.3	41.8	75.5
1978-82	47.4	37.9	66.5

a/ The source data for steel usage are in units of crude steel rather than finished steel. Over the past two decades, there have been marginal increases in the amount of finished steel produced per ton of crude steel.

Source: World Bank, Economic Analysis and Projections Department.

2.08 There are several causes for the decline in intensity of use. First, there are basic changes in the macro-economic characteristics of the industrialized economies. Specifically, investment has declined relative to gross domestic product in the OECD countries and the share of service industries is rising relative to manufacturing. This has resulted in a decline in the share of the economy attributable to the traditional steel using, capital intensive industries. In some cases, such as construction and transportation, the longer term trends have also been accelerated by the severity of the economic downturns in the 1970s. Second, there has been substitution of steel by other materials. Substitution of lighter materials (such as plastics and aluminum) for steel has taken place in a wide range of products and uses. The development of more sophisticated steel products using complex alloys has been an important feature of the steel industry for two or three decades. While this provides for greater value added and more useful products, the substitution of high strength low alloy speciality steels for carbon steel also has the effect of reducing the growth in steel tonnage. Also, technological advances have permitted the substitution of other materials for steel in construction uses, for example the substitution of concrete for steel. Third, there has been a general "downgauging" of product metal requirements in the manufacturing industries, i.e., the shift to smaller and lighter products requiring less material. An important facet of downgauging has been the phased size and weight reduction which has taken place over the past decade to make automobiles more weight and fuel efficient and less costly to fabricate. As an example, the amount of steel required for the average US produced automobile is reported to have declined from 2,253 pounds in 1975 to 1,699 pounds in 1982, a 25% reduction. Fourth, changes have occurred in consumer goods and tastes and in the pattern of goods consumed. Appliance markets (for refrigerators etc.) which tend to be steel intensive are largely saturated and the new wave of consumer demand is for electronic goods which generally use little steel. Other consumer goods have also seen a move away from steel. For example, steel cans have been replaced by aluminum and plastic beverage containers. Such trends are unlikely to be reversed.

2.09 In contrast, steel consumption growth for the LDCs continued strong in the 1970s. In the early 1980's steel consumption trends differed sharply in the face of the LDC debt crisis. From 1980-83 consumption growth occurred only in China and the Republic of Korea. In contrast, sharp reverses were experienced in Brazil and Mexico. For LDCs overall, the annual average growth rate increased from 5.6% per year in the 1960s to 6.2% per year from 1970-83. Consequently, the LDCs' share of the world's steel consumption increased from about 13% in 1970 to 26% in 1983. In 1980, four LDCs each consumed more than 10 mtpy steel and accounted for about 45% of LDC steel consumption, namely China (25%), Brazil (7%) India (7%) and Mexico (6%). The rapid growth of steel consumption in these and other LDCs resulted from the on-going development and expansion of the physical capital stock for basic industries, infrastructure and housing. The pace of steel consumption growth in European CPEs slowed considerably, down from 5.5% annually in the 1960s to 1.9% annually in the 1970s and about minus 2.1% annually from 1980 to 1983.

Future Trends in Supply and Demand

Supply

2.10 World steel production projections to 1995 have been prepared on a country by country basis as shown in Table 2.4 overleaf. Three scenarios have been prepared based on alternative low case, base case and high case GDP growth assumptions and steel consumption estimates as detailed in paras. 2.14 to 2.18. No attempt has been made to identify the timing of economic cycles or specific years in which supply will exceed or fall below consumption. The projections have been prepared so that total supply is

Table 2.4: World Steel Production Projections 1980-95
(in million tons crude steel equivalent)

	Actual				Base Case			Low Case		High Case	
	1980	1981	1982	1983	1985	1990	1995	1990	1995	1990	1995
IDCs											
USA	104	112	67	76	86	92	95	88	90	95	100
Canada	16	15	12	13	15	16	17	15	16	17	22
EC-9	126	125	110	109	115	115	113	107	101	125	122
Japan	111	102	100	97	105	111	111	105	101	116	118
Australia	8	8	6	6	7	8	8	8	8	9	11
Spain	13	13	13	13	13	14	16	13	14	15	18
Sweden	4	4	4	4	4	5	5	4	5	5	6
Other IDCs	9	8	9	8	9	11	11	10	11	11	14
Subtotal IDCs	391	387	321	326	354	372	376	350	346	393	411
LDCs											
Asia											
China	37	36	37	40	45	52	61	50	59	55	64
Viet Nam	-	-	-	-	1	1	2	1	2	1	2
Korea, Dem. Rep.	4	6	6	6	8	9	10	8	9	9	11
India	10	11	11	10	12	14	17	13	15	15	19
Korea, Rep. of	9	11	12	12	13	17	22	16	19	19	25
Indonesia	-	-	-	1	1	2	3	2	3	2	3
Saudi Arabia	-	-	-	-	1	1	1	1	1	1	1
Other Asia	7	6	8	7	8	9	11	8	9	10	14
Subtotal Asia	67	70	74	76	89	104	127	99	117	111	138
Africa											
Zimbabwe	1	1	1	1	1	1	1	1	1	1	1
S. Africa	9	9	8	7	8	9	10	9	10	9	10
Algeria	1	1	1	1	1	2	2	2	2	2	3
Egypt	1	1	1	1	1	2	2	2	2	2	3
Nigeria	-	-	-	-	1	1	2	1	2	1	2
Other Africa	-	-	-	-	-	-	-	-	-	-	1
Subtotal Africa	11	12	11	10	12	15	17	15	17	15	20
America											
Argentina	3	3	3	3	3	4	5	4	5	4	5
Brazil	15	13	13	15	17	19	23	18	21	21	26
Chile	1	1	1	1	1	1	1	1	1	1	1
Mexico	7	8	7	7	8	11	12	9	10	11	13
Venezuela	2	2	2	2	3	4	4	4	5	4	5
Other America	1	-	1	1	1	1	1	1	1	1	2
Subtotal America	29	27	27	29	34	40	46	37	43	42	52
S. Europe											
Turkey	3	2	3	4	3	4	6	4	6	4	6
Yugoslavia	4	4	4	4	4	5	6	5	6	5	6
Other S. Europe	2	2	2	2	2	2	2	2	2	2	2
Subtotal S. Europe	8	8	9	10	9	11	14	11	14	11	14
Subtotal LDCs	115	117	121	125	144	170	204	162	191	179	224
European CPEs											
USSR	148	149	149	152	152	162	171	158	166	165	177
Hungary	4	4	4	4	4	5	5	5	5	5	5
Romania	13	13	13	14	15	18	22	17	21	18	22
Other European CPEs	44	40	38	42	39	39	38	38	36	40	39
Subtotal European CPEs	209	206	204	212	210	224	236	218	228	228	241
Grand Total	714	710	645	663	708	766	816	730	765	800	876
Total IDCs and LDCs	505	504	442	451	498	542	580	512	537	572	635
Total Market Economies a/	464	462	399	405	444	480	507	453	467	507	558

a/ Excludes European CPEs; China; Korea, Dem. Rep.; Viet Nam.

Note: Totals may not add due to rounding.

equal to total demand each year on a trend basis and no specific consideration is given to inventory adjustments which are not considered significant for long run trend projections. In practice it is unlikely that supply and demand will be exactly in balance in any particular year.

2.11 The basic outlook is that IDCs growth will be only 0.6% per year in the base case as shown in Table 2.5 below and there will be persistent overcapacity. For LDCs the outlook is for continued growth in both steel production and production capacity with operating rates at sustainable levels through the period with an annual average growth rate of 3.5% per year from 1985 to 1995.

Table 2.5: Annual Average Growth Rate of Steel Production, 1985-95
(in % per year)

	Base Case	Low Case	High Case
IDCs	0.6	(0.2)	1.5
Asian LDCs	3.6	2.8	4.5
African LDCs	3.5	3.5	5.2
American LDCs	3.1	2.4	4.3
Southern European LDCs	4.5	4.5	4.5
LDCs	3.5	2.9	4.5
European CPEs	1.2	0.8	1.4
Grand Total	1.4	0.8	2.2
IDCs and LDCs	1.5	0.8	2.5
Market Economies	1.3	0.5	2.3

2.12 Steel production estimates for IDCs are based on (i) knowledge of each country's present capacity, (ii) estimates of possible adjustments to reduce uneconomic, excess capacity, (iii) estimates of the net import requirements of LDCs from IDCs and how they will be split between different IDC exporters. Estimates of steel exports from IDCs to LDCs are given in para. 2.20. The base case outlook is for an IDC steel production of 354 million tons in 1985 increasing to 376 million tons by 1995. In this case, steel production for EC-9 and USA remains below the 1980 and 1981 levels. Some excess steel production capacity has been closed in major producing countries in the past decade. The base case indicates further closures of uncompetitive plants. The extent of such closures in particular countries is very difficult to estimate since they will reflect not only changes in the competitive position of individual producers but also governmental attitudes towards minimum levels of domestic steel production capacity which may be viewed as desirable based on strategic or other considerations. In the low case, production in 1995 declines to 346 million tons and in the high case it increases to 411 million tons. In both cases the largest adjustments (between the low case and the high case) occur in the EC-9 and Japan as a result of changes in both domestic consumption and exports of steel. In the high case by 1995 production growth over 1980 levels takes place in smaller producers with new facilities such as Spain and Australia. Even in the high case, however, substantial permanent closures of presently idle steel capacity will be required in the USA and EC-9 since production would be no higher than in 1980 and 1981. In the low case, smaller IDC producers are able to maintain production at around 1980 levels to supply domestic markets and closures of marginal units which are presently operating in EC-9 and USA, as well as permanent closures of presently idle plants, are indicated. The low case projections indicate that unless permanent closures are initiated there will be substantial idle capacity in IDCs in the next few years. Capacity utilization rates in the low case are expected to increase from 75-80% in 1985 to 85-90% in 1995 depending on closures, rationalization and new investments. This projected relationship between demand and supply would mean that steel prices will remain weak. If the high case materializes, capacity utilization would increase from 75-80% in the mid 1980s to 90-95% by 1990. In this case, steel prices would remain weak through the rest of the present decade. After 1990, however, improving demand growth should see the industry operating at close to sustainable capacity by the mid 1990s with commensurately stronger steel prices.

2.13 Base case steel production potential for LDCs was prepared on the basis of known projects (1985-90) and probable projects (1990-95). For the low case some probable projects were excluded and other known projects in part delayed; for the high case, probable projects that could be undertaken were advanced slightly and certain additional projects presently at the planning stage were included by the mid 1990s. For the most part new projects are located in the more advanced LDCs who have existing steel production capacity and who are seeking to develop further capacity to meet their evolving consumption requirements. Several have domestic ore sources but others will require imported ore. Most growth will take place in countries which are the largest producers today, i.e., China, Brazil, India and the Republic of Korea. In addition, moderate increases could be expected for smaller producers such as Mexico. Additional steel production capacity would tend to be concentrated in first, Asian LDCs, and, second, American LDCs with only minor developments in African or European LDCs. Production would be almost entirely for domestic requirements with one or two exceptions--notably Brazil and the Republic of Korea. Even for these countries growth in steel exports would be minor. For European CPEs, production is presently in balance with consumption. It is expected to remain so with an annual average growth from 1985-1995 of about 1.2% per year.

Demand

2.14 Future steel consumption projections have been prepared for IDCs and LDCs based on specific assumptions regarding future economic growth (GDP) and intensity of steel use trends. Consumption projections have also been prepared for European CPEs based on similar factors. The GDP assumptions have been prepared separately for USA, EC-9, Japan, other IDCs and LDCs (as a group) for each of three economic scenarios (namely Base Case, Low Case and High Case). The assumptions indicate overall average annual GDP growth from 1985-95 for IDCs of about 3% in the Low Case, 3.5% in the Base Case and 5% in the High Case. For LDCs, the estimates are in the order of 3.0% per year in the Low Case, 5.0% per year in the Base Case and 6.0% per year in the High Case. The 1980-1985 estimates take into account an economic recovery that is expected to continue in 1985. Detailed assumptions are as shown in Table 2.6 below.

Table 2.6: GDP Growth Assumptions
(in % per year)

	Low Case			Base Case			High Case		
	1980-85	1985-90	1990-95	1980-85	1985-90	1990-95	1980-85	1985-90	1990-95
USA	2.2	2.5	2.3	2.2	3.1	3.0	2.3	4.4	4.6
EC-9	0.9	2.0	2.3	0.9	3.1	3.2	1.1	4.5	5.3
Japan/Others	3.3	3.7	3.7	3.3	4.2	4.1	3.5	6.3	7.0
LDCs	2.5	3.0	3.0	2.8	5.0	5.0	2.9	6.0	6.0

2.15 Estimates of futures rates of decline in steel intensity of use for IDCs were prepared based on an analysis of past trends and underlying causal factors. The rates of decline, in turn, were used to calculate future intensities of use which are expected to decline by 25% to 40% from 1985 to 1995 as shown in Table 2.7 below:

Table 2.7: Industrialized Countries:
Steel Intensity of Use Assumptions, 1985-95
(in grams of steel per $ of GDP in real 1980 terms)

	USA	EC-9	Japan	Others
1985	39.4	33.1	58.0	55.4
1990	33.1-34.1	26.3-27.5	47.6-49.9	44.2-46.7
1995	28.2-30.0	21.3-23.5	38.9-44.2	33.6-39.6

2.16 Overall, it is expected that steel intensity of use will continue to decline, although at a slower rate than previously. It is expected that steel intensity of use will remain lowest in the EC-9 countries and highest in Japan reflecting differences in on-going industrial restructuring trends in the respective countries and a more rapid shift away from heavy industries to light manufacturing and service industries in Europe. Steel products will continue to improve in quality and to be replaced by lighter and stronger materials. Further downsizing of the automobile and less new construction are expected. Better design of products to give longer life, and decrease in population growth rates are other factors. While many of the previous changes are irreversible, the easiest and most beneficial adjustments have been taken. The rate of change will, therefore, be slower. While the potential for further reducing the weight of steel in cars exists, it is not so great as previously. Correspondingly, the scope for further reducing the steel needed for new buildings or even in appliances is reduced compared to the changes that were possible a decade ago. Further, although the trends towards less steel consumption are considered largely irreversible they may also be alleviated in part by a need to repair or replace aging physical infrastructure, especially in the USA, but also in Europe and to a much less extent Japan.

2.17 LDC steel consumption projections were prepared on a country by country basis. For LDCs, estimates were based on an analysis of income elasticity of demand since intensity of use data were not sufficiently reliable. Estimates of income elasticity of demand for steel vary widely from country to country. In general, however, it is lower for the larger LDC steel consumers than the small LDC steel consumers, because the former already satisfied more of their needs which require large amounts of steel. Furthermore, the assumptions also reflect the different developmental circumstances of LDCs vis-a-vis IDCs in that the LDCs tend to spend a greater proportion of their rising income on basic investments in buildings, bridges, factories and other much needed fundamentals of a developing economic infrastructure which tend to be steel intensive as compared to IDCs where such infrastructure is generally well established. For each of the nine largest LDC steel consumers and for the smaller LDC steel consumers as a group, an estimate of future income elasticity was prepared based on historical data and taking into account the degree of industrial maturation existing in some of the more advanced Asian and American LDCs (Table 2.8).

Table 2.8: Income Elasticity of Demand for Steel in LDCs

	1980-85	1985-90	1990-95
Larger LDC Consumers	1.15	1.08	1.00
Smaller LDC Consumers	1.25	1.20	1.15

2.18 The future steel consumption projections are shown in Table 2.9 overleaf. The growth rates implied by the projected steel demand indicate that world steel consumption growth will be in the range of 0.8-2.2% per year from 1985-1995 (Table 2.10). This range is much lower than the 5.5% per year achieved in 1960s but somewhat better than the 0.9% per year from 1970-83. For IDCs, little steel consumption growth is expected. Specifically, IDC steel consumption growth is negative in the low case, 0.4% per year in the base case and 1.3% per year in the high case. Further details are shown below. Steel consumption growth will take place predominantly in LDCs and it appears inevitable that LDCs will substantially increase their share of world steel consumption. LDC steel consumption growth is projected to be in the range 2.2-4.2% per year from 1985-1995. As a result in the base case, LDC steel consumption increases from 23% of world consumption in 1980 to 32% in 1995.

Table 2.9: World Steel Consumption Projections 1980-95
(in million tons crude steel equivalent)

	Actual				Base Case			Low Case		High Case	
	1980	1981	1982	1983	1985	1990	1995	1990	1995	1990	1995
IDCs											
USA	118	128	92	96	110	113	114	108	107	116	123
Canada	14	14	11	11	11	12	13	12	12	13	14
EC-9	106	97	90	88	91	91	91	86	83	92	99
Japan	79	72	70	66	72	74	76	72	75	77	85
Australia	6	7	6	5	6	6	6	6	6	6	7
Spain	9	8	8	8	8	8	9	8	8	9	9
Sweden	4	4	4	4	4	4	4	4	4	4	4
Other IDCs	10	10	9	9	10	10	10	10	10	11	11
Subtotal IDCs	346	340	290	287	311	319	322	305	305	328	352
LDCs											
Asia											
China	42	38	40	48	51	58	68	55	64	60	71
Viet Nam	1	1	1	2	2	2	2	2	2	2	2
Korea, Dem. Rep.	6	6	7	7	7	8	10	8	9	9	10
India	11	12	12	12	13	15	17	14	16	16	19
Korea, Rep. of	6	8	8	9	11	15	19	13	16	18	23
Indonesia	2	2	2	2	2	3	3	2	3	3	3
Saudi Arabia	2	4	5	5	5	6	7	5	6	7	8
Other Asia	34	32	31	34	36	43	46	38	40	46	50
Subtotal Asia	104	103	106	119	127	150	171	138	156	161	186
Africa											
S. Africa	6	7	6	5	6	7	8	7	7	7	8
Algeria	2	2	2	2	3	3	4	3	3	3	4
Egypt	2	2	2	2	2	3	3	3	3	3	4
Nigeria	3	3	3	4	2	3	3	2	3	3	3
Other Africa	4	4	4	4	4	5	6	4	5	6	7
Subtotal Africa	17	18	17	17	17	21	24	19	21	22	26
America											
Argentina	4	2	3	3	3	4	5	4	4	5	6
Brazil	15	12	11	9	12	14	17	13	15	16	19
Mexico	11	13	9	6	8	10	12	9	10	12	14
Venezuela	3	3	3	2	3	4	5	4	5	5	6
Other America	4	4	3	3	3	4	5	4	5	5	6
Subtotal America	37	34	29	23	29	36	44	34	39	43	51
S. Europe											
Turkey	3	3	3	4	4	5	5	4	5	5	6
Yugoslavia	6	6	5	5	6	7	8	7	7	8	8
Other S. Europe	3	4	3	3	4	5	6	5	5	5	6
Subtotal S. Europe	12	13	11	12	14	17	19	16	16	18	20
Subtotal LDCs	170	168	163	171	187	222	258	207	232	244	283
European CPEs											
USSR	151	152	152	152	152	162	171	158	166	165	175
Hungary	4	3	4	4	4	4	4	4	4	4	4
Romania	12	12	12	12	12	13	13	13	13	13	14
Other European CPEs	43	39	37	42	43	45	47	43	45	46	48
Subtotal European CPEs	210	206	205	210	210	224	236	218	228	228	241
Grand Total	726	714	658	668	708	766	816	730	765	800	876
Total IDCs and LDCs	516	508	453	458	498	542	580	512	537	572	635
Total Market Economies a/	467	463	405	401	438	473	500	445	462	501	552

a/ Excludes European CPEs; China; Korea, Dem. Rep.; Viet Nam.

Note: Totals may not add due to rounding.

Table 2.10: Annual Average Growth Rate of Steel Demand, 1985-95
(in % per year)

	Base Case	Low Case	High Case
IDCs	0.4	(0.2)	1.3
Asian LDCs	3.0	2.1	3.9
African LDCs	3.5	2.1	4.3
American LDCs	4.3	3.0	5.8
Southern European LDCs	3.1	1.3	3.6
LDCs	3.3	2.2	4.2
European CPEs	1.2	0.8	1.4
Grand Total	1.4	0.8	2.2
IDCs and LDCs	1.5	0.8	2.5
Market Economies	1.3	0.5	2.3

Supply-Demand Balance

2.19 The steel supply-demand balance for specific countries and regions is quite sensitive to the underlying assumptions and projections regarding steel demand behavior and steel production trends. Demand for and consumption of steel products are basically a function of a country's economic activity. Overall economic changes are inherently difficult to predict in terms of the speed and extent of adjustment. Thus, different economic growth rates alter the projected supply-demand balance. Furthermore, the degree of responsiveness of steel producers in aggregate to demand changes will determine the extent to which periods of oversupply or undersupply persist in the international market. Such responsiveness, includes on the one hand, production and capacity adjustments and, on the other hand, taking measures to slow substitution away from steel and increase demand. Such measures would include finding new uses for steel, introducing new steel products, and improving processing costs to make steel more competitive. The market assessment presented above indicates that IDC producers will compete both to defend domestic markets and to increase exports in order to minimize capacity closures. LDC producers, however, will tend to add new capacity to meet domestic requirements and reduce the use of scarce foreign exchange for steel imports.

2.20 Historically, LDCs have been net importers of steel from industrialized countries. Taking into account the considerations noted in the previous paragraph, the future supply-demand projections indicate that LDCs will continue to be net importers with imports likely to be in the range of 40-65 mtpy crude steel equivalent as shown in Table 2.11 overleaf. Further, it is expected that the USA will continue to be a net importer of steel (of about 20% of steel consumption) and that Japan and EC-9 would be net exporters, together with the Republic of Korea and Brazil. More specific import and export estimates and trade flow linkages have not been attempted. It should be emphasized that the trade flows are in net terms (as opposed to gross exports and imports) and that they are in units of crude steel equivalent, whereas actual trade would be in finished steel. The conversion of the crude steel apparent trade estimates into finished steel units is not straightforward because of different yield coefficients in different countries and the trade estimates should, therefore, be viewed as indicative.

Table 2.11: World Steel Supply and Demand, 1980-95
(in million tons crude steel equivalent)

	Actual				Projected						
					Base Case			Low Case		High Case	
	1980	1981	1982	1983	1985	1990	1995	1990	1995	1990	1995
Supply											
IDCs	391	387	321	326	354	372	376	350	346	393	411
LDCs	115	117	121	125	144	170	204	162	191	179	224
Eur. CPES	209	206	204	212	210	224	236	218	228	228	241
Grand Total	714	710	645	663	708	766	816	730	765	800	876
Demand											
IDCs	346	340	290	287	311	319	322	305	305	328	352
LDCs	170	168	163	171	187	222	258	207	232	244	283
Eur. CPEs	210	206	205	210	210	224	236	218	228	228	241
Grand Total	726	714	658	668	708	766	816	730	765	800	876
Net Exports from IDCs to LDCs	50	49	36	43	43	53	54	45	41	65	49

Note: Totals may not add due to rounding.

2.21 Specific estimates for trade with European CPEs were not prepared. In the early 1970s, these countries were minor (1-3 mtpy) net exporters of steel. More recently, they have tended to be minor net importers but the quantities involved continue to be very small. Without more detailed information on the nature of future trends, no attempt has been made to estimate a specific assumption for net steel trade with European CPEs. The implicit assumption is that gross steel exports and imports to European CPEs will be approximately equal.

2.22 Every steel producing country desires to operate at optimum capacity for financial purposes as well as for socio-political considerations. During times of worldwide recession this may mean exporting steel to countries which already have idle capacity. In effect, it decreases the importing country's capacity utilization and steel-related employment. For many years, the US steel industry has been vulnerable to competition from foreign imports in certain categories of steel. From time to time the industry has sought government assistance to reduce the size of imports. Trade related measures for steel go back to the late 1960s, when the USA, principal steel producer in the post World War II period, became the leading importer of steel, as producers in Europe and Japan sought a share of the unrestricted US market. A series of measures have been implemented since 1968 when, under threats of action by Congress, the Japanese and West Europeans agreed to voluntary restraints on their imports for 3 years. In late 1971 a 10% surcharge was imposed on all imports, and in 1972 agreement on an extension of the voluntary restraint agreements (VRA) was reached. This ended quickly as suits were filed based on the Sherman Anti-Trust Law.

2.23 Other actions have been a system of "trigger prices" initiated by the Administration in 1977, and a series of "antidumping" suits filed before the ITC in 1982, after failure of US government representatives and EC officials to agree on import restrictions in 1981 meetings. Most recently, increased penetration of the US steel market by foreign producers (more than 25% of apparent consumption in the first four months of 1984) has resulted in Bethlehem Steel Corporation and the United Steel Workers of America filing a petition in January 1984, under Section 201 of the 1974 Trade Act, before the International Trade Commission (ITC) requesting that imports of steel be restricted to 15% of the US market. A ruling by the ITC in mid-June 1984 found that imports were a source of injury in five of nine product categories, representing over 70% of total US steel consumption. However, the proposed remedies were not enforced by the President of the United States. Instead, other measures were preferred including negotiations to achieve voluntary restraints by steel exporters to the USA. At the same time, Congress is considering possible legislative means to reduce steel imports and protect US producers.

2.24 The world steel outlook is critical in considering the production prospects of existing iron ore mines as well as determining the need for new iron ore mines. The steel industry comprises virtually the entire market for iron ore. An estimated 98% of consumed iron ore goes to steel industry blast furnaces to produce pig iron for steelmaking. The remainder is used in steelmaking furnaces, direct reduction plants and miscellaneous uses. Iron ore production and consumption is thus inextricably dependent on steel industry production and consumption trends. Further, steel mills have close ties with the iron mines in terms of ownership and long-term market commitments, as discussed in Chapter III.

III. WORLD IRON ORE - PAST TRENDS AND CURRENT STATUS

3.01 This chapter reviews past production and consumption patterns for iron ore and examines the structure of the international iron ore industry with respect to the impact of steel company involvement in iron ore mines. Further, the cost structure of major producing regions is compared to assess their competitiveness in exporting to the US, European and Japanese markets. The next section focuses on different types of marketing arrangements and pricing mechanisms. Past price trends are reviewed and the increased importance of transactions at spot market prices as well as the impact of exchange rate changes on iron ore export prices are discussed. Volume and patterns of international iron ore trade, supplemented by a review of shipping costs are presented to show the evolution of trade and to illustrate recent shifts of supply.

Production and Consumption

Production

3.02 Iron ore as found in nature has a variety of physical and chemical properties. The main ores consist of the two iron minerals, magnetite (Fe_3O_4) and hematite (Fe_2O_3). Other non-iron bearing minerals such as quartz (a combination of silica and oxygen) occur in the iron ore. In addition, there are a host of other elements that occur, from trace amounts to a few percentages in the ore. The most undesirable of these from the point of view of iron and steelmaking are sulphur, phosphorus, arsenic and titanium. The average grade in most of the important producing countries such as Australia and Brazil, is 65% iron content. Typical iron ore in Brazil and Australia is also very low in impurities. The average grade of North American crude ore is much lower, 32% iron in the USA and 35% in Canada.

3.03 Brazilian, Australian and most of the West African iron orebodies form topographic highs because of a resistance to erosion and the orebodies can easily be mined from the side of the hill. Very little waste removal is required to get at the ore. In contrast to this, North American ores require pit development and must undergo extensive blasting because of the inherent hardness of the ores. While the waste (barren rock) to ore ratio may be less than 0.2 in Brazil and Australia the ratio is closer to 1 in Canada and the United States. For some ore bodies it is on the order of 4 or 5 as for example, Minnesota and Michigan taconites. Underground mining of iron ore is rare because of the high cost associated. Among the more important producers, only Sweden and France operate underground mines and only Sweden produces at competitive cost.

3.04 Many of the important iron ore mines produce lump ore and fines (sinter feed). Lump ore and fines are usually produced at the mine or loading port site by screening of high-grade ores. The iron content of the final product is generally 62-68%. However, some consumers prefer to purchase high-grade run-of-mine ores and screening is done at the steel plant site. While run-of-mine or screened lump is charged directly to the blast furnace, the fines must be first agglomerated by sintering (i.e., mixed with coke breeze and fired on a travelling grate to produce a coarse, porous sinter-like product). The finest fraction of these ores may not be suitable for sintering and these ultra fines, which may account for about 25 per cent of the total ore, are used to make pellets.

3.05 Concentrates at 62-65% iron content are produced from low-grade ores by separating the iron ore minerals from the waste (gangue). The upgrading process, or beneficiation, entails a higher production cost than that for the simple mining and screening of run-of-mine high-grade ores because of the additional labor, materials, energy and capital required. If the concentrate is coarse, it can be used directly for sintering or, after further grinding, for pelletization. These concentrates are often blended with high-grade fines at the steel plant site before sintering. The concentration of iron ore results in the loss of some of the iron. Iron recovery usually exceeds 90 per cent.

3.06 Ultra fine concentrates, in addition to ultra fines from screening high-grade ores, are usually pelletized. In contrast to the sintering process, pelletization involves balling the ultra fine ore and concentrate with bentonite, then hardening by the application of heat. Pellets average 62-68% iron content. Because sinter is more friable than pellets, almost all sinter is produced near the blast furnace in order to minimize handling, whereas most pellets are produced at the mine site or shipping terminal. Both sintering and pelletizing are energy intensive. However, sintering uses low-quality energy (coke breeze made from coal) while pelletizing requires high-quality energy (oil or gas). Sintering on the other hand, gives rise to more serious pollution problems.

3.07 World production of iron ore grew at about 3.7% per annum from 1960-75, stagnated between 1975-79, and decreased by about 7.9% per year between 1979-83. Reported iron ore shipments suggest that production in 1984 will be considerably higher than in 1983. Over the past two decades, there has been a shift in production away from the industrialized countries, particularly the USA and EC countries, toward the LDCs and Australia. LDCs accounted for about 41% of total iron ore production in 1983, compared to 28% in 1960. Production from LDCs and Australia accounted for about 81% of all 1983 production in market economies. The largest iron ore producer in 1983 was the Soviet Union (245 million tons), followed by Brazil (92 million tons), Australia (72 million tons), China (72 million tons), India (48 million tons), the USA (39 million tons), Canada (30 million tons), South Africa (25 million tons) and Liberia (15 million tons). Their combined share of world production in 1983 was 85%. Table 3.1 overleaf summarizes production and the rate of growth of iron ore from 1960 through 1983:

Table 3.1: World Production of Iron Ore, 1960-83
(in million tons)

	1960	1970	1975	1980	1981	1982	1983	Annual Average Growth Rate (%) 1960-70	1970-80	1980-83
IDCs	262	328	337	296	278	214	190	2.3	(1.0)	(13.7)
LDCs	145	240	324	329	326	313	305	5.2	3.2	(2.5)
Subtotal DCs and LDCs	407	568	661	625	604	527	495	3.4	1.0	(7.5)
European CPEs	115	206	242	251	249	250	251	6.0	2.0	0.0
Grand Total	522	774	903	876	853	777	746	4.0	1.2	(5.2)

Source: World Bank, Economic Analysis and Projections Department.

Consumption

3.08 Total world apparent consumption[4] of iron ore grew at an annual average rate of 3.9% per year from 1960-70. Growth slowed to 1.2% p.a. from 1970-80 and consumption declined by 2.9% p.a. between 1980-83. Firm 1984 consumption figures are not yet available but are expected to be in the order of 835 mtpy, about 5% higher than in 1983. Table 3.2 below summarizes the apparent consumption of iron ore from 1960-83.

Table 3.2: World Apparent Consumption of Iron Ore, 1960-83
(in million tons)

	1960	1970	1975	1980	1981	1982	1983	Annual Average Growth Rate (%) 1960-70	1970-80	1980-83
IDCs	324	469	491	426	424	344	347	3.8	(1.0)	(6.6)
LDCs	82	94	157	175	174	178	181	1.4	6.4	1.1
Subtotal IDCs and LDCs	406	563	648	601	578	522	528	3.3	0.7	(4.2)
European CPEs	120	208	249	266	261	259	265	5.7	2.5	(0.1)
Grand Total	526	771	897	867	859	781	793	3.9	1.2	(2.9)

Source: World Bank, Economic Analysis and Projections Department.

4/ There are no statistics in iron ore consumption published. Apparent consumption is estimated based on iron ore production plus country imports less country exports.

3.09 The major iron ore consuming areas are North America, Western Europe, Eastern Europe, East Asia, and Australia and New Zealand. In 1973 these accounted for 96% of world iron ore consumption and in 1983 for 92%. The combined share of the other consuming areas (South Asia, Latin America, and Africa) increased from 4% in 1973 to 8% in 1982. Between 1973 and 1983 the combined shares of North America and Western Europe dropped from 47% to 30%. Latin America's share went up from 2% to 5%. Eastern Europe's share increased from 25% to 33%, and that of East Asia, Australia and New Zealand from 24% to 26%.

3.10 In terms of product, the choice for modern steel plants is essentially between sinter feed and pellets with lump ore being used on a percentage basis in many blast furnaces. One of the economic reasons for the preference of sinter feed by European and Japanese steelmakers is the ability of sinter plants to utilize coke and internally generated energy from blast furnace coke oven gases. In addition, many different ores can be blended to a consistent feed material, including ores of lower quality that may appear on the spot market at low cost. In North America, the disappearance of high grade natural ores influenced the use of hard low-grade ores, and although the capital costs were high for the pellet plants, a superior pellet product made for more efficient ore usage and higher productivity in steelmaking. Uniformity, ease of handling and consistent action in the furnace generally favor pellets, but state-of-the-art sinter is as consistent in quality as pellets. Moreover, sinter has, beside cost, the advantage that it avoids the segregation problems in the blast furnace caused by the pellets' shape. Therefore, sinter use can be expected to remain high for the foreseeable future, especially by mills in Europe and Asia which can receive cheap high quality sinter feed.
Table 3.3 overleaf shows the consumption by ore type in North America, the EC and Japan from 1975 to 1980.

Table 3.3: Ore Consumption by Type for Selected Users, 1975-80
(in million tons)

	Pellets	Fines and Other Ores for Sintering	Lump Ore and Other Direct Use Ores	Total
EC				
1975	6.1	131.0	30.1	167.2
1976	7.1	138.0	25.9	171.0
1977	7.4	129.5	28.0	164.9
1978	9.6	129.5	11.4	150.5
1979	14.8	120.8	33.0	168.6
1980	13.9	121.3	18.8	154.0
Source: Iron-Steel Statistics for Europe.				
North America				
1975	62.1	23.4	22.4	107.9
1976	76.0	22.9	17.0	115.9
1977	72.6	21.4	15.0	109.0
1978	81.7	22.2	13.9	117.8
1979	86.4	20.7	9.6	116.7
1980	68.1	15.6	7.0	90.7
Source: American Iron Steel Institute.				
Japan				
1975	16.9	108.9	a/	125.8
1976	16.5	111.9		128.4
1977	18.1	111.9		130.0
1978	20.2	96.4		116.6
1979	25.1	100.8		125.9
1980	22.1	106.0		128.1

a/ Included in fines and other ores

Source: Japan Iron & Steel Federation.

3.11 Pellet consumption in the EC increased from 3.6% of total ore consumption in 1975 to 9% in 1980, replacing some of the lower grade direct use ores of intra EC origin, whose share of total consumption decreased from 18% in 1975 to 12.2% in 1980. Ores for sintering maintained their share of consumption at about 78-79%. Pellets dominate North American consumption. Their share increased from 57.5% in 1975 to 75.1% in 1980. As high grade direct use ores became more scarce, their share of consumption decreased from 20.7% in 1975 to 7.7% in 1980. Use of fines decreased from 21.6% in 1975 to 17.2% in 1980 because domestic pellets replaced off-shore fines from Venezuela. Pellets account for about 17% of Japan's ore consumption. Individual data on sinter feed and lump ore is not available but it is estimated that their respective shares of total consumption are 70% and 13%.

Structure of the Industry

3.12 This section addresses two structural aspects which have considerable impact on the competitive international position of different iron ore producers. The first one is the industry's ownership structure and its evolution, in particular with regard to steel company involvement. The second one is the cost structure of major producers.

Ownership

3.13 The ownership patterns of existing iron ore mines include various combinations of private, public, domestic, and foreign shareholding. Countries with wholly government-owned iron ore industries include Chile, Venezuela, Peru, Algeria, and Mauritania, in addition to the CPE producers. Wholly privately owned industries exist in Australia and the USA. Combined private and government ownership exists in India, Liberia, Sweden, France, South Africa, and Brazil.

3.14 The most significant ownership aspect is whether or not steel companies have directly invested in a mine. During project preparation their financial commitment encourages other investors and lenders. Later, during operation, they offer a relatively secure market outlet for at least part of the production and the prospect of financial support, should difficulties arise. One motive for steel company investments in iron ore mines is to maintain a plentiful iron ore production capacity, which in turn tends to keep iron ore prices down. Investments are also made to diversify sources of supply and secure supply in general.

3.15 In the 1950s and 1960s US steel companies invested in Venezuelan and West African (Lamco) iron ore mines, replacing decreasing supplies of high-grade direct-shipping ores from the Lake Superior region. With the development of the pelletization process, which permitted upgrading of low-grade US (and Canadian) ores to a high quality product, the necessity for off-shore investments by US steel companies ceased. In the 1960s and earlier, German, Italian, and Spanish steel makers invested in West African (Bong) and Brazilian iron ore mines (Ferteco, Mannesmann) as well as in Brazilian pelletizing plants (Hispanobras, Itabrasco). All of these, except Lamco, were or are captive operations, producing exclusively for their foreign steel company shareholders. After the 1960s, with large independent capacities coming on stream, there was no further need for investments by European steel mills in off-shore iron ore mines.

3.16 North American steelmakers have invested in North American iron ore mines and pelletizing plants as well, often in form of joint ventures, to diversify their raw materials supply while at the same time seeking to benefit from vertical integration. At present they control 86% of the US production capacity and 84% of the Canadian one.

3.17 Japanese steel as well as trading companies, while largely relying on long-term contracts to meet their iron ore needs, have invested seed funds to help bring about development of the major Australian mines (Hammersley--divested recently, Mt. Newman, Robe River) in the 1960s. More recently Japanese steel companies have invested in the Carajas mine in Brazil currently under construction. Whereas the equity investment in Australian mines were motivated by expected higher iron ore demand, supply diversification and enhancement of stable price prospects appear to have been the major rationale for the investment in Carajas, although at the time that the decision was made to invest in Carajas projections of iron ore demand were considerably higher than they are now. Supply diversification too was the main motive for investing in the NIBRASCO pelletizing plant in the 1960s and the Capanema mine in the early 1980s, both of which are in Brazil and are captive operations, i.e., they produce exclusively for the Japanese shareholders.

3.18 Table 3.4 below summarizes the current steel company ownership of iron ore mines in major producer countries. As mentioned, a large majority of the North American mines are owned by the steel companies of Canada and the US. In comparison, Australia, Brazil and West Africa, the major producers of seaborne iron ore, have only minor steel company involvement and in general operate independently.

Table 3.4: Steel Company Ownership of Iron Ore Mines in Major Producer Countries

Country	Production Capacity (mtpy)	Steel Company Ownership (%)				
		US-Canadian	Japanese	W.Europe	Australian	Total
USA	75	86	-	-	-	86
Canada	50	84	-	4	-	88
Australia	100	-	16	-	11	27
Brazil	140 a/	-	5	9	-	14
West Africa	25	-	-	15	-	15

a/ Including Carajas.

Source: World Bank, Industry Department.

3.19 In assessing the prospects for direct steel company investments in future off-shore iron ore projects, it is important to recollect that steel companies have tended to view security of supply and stable prices of their raw materials as a critical requirement for their own long-term viability. In the past, their strategy for achieving these two objectives was to diversify sources of supply and to encourage plentiful iron ore production capacity worldwide. In pursuing this strategy steel companies have generally limited their financial involvement to the minimum necessary. However, with weak long term growth prospects for iron ore demand and, after development of Capanema and Carajas, more than ample supply until the early 1990s, steel company concern to further diversify supply for risk management purposes has been greatly reduced. There is expected to be little, if any incentive for steel companies to invest in iron ore mines which will be producing before the mid-1990s, except that European steel mills may be interested in replacing defunct West African capacity to maintain present levels of supply diversification.One of the major producers (LAMCO in Liberia) will deplete its developed reserves by the end of the 1980s and one mine (NIOC in Liberia) ceased operations in early 1985. If West Africa's share of iron ore supply to the European steel mills is to be maintained, replacement capacity will need to be developed. Whether the European steel mills would be prepared to make a direct investment, will primarily depend on the degree of supply concentration (Brazil) deemed tolerable to them during the 1990s as well as supply prospects in general.

Cost Structure of Major Producing Regions

3.20 The producing regions for this comparison consist of the USA (Minnesota), Canada (Quebec-Labrador), Australia (Northwest), Brazil and West Africa, representing about 67% of market economy production in 1983. Other regions might have been included, but adequate information for comparative purposes was not available. The analysis presents representative production costs for each region, both in aggregate and in terms of costs of different inputs, which are then used to estimate delivered ore costs to the markets. Varying accounting methods for remaining mine life and associated capital costs, shifting exchange and inflation rates in supplier countries, and the fact that production costs are one of the more closely guarded secrets of the industry, in particular in the USA and Canada, increase the difficulty of comparing costs. Therefore, the cost data presented should be viewed as indicative of competitive ranking and cost structure of different regions, rather than as an exact estimate of individual cost elements. Further, the costs of specific producers in each region will range around the average figures presented below.

3.21 Table 3.5 overleaf shows the comparator group's 1984 fob costs per ton of sinter feed. Fob costs are here defined as those costs incurred in delivery to the hold of a ship at the producer's terminal. It should be noted that, in the face of weak demand, low prices and extreme competitive pressures, most producers have been undertaking substantial cost reduction efforts in the past few years. Some producers have suggested that late 1985 costs may therefore be significantly lower than the estimates shown in the table for 1984 especially in North America where greatest scope exists for cost reductions. However, insufficient information is available to permit the table to be updated.

Table 3.5: Estimated Comparative Sinter Feed FOB Costs in 1984
(US$ per ton)

Cost Component	USA US$	USA %	Canada US$	Canada %	Australia US$	Australia %	Brazil US$	Brazil %	West Africa US$	West Africa %
Labor	6.9	25	5.9	25	3.4	23	1.0	7	4.0	22
Energy	4.4	16	2.2	9	0.7	5	0.9	6	1.6	9
Supplies	6.2	22	6.2	26	4.2	28	4.2	30	4.7	26
Transport and Handling	4.4	16	3.9	17	3.0	19	3.9	28	3.2	18
Operating Costs	21.9	79	18.2	77	11.3	77	10.0	71	13.5	75
Depreciation and Amortization	2.2	8	2.4	10	1.6	11	2.1	15	2.6	15
Interest	1.1	4	1.2	5	0.8	5	1.1	7	0.6	4
Royalties and Management Fees	1.2	4	1.2	5	0.5	3	0.4	3	1.1	6
Local and Royalty Taxes	1.5	5	0.6	3	0.6	4	0.5	4	0.1	0
Total Costs	28.0	100	23.6	100	14.8	100	14.1	100	17.9	100

Source: World Bank, Industry Department.

3.22 The sinter feed cost structures of these producers are similar in that operating costs represent 75-78% of production cost and overhead expenses 22-25%. The relative weight of individual cost categories is also quite uniform with three exceptions. First, Brazil's labor costs are very low and represent only 7% of total production cost, as compared with 22-25% for the other producers. Second, Brazil's transport and handling costs at 28% of its total cost are relatively much higher than the average of 17% for the other producers. Third, the relative energy costs in the US, due to hard low-grade ore mined, represent 16% of total cost as compared with an average 7% for the other producers.

3.23 Australia and Brazil, the biggest producers of sinter feed, are also the lowest cost producing regions. Brazil's costs are slightly lower than those of Australia, but the difference falls within the margin of data inaccuracies and therefore both producers' Fob costs can be considered equal. Australia has lower transport and energy costs, whereas Brazil has much lower labor costs. West Africa's costs are 24% higher than those of Australia and Brazil. The most significant difference to Brazil are labor costs. At US$4 per ton, West Africa's cost is four times higher than Brazil's. The USA and Canada are the highest cost producing regions of sinter feed. The overall cost for Canada is 67% greater than Brazil's corresponding cost while that for the US is 98% higher than Brazil's cost. Higher costs are not limited to a few categories, but are evident across the board. Due to lower energy and local as well as royalty taxes, Canadian production costs are 16% below those of the USA. It should be noted, however, that US and Canadian producers are making sustained efforts to reduce costs, especially labor and energy costs, and reduce differentials vis-a-vis other producers.

3.24 Comparative costs for the production of pellets follow similar patterns as shown in Table 3.6 below (West Africa has no significant pellet production and is therefore not included in the comparison). As with sinter costs, it is suggested by producers that by late 1985 costs are noticeably lower than in the table below, especially for North American producers.

Table 3.6: Estimated Comparative Pellet FOB Costs in 1984
(US$ per ton)

Cost Component	USA		Canada		Australia		Brazil	
	US$	%	US$	%	US$	%	US$	%
Labor	8.6	22	7.1	20	5.5	23	1.6	7
Energy	8.2	21	6.3	18	3.5	14	3.0	14
Supplies	7.5	19	7.6	22	7.4	30	7.2	33
Transport and Handling	3.8	9	3.9	11	2.9	12	3.9	17
Operating Costs	28.1	71	24.9	71	19.3	79	15.7	71
Depreciation and Amortization	3.2	8	3.3	10	2.4	10	3.2	15
Interest	1.7	4	1.7	5	1.2	5	1.7	8
Royalties and Management Fees	2.8	7	2.9	8	0.8	3	0.7	3
Local and Royalty Taxes	4.0	10	2.3	6	0.7	3	0.6	3
Total Costs	39.8	100	35.1	100	24.4	100	21.9	100

Source: World Bank, Industry Department.

3.25 Brazil is the lowest cost pellet producing region. Additional labor cost advantages of US$1.42 per ton as compared with sinter feed are the main reason for making pellet production in Brazil 10% less costly than in Australia. Pellet production costs in the USA are 82% higher than Brazil and 13% higher than in Canada; the latter's costs are 60% above the Brazilian ones.

3.26 Competitiveness is not only determined by production cost but also by transport costs[5] which significantly influence the cost of iron ore delivery to a given destination. Delivered 1983 costs of sinter feed and pellets to Europe (Rotterdam), Japan (Yokohama), and the USA (Northern Harbors) are presented in Table 3.7 overleaf. Subsequently delivered costs in the US Great Lakes area are given and the potential for penetration of this market by offshore ore is discussed.

5/ For details on freight rates see paras 3.54-3.55.

Table 3.7: Comparative 1983 CIF Cost for Sinter Feed and Pellets
(US$ per ton)

To	From	Delivered Cost Sinter Feed	Delivered Cost Pellets
Rotterdam	Australia (Port Hedland)	22.7	32.0
	Brazil (Tubarao)	19.1	26.6
	Canada (Sept Isles)	27.1	38.3
	West Africa (Buchanan)	21.5	-
Yokohama	Australia	18.5	27.8
	Brazil	21.2	28.7
US-Northern Harbors	Brazil	18.6	26.2
	Canada	24.2	36.2
	West Africa	21.5	-

Source: World Bank, Industry Department.

3.27 The table indicates how the competitive ranking of different producers changes as a result of freight rate differentials for delivery of iron ore to specific markets. West African ore delivered to Rotterdam is 6% less costly than Australian ore, although its fob costs are 20% higher. The delivered cost of Australian sinter feed and pellets to Japan is respectively 15% and 4% lower than that of the Brazilian products, whereas respective Australian fob costs are 5% and 11% higher than the Brazilian ones. Canada's proximity to northern US harbors narrows its cost disadvantage in this market; to a lesser extent this is also the case in Rotterdam vis-a-vis Brazilian ores.

3.28 The cost data demonstrates that Brazil is the lowest cost supplier in the Atlantic market and Australia in the Pacific market. The cost comparisons also raise the question whether offshore ores can penetrate the US market. At issue here is not the East Coast market, which is already wholly supplied by Canadian and offshore ores, but the Great Lakes market, which represents 75% of total US iron ore consumption. Since most of the iron ore mines are owned by steel companies, which have to meet the mines' debt service obligations in any event, new iron ore suppliers attempting to enter the USA market will have to compete with the variable costs of North American producers rather than total costs.

3.29 In physical terms it is conceivable to deliver iron ore into the mid-continent area of the US from foreign suppliers via either the St. Lawrence Seaway, rail from eastern seaboard ports or barge on the Mississippi and Ohio River networks. Rail transport to Chicago, where the bulk of low cost steel capacity in the US is located, would cost about US$20-24 per ton, far above the competitive margin of offshore ores. Transport by barge would cost about US$10 per ton into the mid-continent market, but would be limited to the few steel mills, which receive coal by barge and therefore have unloading facilities. Probably the most feasible way to transport larger volumes of offshore ore to Chicago would be through the St. Lawrence Seaway with reloading on smaller ships in Contrecour, Quebec. Freight, unloading and handling charges would be in the order of US$6.50 per ton to Chicago. The cif cost to Chicago of the lowest cost offshore ore, i.e., from Brazil, would be about US$25 per ton for sinter feed and about US$33 per ton for pellets, as compared with US$24 per ton for US sinter feed and US$35 per ton for US pellets. The comparison indicates that there is currently no compelling cost argument for US steel mills in the Great Lakes area to purchase offshore ores. Further it would be expected that North American miners would make major efforts to keep costs competitive with any imports. In addition, steel companies are concerned about the long term availability of their sources of supply (in domestic negotiations most US steel companies insist on 30 years reserves before taking an interest in a project), and any new competitors from abroad would have to assure domestic steel companies of stable long-term supplies. This would probably be a difficult task, and while some US steelmakers would buy offshore ore on a price basis, they would do so only sporadically and for small amounts.

3.30 The cost comparisons presented earlier in this section show the current competitive alignment of the different producers. Regarding the evolution of costs over the next few years, several comments can be made. First, Australia's position as a lowest cost producing region should remain stable during the rest of the 1980s and into the early 1990s. As Carajas is being phased in from 1986, average Brazilian production costs will rise due to increased depreciation and interest charges, but Brazil can still be expected to remain a low cost producer. The average cost of West African ore will also increase. Mauritania's Guelbs project will drive up operating costs, depreciation and interest; if the Western Area deposit in Liberia or any other deposit elsewhere in West Africa is developed, higher depreciation and interest charges will also increase average production costs. Second, since iron ore prices are normally set in US$, any variation of a producer country's currency against the US$ in constant terms has competitive implications, which increase with the local portion of production costs. Based on estimates of the local portion of production costs in selected producer countries and the constant term exchange variations of the local currencies in question as compared to the US$, Table 3.8 overleaf shows the resulting changes of constant term production costs during the period between the second quarters of 1981 and 1983. Whereas Australia, Brazil, and Sweden enjoyed substantial cost decreases, production costs in West Africa and India decreased only slightly or not at all, and Canadian costs even increased in US$ terms for the period considered.

Table 3.8: Impact of Constant Term Local Currency Variations against US Dollar on Selected Iron Ore Producers
(percent)

Country	Estimated Local Content in Production Costs	Constant Term Devaluation (Revaluation) of Local Currency against US$ a/	Real Term Decrease (Increase) of Production Costs in US$ terms a/
Australia	90	17.0	13.1
Brazil	80	17.4	11.8
Canada	95	(4.3)	(4.1)
India	60	9.0	5.0
Liberia	20	-	-
Mauritania	20	8.0	1.5
Sweden	85	44.0	26.0

a/ Between second quarters of 1981 and 1983.

Source: World Bank, Industry Department.

The analysis underlines the considerable influence that differing exchange rate adjustments have on relative production costs, emphasizing the variability of production costs over time. The absolute impact of exchange rate adjustments is somewhat softened by the adjustment of debts which are denominated in foreign currency. Both interest and amortization of such debt increases in terms of local currency due to devaluation, and correspondingly, decreases due to revaluation.

Marketing of Iron Ore

3.31 Long-term contracts have been the main instrument for marketing iron ore and are expected to continue to dominate transactions between suppliers and consumers. The international spot market for iron ore has traditionally been very small with only about 10% being traded on a spot basis. However, due to reduced demand and worldwide excess iron ore production capacity, the importance of the spot market has increased in recent years. Iron ore from mines that are captive to the steel industry is produced and shipped on the basis of schedules set by the steel company owners. Most mines negotiate their marketing arrangements directly with the steel mills.

Long-Term Contracts

3.32 Long-term contracts are usually concluded for periods from 5 years up to 10 years, specifying annual off-take volume, chemical and physical properties, penalties and duration of contract. While some of the early long-term contracts in the 1960s contained price and escalation clauses, today's long-term contracts specify no prices. Prices are negotiated separately on an annual basis. Although the long term contract specifies the volume of annual shipments, the steel companies in practice adjust their off-take to the actual ore requirements of a given year. Downward adjustments are the rule, because steel companies, seeking to secure ample supply, have tended to overcontract themselves. As a result, the cumulative iron ore demand suggested by existing long term contracts is considerably higher than actual demand. For example, Japan's expected iron ore imports in 1984 are estimated at 110 million tons, 31% below the contracted volume of 160 million tons.

3.33 Generally, steel companies stress the importance of maintaining long-term supply relationships and tend to treat suppliers equitably by reducing off-takes proportionately. However, the present and medium-term oversupply is so large and projected demand growth so small, that some steel mills have chosen to neglect servicing of their long-term contracts and instead supply themselves increasingly on a spot basis. Reportedly, one European steel company has suggested to cancel all of its existing long-term contracts. Japanese steel makers have responded by undertaking a study to develop policies regarding contract extension upon expiration with a view to slimming their contract volume. While no specific results are known (the study was completed in late 1984), it is expected that there will be no automatic renewal for any of the Japanese contracts. Instead various conditions will be set out based on which renewal will be considered.

3.34 As a tool used by the steel companies to encourage new iron ore developments, the long-term contract has lost much of its previous effectiveness. While it continues to confirm the acceptability of a mine's output in terms of product and quality, and establishes that the steel company wishes to form a long-term supply relationship, it offers little, if any, assurance that the annual tonnages stipulated will be lifted. This implies that the assessment of the marketing potential of a new iron ore mine has to be based primarily on general demand/supply prospects and cost competitiveness.

Spot Market

3.35 Although traditionally very little iron ore was sold in the international spot market, indications are that the volume of transactions in the spot market has been increasing since 1982 when demand contraction began to be fully felt. Iron ore producers face low off-takes on their contracts and appear to be increasingly forced to make sales on a spot basis, reportedly at discounts of up to 25%. Steel companies tend to believe that iron ore oversupply will continue for some time and take advantage of the price opportunities offered. German steel mills expected to buy about one third of their 1984 volume in the spot market. On the supply side, South Africa's long-term European contracts have expired and have not been renewed. Therefore all sales are transacted on a spot basis. South African discounts in 1984 were reported particularly high, designed to recapture a share of the long-term contract market lost when contracts were not renewed. Strong competition for scarce demand can be expected for the rest of the 1980s and therefore the spot market is not likely to diminish during this period, although major suppliers and consumers will continue to do most of their business on the basis of long-term contracts.

Captive Mines

3.36 Captive production is not marketed in the true sense, but the steel company owners of such mines determine their annual iron ore requirements, which then become the basis for the production and shipment program. The steel company owners of mines in the USA and Canada have full joint discretion to adjust the production program at any time to reflect their changing needs, although lending institutions often insist that mines operate at specified rates of capacity to assure repayment of loans, making it more difficult to curtail production. Captive mines in developing countries that are owned not only by foreign steel companies but also by local shareholders (Government, public enterprises), have generally a commercial arms-length relationship with the steel companies, who have less short-term discretion with respect to the production program. A decrease in production is more difficult to implement in developing countries, because Governments are concerned about the employment, foreign exchange earnings, tax and royalty implications of lower production.

3.37 The relative importance of captive supplies in relation to overall market volume is greatest in North America, where they represent about 90% of total tonnage. Captive supplies as share of seaborne iron ore traded outside North America, the main competitive world iron ore market, represent roughly 20% of total trade volume.

3.38 During the recession in 1982 and 1983, captive West African and Brazilian mines and pelletizing plants of European and Japanese steel companies, which supply themselves also through long-term contracts, have fared much better than independent mines. They were given supply priority and generally produced at full capacity. Captive mines in North America were also given supply priority but production cut-backs and temporary closures were nevertheless common, because with only few independent suppliers, their steel company owners had less possibilities of deflecting demand reductions away towards independent producers.

Iron Ore Prices and Pricing

3.39 When comparing iron ore products, the two important factors are: chemistry, including iron content, and physical structure. If both structure and chemistry of an ore are favorable, iron and steel- making costs are reduced and the steel producer is willing to pay a higher per unit price for this ore than for one with less favorable properties. Although an ore with high iron content and good structure is desirable from the point of view of increasing productivity, the buying preference may be given to another ore of lower quality if the price is low enough to compensate for its less favorable characteristics. Structure is one of the principal determinants of price. This is reflected in the wide spread of prices between pellets and lower valued ores such as lump ore and run-of-mine ores, concentrates and fines. Pellets can be charged directly to the blast furnace as can lump ore but the latter can decrepitate in the furnace, thereby lowering its value to the steel mill operator. All mine products other than lump ore must be agglomerated and, because of the costs involved, command lower prices when purchased in an unagglomerated form. In the past the price differentials between pellets, lumpy ores and sinter fines have been large enough for the mills to favor sinterfeed for their sinter plants and/or lumpy ores for direct feed for their blast furnace. However, during the last two to three years some pellet producers, competing in the seaborne market, have had to accept reduced differentials and pellets are now becoming economically more competitive. In addition, pellet producers can now meet many of the steel mills' special quality demands and this adds further to the competitiveness of pellet.

Pricing System

3.40 There are two distinct international price structures in the world. North America comprises one pricing area, while the rest of the market economies forms the other. Because of the integrated structure of the iron and steel industry in North America iron ore prices are generally determined by production costs. Consequently, the North American iron ore price has moved over time on a continuing upward trend, reflecting increasing costs of production. Elsewhere the price of iron ore is determined by market forces. Most ores are priced in US$ and on an fob basis; Australian and Venezuelan ores to Europe are sold on a cif basis. Shipping is arranged separately, and usually by the consumers; e.g., Japanese, US and Western European steel companies. The major exceptions are Venezuela, India and Brazil which own sizeable fleets.

3.41 Prices quoted in the North American iron ore trade are based on the cif Lake Erie base price, from which the transportation cost from the producer terminal to Lake Erie has to be subtracted to arrive at the fob price. However, because of the structure of the industry, very little ore moves at the quoted price. Most iron ore shipments come from captive mines which are owned by one or several steel companies and operated by one of the four major managing companies.[6/] Because of this structure up to 95% of all North American production moves to the consumers at cost, which includes a royalty for the owner of the deposit and an operating fee for the mine manager.

3.42 The delivered price of certain key ores sets the pattern for others in the markets of Western Europe and Japan. In the former, Brazilian ore has traditionally been the price leader; however, in 1983, 1984 and 1985 Canadian suppliers, seeking market share at the expense of price concessions, were the first to conclude prices in Europe, which action interfered with Brazil's negotiations. Although Australia is Japan's major supplier, price negotiations with the Japanese mills are very much influenced by the Brazilian price set for Europe, adjusted for excess freight, as described further below in this paragraph. If other ores entering these markets are comparable in quality and grade, they usually command the same cif price. By subtracting the appropriate shipping charge, the fob price is established for each producer. Thus, for any one ore there could be as many fob prices as markets and suppliers, because of

6/ Cleveland Cliffs, Hanna, Oglebay Norton, Pickands Mather.

the different shipping distance and transportation charges involved. The only known exception to this pricing mechanism is that Brazilian FOB prices for Japan are set by deducting from the Brazilian FOB price for Europe 50% of the freight differential between Brazil and Japan, and Brazil and Europe. The other 50% of the freight differential is, apparently for reasons of supply diversification, borne by the Japanese steel mills. Price competition is very intense in both markets because of the availability of high-quality iron ores from many sources. European prices are traditionally set in December prior to the year of shipment whereas prices in the Japanese market are usually set by March, before the beginning of the Japanese fiscal year.

3.43 Whereas captive production in North America is moved at cost, pricing of production in LDCs that is captive to European and Japanese steel companies follows the same rules as for independently produced ore. A theoretical cif price is calculated and adjusted for freight to arrive at the fob equivalent.

Prices

3.44 International iron ore prices from 1960-85, as exemplified by Brazilian sinter feed prices cif Europe, are shown in Table 3.9 overleaf. Throughout most of the 1960s prices decreased in current terms and in 1970 were 11% lower than in 1960. In the 1970s and through 1984, current prices oscillated around an increasing trend line with pronounced annual variations both upward and downward. In constant terms, iron ore prices declined steadily by 56% between 1960 and 1978, reflecting the implementation of high volume and low cost mines during that period. Between 1978 and 1983 prices in constant terms remained relatively unchanged, indicating the absence of still cheaper new capacity. The sharp decreases in 1983 and 1984 were motivated by the appreciating US dollars, weak demand, and keen competition among producers. 1985 iron ore prices in current terms are about 1.5% higher than in 1984, reflecting a general strengthening of demand in the second half of 1984.

Table 3.9: Brazilian Sinter Feed Prices per Ton CIF Europe

Year	Current US$	Annual Price Change (%)	Annual Inflation (MUV) Index	1980 Constant US$	Iron Ore Price Index (1980=100)
1960	17.1	-	-	53.6	222
1965	15.7	0	0.8	49.1	203
1970	15.2	28.8	6.1	41.0	169
1975	22.6	18.9	10.6	35.1	145
1976	21.9	(3.1)	1.4	33.5	139
1977	21.6	(1.4)	9.4	30.3	125
1978	19.4	(10.2)	14.0	23.8	98
1979	23.3	20.1	12.4	25.5	105
1980	24.2	3.8	9.2	24.2	100
1981	23.6	(2.5)	0.5	23.5	97
1982	24.7	4.7	(3.0)	25.3	105
1983	21.5	(13.0)	(1.2)	22.3	92
1984	20.2	(6.0)	(1.8)	21.4	88
1985 a/	20.5	1.5	(0.5)	21.8	90

a/ Estimated.

Source: World Bank, Industry Department.

3.45 As mentioned earlier, most of the US and Canadian ore is moved at cost in the North American market. At an estimated sinter feed cost in 1984 of US$33 per ton cif Chicago, the cif price of sinter feed sold in Europe is only about two-thirds of that in North America. This implies that US steel companies pay 50% more for their iron ore than their European and Japanese competitors. It also implies that Canadian producers selling ore in the European market, realize much lower prices for their products than in the North American market, which they accept to achieve economy of scale (pellets). Another reason is that sinter type ores have hardly any market in North America and since they are produced at marginal costs, they can be sold in Europe at competitive prices, and have been setting European price trends in 1983, 1984 and 1985.

3.46 Differing rates of exchange rate adjustments in different countries and their impact on the real price of iron ore in local currency for selected producer and consumer countries are shown in Table 3.10 overleaf.

Table 3.10: Impact of Devaluation of Local Currencies on Iron Ore Prices between the Second Quarters of 1981 and 1983

Country	Devaluation against US$ (%)	Rate of Inflation a/ 1981/II=100	Increase (Decrease) in Constant Price of Iron Ore in Terms of Local Currency b/ (%)
Australia	30.9	123	0.7
Brazil	467.3	438	22.5
Canada	2.7	118	(17.7)
India	19.0	120	(6.2)
Liberia	-	109	(13.2)
Mauritania	13.0	115	(7.0)
Sweden	54.5	118	23.9
FR Germany	9.2	109	(5.2)
Japan	8.0	105	(2.7)

a/ Measured in terms of consumer price indices.
b/ The iron ore price in US$ terms decreased by 5.4% during the reference period.

Source: World Bank, Industry Department.

Despite price reductions of 5.4% in US$ terms, Swedish and Brazilian producers enjoyed substantial real term price increases in local currency. Canada, Liberia, Mauritania and India suffered considerable real term price losses. With the continued appreciation of the US$, exchange rate changes remain a critical factor for the competitiveness and viability of most iron ore producers.

International Iron Ore Trade

3.47 This section presents volume and patterns of the international iron ore trade. In the context of this study, which focusses on international trade flows, domestic iron ore trade is of little interest and therefore has been excluded from the analysis. Between 1960 and 1982, the volume of iron ore traded internationally has doubled from 155 million tons to 317 million tons. The two major trading areas are the Atlantic market and the Pacific market, with two exporting countries, Brazil and Australia, supplying significant tonnages to both markets. Supply profiles for the major consumers show the USA to have only one large foreign supplier, Canada, which supplied 18% of US requirements in 1983. The EC's major suppliers were Brazil, Canada and Liberia. Japan obtained ore from 11 countries, but two, Australia and Brazil, furnished 67%.

Volume of Trade

3.48 Exports of iron ore have developed significantly over the past two decades. Between 1960 and 1983, total exports doubled, from 151 million tons per year (mtpy) to 301 mtpy (1979 being the peak year with 389 mtpy) as shown in Table 3.11 overleaf.

Table 3.11: World Iron Ore Trade, 1960-83
(in million tons)

	1960	1970	1975	1979	1980	1981	1982	1983	Annual Average Growth Rate (%) 1960-70	1970-80	1980-83
Imports											
IDCs	135	278	318	320	299	286	232	225	7.5	0.7	(9.0)
LDCs	1	3	5	21	24	20	34	31	11.6	23.1	8.9
Subtotal IDCs and LDCs	136	281	323	341	323	306	266	256	7.5	1.4	(7.5)
European CPEs	19	38	51	59	58	53	51	45	7.2	4.3	(8.1)
Total Imports a/	155	319	374	400	381	359	317	301	7.5	1.8	(7.6)
Exports											
IDCs	73	138	164	176	165	150	128	130	6.6	1.8	(7.6)
LDCs	63	148	172	174	184	176	156	138	8.9	2.2	(9.1)
Subtotal IDC and LDCs	136	286	336	350	349	326	284	268	7.7	2.0	(8.4)
European CPEs	15	36	44	39	38	34	32	33	9.1	0.5	(4.6)
Total Exports a/	151	322	380	389	387	360	316	301	7.9	1.9	(8.4)

a/ Differences due to discrepancies in trade statistics and ores in transit.

Source: World Bank, Economic Analysis and Projections Department.

3.49 The major iron ore importers are IDCs, accounting for about 74% of total trade. Japan has become by far the largest importer (109 million tons in 1983), followed by the FRG (35 million tons), Belgium-Luxemburg (18 million tons), and the USA (14 million tons). The two leading exporting countries are Australia (74 million tons) and Brazil (70 million tons), followed by USSR (33 million tons), Canada (26 million tons), and India (21 million tons). The European CPEs have steadily accounted for about 10-15% of iron ore trade since 1960. While they have traditionally confined their trade to themselves, since 1975 they have become net importers of 8-16 mtpy from market economies. The USSR is the biggest producer, with 244 million tons in 1983 out of a total European CPE production of 251 million tons. Iron ore imports by LDCs have grown consistently between 1960-83, reflecting their efforts to build up domestic steel production capacities. About 80% of their iron ore needs were met by LDC exporters, indicating the emergence of a South/South trading pattern for iron ore.

Trade Patterns

3.50 As mentioned, the two major iron ore trading areas are the Atlantic market and the Pacific market. Only Australia and Brazil sell significant tonnages in both markets. Minor tonnages are placed in the respective distant market by India, Canada, and South Africa. Producers that compete in both markets have to accept lower FOB prices for products shipped to the more distant market because of freight differentials. Only low cost producers, which are able to minimize the freight disadvantage through high volume and large bottoms, can remain long-term suppliers to both markets. The evolution of international iron ore trade is shown in more detail in a series of tables below. They provide the 1979-83 supply profiles for each of the major consuming areas, i.e., the EC, Japan, and USA.

3.51 The supply profile of the EC is shown in Table 3.12 below.

Table 3.12: Supply Profile of the EC, 1979-83 a/
Imports by Source

Source	1979 mt	1979 %	1980 mt	1980 %	1981 mt	1981 %	1982 mt	1982 %	1983 mt	1983 %
Brazil	30.8	22.3	30.4	24.6	31.5	26.6	29.1	27.7	25.7	26.5
Canada	18.8	13.6	16.5	13.3	15.7	13.3	14.4	13.7	12.2	12.6
Liberia	15.5	11.2	14.0	11.3	14.5	12.2	12.0	11.4	12.5	12.9
Sweden	19.3	14.0	17.3	14.0	14.3	12.1	9.8	9.3	8.1	8.3
Australia	11.7	8.5	10.9	8.8	9.5	8.0	10.2	9.7	12.1	12.4
Mauritania	7.4	5.4	6.8	5.5	6.7	5.6	6.3	6.0	6.1	6.3
S. Africa	8.8	6.4	6.6	5.3	7.0	5.9	5.4	5.1	2.9	3.0
France	9.8	7.1	8.7	7.0	5.9	5.0	5.6	5.3	5.0	5.1
Venezuela	6.3	4.6	5.6	4.5	6.0	5.1	5.3	5.0	3.5	3.6
Norway	3.7	2.7	2.7	2.2	3.1	2.6	2.5	2.4	4.4	4.5
Others b/	5.8	4.2	4.2	3.5	4.2	3.6	4.6	4.4	4.5	4.8
	137.9	100.0	123.7	100.0	118.4	100.0	105.2	100.0	97.0	100.0

a/ Excluding Denmark, Greece, Ireland.
b/ Spain, India, USSR, Algeria.

Source: Association of Iron Ore Exporting Countries.

The EC has a relatively evenly distributed supply pattern. The biggest supplier is Brazil, whose share of the EC market was 26.5% in 1983 followed by West Africa with about 19.2%. Canada, and Australia supply about 12% each, Sweden about 8%, France about 5%, and Venezuela and South Africa about 3%. Australia has made steady progress, increasing its supply share from 8.5% in 1979 to 12.4% in 1983, mainly as a result of favorable freight rates and competitive prices. Brazil, offering high grade ores, also expanded its market share, from 22.3% in 1979 to 26.5% in 1983. France's share dropped, reflecting the decreasing acceptability of its low grade minette ores. Sweden's share decreased as a result of declining market for relatively high phosphorus ores.

3.52 Japan's supply profile is shown in Table 3.13 below:

Table 3.13: Supply Profile of Japan, 1979-83: Imports by Source

Source	1979 mt	1979 %	1980 mt	1980 %	1981 mt	1981 %	1982 mt	1982 %	1983 mt	1983 %
Australia	55.3	42.5	60.0	44.9	54.9	44.5	54.1	44.4	49.7	45.7
Brazil	26.1	20.1	28.5	21.3	27.2	22.1	27.3	22.4	23.5	21.6
India	17.1	13.1	16.5	12.4	15.6	12.6	15.7	12.9	14.6	13.4
S. Africa	7.2	5.5	6.3	4.7	5.8	4.7	6.5	5.4	5.1	4.7
Chile	6.7	5.1	7.1	5.3	6.2	5.0	5.6	4.6	5.0	4.6
Canada	4.6	3.5	3.4	2.5	4.4	3.6	2.9	2.4	3.2	2.9
Philippines a/	4.0	3.1	4.1	3.1	3.6	2.9	3.9	3.2	3.1	2.8
New Zealand	3.0	2.3	3.0	2.2	2.7	2.2	2.6	2.2	2.4	2.2
Peru	3.0	2.3	2.5	1.9	2.0	1.6	2.1	1.7	1.5	1.4
Mauritania	0.7	0.5	1.0	0.7	0.7	0.6	0.7	0.6	0.4	0.4
Liberia	0.4	0.3	0.4	0.3	0.3	0.2	0.3	0.2	0.3	0.3
Others	2.2	1.7	0.9	0.7	-	-	0.1	0.0	0.0	0.0
Total	130.3	100.0	133.7	100.0	123.4	100.0	121.8	100.0	108.8	100.0

a/ Re-exports, approx. 50% from Australia, 50% from Brazil.

Source: Association of Iron Ore Exporting Countries.

Japan's iron ore supply is concentrated on three producers. In 1983 Australia supplied about 46% of Japan's iron ore demand, Brazil about 22%, and India about 13%; their combined share of the Japanese market was about 81% in 1983. South Africa supplied 5%, five more suppliers share relatively evenly in 13%, and West Africa supplied the remaining 1%. Since the Philippines are a re-exporter of sinter produced from iron ore supplied equally by Australia and Brazil, Australia's supply share in 1983 would increase to about 47% and Brazil's to about 23%. Both Australia and Brazil have increased their market share since 1979. Canada's share has been the most erratic among all suppliers indicating that it cannot be considered firmly entrenched in the Japanese market. Although there are changes in the market shares of individual suppliers, the data suggests that the Japanese steel companies change their supply relationships only slowly and over an extended number of years.

3.53 The supply profile of the USA is shown in Table 3.14 below:

Table 3.14: Supply Profile for the USA, 1979-83: Imports by Source

	1979		1980		1981		1982		1983	
Source	mt	%	mt	%	mt	%	mt	%	mt	%
USA	82.0	70.5	65.2	72.0	73.3	71.8	45.4	75.4	34.8	72.1
Canada	23.0	19.8	17.6	19.4	19.1	18.7	9.4	15.6	8.9	18.4
Liberia	2.2	1.9	1.6	1.8	2.2	2.1	2.4	4.0	1.8	3.7
Venezuela	4.6	4.0	3.7	4.1	5.2	5.1	1.8	3.0	1.4	2.9
Brazil	3.1	2.7	2.0	2.2	1.8	1.8	1.0	1.7	1.3	2.7
Others	1.3	1.1	0.5	0.5	0.5	0.5	0.2	0.3	0.1	0.2
Total	116.2	100.0	90.6	100.0	102.1	100.0	60.2	100.0	48.3	100.0

Source: Association of Iron Ore Exporting Countries.

The table shows that the USA imports less than 10% of its iron ore demand from off-shore and thus its steel industry is the most self-sufficient of the major producer countries as far as reliance upon domestic ore is concerned. Both Liberia and Venezuela ship tonnages to the USA under special arrangements. All of the Liberian tonnage reflects Bethlehem's offtake from the Lamco Joint Venture in which it formerly owned 25% of the shares. Bethlehem sold its share in Lamco in 1984 but will continue purchasing about 2 mtpy under contract through 1987. Venezuela's tonnages reflect deliveries from nationalized iron ore mines previously owned by US steel companies (Bethlehem and Orinoco Mining-U.S. Steel). Brazil is the only off-shore supplier without special ties to US steel companies. Although tonnages are small, Brazil maintains a presence in the US market, hoping to take advantage eventually of opportunities to further penetrate the US market.

Shipping Costs for Major Trade Routes

3.54 Comparative ocean spot shipping rates are given, as are freight differentials between the USA, Europe, Japan, and ore ports in Canada, Brazil, Africa, and Australia. Ocean freight rates, which vary with the fuel price for Bunker C fuel and availability of vessel tonnage, increased strongly during the economic upturn of the late 1970s but have fallen off since 1980 as shown in Table 3.15 overleaf.

Table 3.15: Comparative Iron Ore Inland Water and Ocean Freight Rates, 1975-83 a/
(in US$ per ton)

	1975	1980	1981	1982	1983
Canada					
Sept Isles to US Northern Harbors	1.80	3.45	2.70	2.00	2.05
Sept Isles to Rotterdam	2.95	6.90	3.90	4.30	4.20
Brazil					
Tubarao to US Northern Harbors	3.45	8.35	8.10	5.90	4.90
Tubarao to Rotterdam	3.45	8.65	6.05	4.00	5.35
Tubarao to Yokohama	5.40	8.85	11.05	8.15	7.45
Liberia					
Buchanan/Monrovia to Rotterdam	3.20	7.15	6.55	4.65	4.05
Buchanan to US Northern Harbors	2.85	7.70	5.95	4.70	4.05
Australia					
Port Hedland to Yokohama	3.20	5.40	5.70	4.30	4.05
Port Hedland to Rotterdam	5.20	9.85	9.55	7.10	8.25

a/ Ocean rates based on spot quotes per DWCT for average voyage and ship size.

Sources: Skillings; Cleveland Cliffs; Shipping Statistics and Economics.

3.55 Table 3.16 overleaf shows the differential in transportation costs from Australia, Brazil, Canada, and Liberia to the US northern harbors, Yokohama, and Rotterdam, during 1975-83. Canadian ores enjoy a significant freight advantage to US northern harbors. The advantage was smallest in 1975 when freight rates were low and largest in 1980 and 1981 when freight rates were high. Freight rates to US northern harbors from Brazil and Liberia changed relatively in parallel; Liberia's freight advantage over Brazil was generally about US$1. Freight differentials to Rotterdam are much less significant among Canada, Liberia, and Brazil than to US northern harbors. Freight rates from Canada were the lowest in 1975, 1980, and 1981, but freight rates from Brazil were lowest in 1982 and from Liberia in 1983. The Brazilian freight differential to Yokohama was about US$5 in 1975, 1980 and 1981, but was only about US$3.95 in 1982 and US$3.45 in 1983.

Table 3.16: Ocean Freight Differentials, 1975-83
(in US$ per ton)

		1975	1980	1981	1982	1983
To:	US Northern Harbors					
From:	Sept Isles (Canada)	-	-	-	-	-
	Tubarao (Brazil)	2.00	5.25	5.50	3.95	2.90
	Buchanan (Liberia)	1.05	4.25	3.25	2.70	2.00
To:	Rotterdam					
From:	Sept Isles	-	-	-	0.30	0.15
	Tubarao	0.50	1.80	2.50	-	1.35
	Buchanan	1.10	0.25	2.70	0.70	-
	Port Hedland (Australia)	2.30	3.00	5.75	4.15	4.30
To:	Yokohama					
From:	Tubarao	5.15	4.75	5.45	3.95	3.45
	Port Hedland	-	-	-	-	-

Sources: Skillings; Cleveland Cliffs; Shipping Statistics and Economics; World Bank, Industry Department.

IV. WORLD IRON ORE - FUTURE TRENDS

4.01 This chapter presents projections of future world iron ore demand through 1995, which are supplemented by demand projections for seaborne iron ore. Next, based on estimated iron ore production potential, the available supply of seaborne iron ore is projected and the resulting supply/demand balance of seaborne iron ore is examined. The seaborne iron ore market is the dominant one in which iron ore is traded internationally and its supply/demand balance defines whether there is a need to develop new production capacity for export or not. The analysis indicates one or two new iron ore export projects at most will be required by 1995. By comparison there are about twenty projects which have been considered or are under preparation in different regions. While it is presently speculative to predict which project or projects will be first to be implemented, a comparative analysis of the requirements to implement a new iron ore export project, indicates that only projects with financially strong sponsors, low costs, high quality ore and firm support from steel mills in terms of financial participation as well as purchase contracts will warrant serious consideration given the present market situation.

Derived Iron Ore Demand

4.02 The derived iron ore demand from 1985 to 1995 is based on the steel projections and assumptions of Chapter II. Iron ore requirements per ton of crude steel equivalent are projected to decrease because of increasing steel production in electric arc furnaces using scrap as a major input, more efficient new steel plants, efficiency improvements in existing plants, the phase out of old and inefficient capacities, and higher average grade of iron ore. The trend to lower iron ore consumption per ton of crude steel produced is worldwide, except in European CPEs, where a constant trend is forecast. Table 4.1 below shows the projected input coefficients for different countries and groups of countries and further details are provided in the Annex.

Table 4.1: Projected Input Coefficients of Iron Ore per Ton of Crude Steel Equivalent

	1985	1990	1995
USA	0.89	0.84	0.81
EC-9	1.06	1.05	1.03
Japan	1.13	1.13	1.12
Other IDCs	1.20	1.16	1.14
LDCs	1.23	1.17	1.15
European CPEs	1.30	1.30	1.30
Asian CPEs	1.80	1.70	1.60

4.03 Table 4.2 overleaf shows the resulting derived iron ore demand country by country in 1985, 1990, and 1995 for base case, low case and high case scenarios. In the base case world demand increases from 856 million tons in 1985 to 954 million tons in 1995. IDC base case demand is estimated at 382 million tons in 1995, only just higher than 1985 (376 million tons). By comparison LDC base case demand increases substantially from 206 million tons in 1985 to 266 million tons in 1995. Nearly two thirds of the expected LDC demand increase is found in Asia (especially in China, Korea R. and India). In the high case, world steel demand increases by over 170 million tons from 1985 to 1995 with 45 million tons increase in IDCs, 86 million tons in LDCs and 42 million tons in European CPEs. In the low case, demand grows by only 40 million tons with growth in LDCs and European CPEs being partially offset by a decline in IDCs.

4.04 The implied annual average growth rates of future world iron ore demand are 1.1% per year under the base case, 0.5% per year under the low case, and 1.9% under the high case. Demand growth in IDCs is almost zero under the base case and under the low case would be negative at -0.7% per year. LDCs account for 61% of total demand growth and European CPEs for 33%. The demand growth rates for the various consumer groups under the three scenarios are summarized in Table 4.3 on page 45.

Table 4.2: World Derived Iron Ore Demand 1980-95
(in million tons)

	Actual				Projected						
					Base Case			Low Case		High Case	
	1980	1981	1982	1983	1985	1990	1995	1990	1995	1990	1995
IDCs											
USA	94	102	59	68	77	77	77	74	73	80	81
Canada	14	18	15	16	18	19	19	17	18	20	25
EC-9	145	143	119	118	122	121	116	112	104	131	126
Japan	131	120	113	109	119	125	124	119	113	131	132
Australia	10	10	7	7	8	9	9	9	9	10	13
Spain	16	16	16	15	16	16	18	15	16	17	21
Sweden	5	5	5	5	5	6	6	5	6	6	7
Other IDCs	11	10	10	9	11	13	13	12	13	13	16
Subtotal IDCs	426	424	344	347	376	386	382	363	352	408	421
LDCs											
Asia											
China	67	65	66	70	81	88	98	85	94	94	102
Viet Nam	-	-	-	-	2	2	3	2	3	2	3
Korea, Dem. Rep.	7	11	11	11	14	15	16	14	15	15	18
India	14	15	15	14	15	16	20	15	17	18	22
Korea, Rep. of	11	13	15	15	16	20	25	19	22	22	29
Indonesia	-	-	-	1	1	2	3	2	3	2	3
Saudi Arabia	-	-	-	-	1	1	1	1	1	1	1
Other Asia	9	8	11	9	10	11	12	9	10	12	17
Subtotal Asia	108	112	118	120	140	155	178	147	165	166	195
Africa											
Zimbabwe	1	1	1	1	1	1	1	1	1	1	1
S. Africa	12	11	9	9	10	10	11	10	11	11	11
Algeria	2	1	1	1	1	2	2	2	2	2	3
Egypt	2	1	1	1	1	2	2	2	2	2	3
Nigeria	-	-	-	-	1	1	2	1	2	1	2
Other Africa	-	-	-	-	0	1	1	-	-	1	1
Subtotal Africa	17	14	12	12	14	17	19	16	18	18	21
America											
Argentina	4	4	4	4	4	5	6	5	6	5	6
Brazil	19	17	17	18	21	22	26	21	24	25	30
Chile	1	1	1	1	1	1	1	1	1	1	1
Mexico	9	10	9	9	10	12	14	11	11	13	15
Venezuela	3	3	3	3	4	5	5	5	5	5	6
Other America	1	1	1	1	1	1	1	1	1	1	2
Subtotal America	37	36	35	36	41	46	53	44	49	50	60
S. Europe											
Turkey	4	3	4	5	4	5	7	5	7	5	7
Yugoslavia	6	6	6	5	5	6	7	6	7	6	7
Other S. Europe	3	3	3	3	2	2	2	2	2	2	2
Subtotal S. Europe	13	12	13	13	11	13	16	13	16	13	16
Subtotal LDCs	175	174	178	181	206	231	266	220	248	247	292
European CPEs											
USSR	188	189	189	190	198	211	222	205	216	215	230
Hungary	5	5	5	5	5	6	6	6	6	6	6
Romania	18	18	18	19	20	23	29	22	27	23	29
Other European CPEs	53	49	47	51	51	51	49	49	47	52	51
Subtotal European	266	261	259	265	274	291	306	282	296	296	316
Grand Total	867	859	781	793	856	908	954	865	896	951	1,029
Total IDCs and LDCs	601	598	522	528	582	617	648	583	600	655	713
Total Market Economies a/	527	522	445	447	486	512	531	482	488	544	591

a/ Excludes European CPEs; China; Korea, Dem. Rep.; Viet Nam.

Note: Totals may not add due to rounding.

Table 4.3: Annual Average Growth Rate of Iron Ore Demand, 1985-95
(in % per year)

	Base Case	Low Case	High Case
IDCs	0.2	(0.7)	1.1
Asian LDCs	2.4	1.7	3.4
African LDCs	3.1	2.5	4.1
American LDCs	2.6	1.8	3.9
Southern European LDCs	3.8	3.8	3.8
LDCs	2.6	1.9	3.6
European CPEs	1.1	0.8	1.4
Grand Total	1.1	0.5	1.9
IDCs and LDCs	1.1	0.3	2.1
Market Economies	0.9	0.0	2.0

4.05 To calculate the projected demand of seaborne iron ore, the portion of total demand supplied from domestic sources, and through intra-EEC, North American and CPE trade has been deducted from the country demand figures given in the table of para. 5.03. World demand of seaborne iron ore is projected to increase from 294 million tons in 1985 to 340 million tons in 1995, equivalent to an annual average growth rate of 1.5%. 30% of the additional demand for 46 million tons would be generated by IDCs, 7% European CPEs, 46% by Asian LDCs including Asian CPEs, and 17% by the other LDCs. The forecast is sensitive to iron ore demand of the Republic of Korea, which accounts for 8 million tons or 17% of total additional demand. Korea is in the process of building up large steel production capacities, which depend mainly on steel exports. If export or construction plans do not materialize, Korea's iron ore requirements could be much lower than assumed here. Imports of seaborne iron ore by Asian CPEs are shown to increase from 6 mtpy in 1985 to 11 mtpy in 1995, as compared with their overall demand growth of 20 mtpy, of which 17 million tons is in China. The forecast assumes that domestic sources and intra CPE trade will supply most of the increased requirements, and that seaborne iron ore will only be imported at the margin. Therefore, China's imports in particular could be considerably above those forecast, if expansion of domestic production capacity were to lag behind growing ore requirements. Table 4.4 overleaf shows the demand for seaborne iron ore on a country-by-country basis:

Table 4.4: Projected World Demand of Seaborne Iron Ore, 1985-95
(in million tons)

	Base Case			Lower Case		High Case	
	1985	1990	1995	1990	1995	1990	1995
IDCs							
USA	7	7	7	7	7	9	10
EC-9	97	102	102	93	90	112	112
Japan	119	125	124	119	113	131	132
Spain	8	8	10	7	8	9	13
Other IDCs	8	10	10	9	10	10	13
Subtotal IDCs	239	252	253	235	228	271	280
LDCs							
Asia							
Asian CPEs	6	8	11	7	10	11	15
Korea, Rep. of	14	17	22	16	19	19	26
Indonesia	1	2	3	2	3	2	3
Saudi Arabia	1	1	1	1	1	1	1
Other Asia	8	10	12	8	10	11	16
Subtotal Asia	30	38	49	34	43	44	61
Africa							
Egypt	-	1	1	1	1	1	2
Nigeria	1	1	2	1	2	1	2
Subtotal Africa	1	2	3	2	3	2	4
America							
Argentina	3	3	4	3	4	3	4
Mexico	2	4	6	3	4	4	7
Subtotal America	5	7	10	6	8	7	11
S. Europe							
Turkey	1	2	3	2	3	2	4
Yugoslavia	-	-	1	-	1	-	2
Other S. Europe	-	-	-	-	-	-	1
Subtotal S. Europe	1	2	4	2	4	2	7
Subtotal LDCs	37	49	66	44	58	55	83
European CPEs	18	19	21	16	18	20	22
Grand Total	294	319	340	295	304	346	385
Total IDCs and LDCs	276	301	319	279	286	326	363
Total Market Economies a/	270	293	308	272	276	315	348

a/ Excludes European CPEs; China; Korea, Dem. Rep.; Viet Nam.

Iron Ore Supply Potential

4.06 This section forecasts the available supply potential of seaborne iron ore. In a first step the production potential of all market economy producers is estimated through 1995. In a second step the available supply of seaborne iron ore is derived by deducting production targeted for domestic, intra-EC-9 and intra-North American consumption. In addition, US production is assumed to be consumed entirely within North America because with their high production costs US producers could not expect to compete in the seaborne iron ore market.

Production Potential

4.07 Future iron ore production potential in market economies, as shown in Table 4.5 overleaf, are derived from a country by country and, where available, mine by mine review of design capacity, most recent performance, known depletions, expansions or new projects under implementation and temporary as well as permanent closure of mines because of economic reasons. Expansions and new projects which are in various planning stages, but for which implementation has not yet started, have been disregarded. The forecasts necessarily involve judgement, besides factual data, particularly where mine closures for economic reasons are involved (France, USA). Also, design capacities and actual capacity utilization show large differences in key producer countries (Australia, India, Canada, USA), and it is difficult to predict which utilization factors will prevail in the future. For many producers, however, present production potential is considered to be much less than original design (nameplate) capacity.

4.08 Total production potential is expected to increase slightly by 1990, but decrease by 1995 to slightly below the 1985 levels. Shutdown of uneconomic capacities in the US, France, and Canada account for the bulk of production reductions in IDCs. Liberia's iron ore production will cease in the early 1990s if depleted deposits are not replaced by new developments. Iran's increase from 1 mtpy in 1985 to 5 mtpy in 1990 reflects the completion of one major new development currently in detailed design/ engineering phase. India's capacity is expected to increase as existing facilities produce at levels which are closer to design capacity (about 60-65 mtpy) than at present. Brazil's capacity increases by 21 mtpy between 1985 and 1990 as the Carajas mine (35 mtpy) is coming on stream, Capanema produces at full capacity (10 mtpy), and CVRD's Minas Gerais production decreases.

Table 4.5: Production Potential of Iron Ore in Market Economy Countries
(in million tons)

	Maximum Annual Production 1950-1983		Actual Production			Projected Production Potential		
	Tonnage	Year	1980	1982	1983	1985	1990	1995
IDCs								
Australia	97.7	1975	95.5	87.8	71.4	100	100	95
Canada	59.9	1979	48.7	33.0	29.9	50	45	45
USA	91.2	1970	70.7	37.1	38.6	75	70	65
France	57.4	1970	29.0	19.7	16.2	20	15	10
Sweden	36.2	1974	27.2	16.1	13.5	19	20	22
Spain	8.8	1980	8.8	7.6	7.5	8	8	8
New Zealand	3.9	1979	3.3	3.0	2.2	3	3	3
Norway	4.1	1981	3.8	3.3	3.5	4	4	4
Others a/			8.4	6.4	6.1	5	4	4
Subtotal IDCs			295.4	214.0	188.9	284	269	256
LDCs								
Africa								
Liberia	25.0	1974	18.2	17.5	15.4	16	8	-
Mauritania	11.7	1974	8.6	8.2	6.6	9	9	9
South Africa	31.6	1979	26.3	24.6	16.6	25	25	25
Algeria	3.9	1982	3.4	3.9	3.7	4	4	4
Others b/			3.8	2.1	4.0	4	5	5
Subtotal Africa			60.3	56.3	46.3	58	51	44
Asia								
India	47.6	1983	40.7	42.0	47.6	46	48	51
Iran	0.6	1982	0.6	0.6	n.a.	1	3	5
Others c/			0.8	1.0	1.1	1	1	1
Subtotal Asia			42.1	43.6	48.7	48	52	57
America								
Brazil	97.8	1981	96.6	93.9	92.1	119	140	145
Chile	12.2	1971	8.8	5.8	5.2	7	7	7
Venezuela	26.7	1974	16.1	10.5	10.2	15	15	15
Peru	11.6	1971	5.6	5.9	4.2	6	6	6
Mexico	8.4	1983	8.1	7.7	8.4	8	8	8
Others d/			0.9	1.0	1.4	2	3	3
Subtotal America			136.1	124.8	121.5	157	179	184
S. Europe								
Yugoslavia	5.1	1982	4.5	4.9	5.0	5	5	5
Turkey	3.4	1976	2.5	2.6	3.2	2	3	3
Others e/			2.0	2.0	1.3	2	2	2
Subtotal S. Europe			9.0	9.5	9.5	9	10	10
Subtotal LDCs			247.5	234.2	226.0	272	292	294
Total Market Economy			542.9	448.2	414.9	556	561	550

a/ Austria, Belgium, Finland, FRG, Luxembourg, Japan, UK
b/ Angola, Nigeria, Sierra Leone, Zimbabwe, Egypt, Tunisia
c/ Korea, Rep. of; Malaysia; Indonesia; Thailand
d/ Argentina, Colombia
e/ Greece, Portugal

Source: Skillings; Tex Report; World Bank, Industry Department.

Available Supply of Seaborne Iron Ore

4.09 The supply potential of seaborne iron ore is shown in Table 4.6 below:

Table 4.6: Projected World Supply Potential of Seaborne Iron Ore
(million tons)

	Base Case			Low Case		High Case	
	1985	1990	1995	1990	1995	1990	1995
IDCs							
Australia	92	91	86	91	86	90	82
Canada	24	18	18	20	19	17	12
Sweden	14	14	16	15	16	16	15
New Zealand	3	3	3	3	3	3	3
Norway	4	4	4	4	4	4	4
Subtotal IDCs	137	130	127	133	128	130	116
LDCs							
Africa							
South Africa	15	15	14	15	14	14	14
Liberia	16	8	-	8	-	8	-
Mauritania	9	9	9	9	9	9	9
Algeria	3	2	2	2	2	2	1
Others	1	1	1	1	1	1	1
Subtotal Africa	44	35	26	35	26	34	25
Asia							
India	31	32	31	33	34	30	29
Subtotal Asia	31	32	31	33	34	30	29
America							
Brazil	98	118	119	119	121	115	115
Venezuela	11	10	10	10	10	10	9
Chile	6	6	6	6	6	6	6
Peru	6	6	6	6	6	6	6
Subtotal America	121	140	141	141	143	137	136
Subtotal LDCs	196	207	198	209	203	201	190
Grand Total	333	337	325	342	331	331	306

It should be noted that the high and low cases do not refer to the availability of seaborne iron ore, but to the underlying scenarios for total iron ore demand (as discussed in para. 4.05). Accordingly, less seaborne iron ore is available under the high case, because domestic iron ore demand of those countries which are iron ore producers as well as consumers absorbs a greater share of production. For the low case the argument is reversed. The table indicates that Brazil and Australia can be expected to remain the dominant suppliers over the next 10 years. However, whereas Brazil would increase its share of total supply capacity from 29% in 1985 to 37% in 1995, Australia's share would decline form 28% in 1985 to 26% in 1995. West Africa's share would also decline in absence of new developments, from 8% in 1985 to 3% in 1995. It should also be noted that there are no seaborne iron ore exports anticipated from European CPEs. Thus, European CPEs are expected to be net importers of seaborne iron ore.

Supply-Demand Balance of Seaborne Iron Ore

4.10 The demand and supply potential forecasts of the previous sections result in the following balance of seaborne iron ore (Table 4.7).

Table 4.7: Projected Supply Potential-Demand Balance of Seaborne Iron Ore, 1985-95
(million tons)

	Base Case			Low Case		High Case	
	1985	1990	1995	1990	1995	1990	1995
Supply Potential	333	337	325	342	331	331	306
Demand	294	319	340	295	304	346	385
Supply Surplus (Deficit)	39	18	(15)	47	27	(15)	(79)

Under all three scenarios, seaborne iron ore will be in oversupply during the rest of the 1980s. By 1990, the high case stipulates a small supply deficit, whereas oversupply continues under the other two cases. By 1995, the base case projects a small supply deficit, the high case a larger one, and under the low case iron ore continues to be in oversupply. In summary, near and medium term iron ore prospects are poor and only by the early to mid-1990s can a balance of supply and demand be expected. Accordingly, new production capacity cannot be justified if start-up is scheduled before 1990 at the very earliest, and is probably not required before 1995. The forecast also implies that seaborne iron ore prices are likely to remain under pressure. Occasional price increases may well remain limited to adjustments for (all or part of) inflation, with upward or downward modifications to account for currency realignments.

4.11 Factors that could alter the global iron ore balance as projected under three cases are unexpected demand developments in the IDCs, European CPEs, Republic of Korea and China. A strong economic recovery in the IDCs in line with the assumptions underlying the high case, could erase the oversupply before 1990. European CPEs also present an upward potential. Most of their additional iron ore requirements are assumed to be met by expanded domestic production. To improve their steelmaking processes, higher quantities of high grade seaborne iron ore products to blend with lesser grade intra-CPE products would be very desirable. A principal change of industrial import policy in that direction could generate substantial additional demand by these CPEs. The Republic of Korea presents a downward risk to demand. If this country's ambitious steel growth plans fail to materialize in time or at target, its iron ore demand could drop substantially and prolong the oversupply period. Similarly, steel production growth plans of China may not be met or foreign exchange constraints could limit actual purchases of seaborne iron ore.

4.12 Shipments of iron ore in 1984 were significantly above the depressed 1983 levels. Many producers have been operating at presently sustainable full capacity and current pellet supply is apparently sold out. This implies that production capacity idled during 1982 and 1983 is restored only at a slow and cautious pace. The actual oversupply in the market place is therefore less than indicated by the projected supply/demand balance. With few exceptions however, and these are reflected in the country by country production capacity forecasts, a large portion of the idle capacities can be brought on stream relatively quickly if producers perceive sustained demand for the incremental production.

4.13 How the supply surplus will affect individual iron ore exporters depends mainly on the steel companies' supply diversification strategy. Product structure and quality are of significant importance as well. When considering their supply options, steel companies will continue to favor supply from any captive mines or pelletizing plants that they own. Changes in their supply patterns, if any, are likely to be gradual to minimize disruptions to the constant quality of blast furnace burden that steel companies prefer. Both Japanese and EC steel companies will have to decide whether to increase Brazil's supply share further and if so at whose expense. Brazil's supply capacity will increase by 20 million tons until 1990 and while some of the additional supply will be absorbed by growing LDC demand, the major portion will compete in the European and Japanese markets, where demand until 1990 is projected to increase by only 6 million tons. EC steelmakers will further need to examine their supply diversification objectives in light of West Africa's probable declining production capacity over the next 10 years. Iron ore production in Liberia may cease entirely in the early 1990s and the corresponding EC demand share of about 11% will have to be reallocated among the remaining suppliers, most notably Brazil, if new iron ore developments are not undertaken in West Africa.

Future Production Prospects

4.14 New iron ore projects in the pipeline could add up to 203 mtpy to seaborne supply by 1995, whereas only 15 million tons would be needed as per the base case forecast in para. 5.10. Potential new capacity in Australia totals 85 mtpy, in West Africa 63 mtpy, in Brazil 25 mtpy, in India and Saudi Arabia 10 mtpy each, and 5 mtpy each in South Africa and Sweden. Expansion projects could add 40 mtpy to supply capacity, replacement projects in the vicinity of depleted deposits 29 mtpy and greenfield type projects 134 mtpy. In terms of investment per annual ton of new capacity, expansion projects can be as low as US$20, whereas replacement projects have capital costs of US$25-75 per ton and greenfield projects US$100 per ton and above. A list of potential major iron ore projects is shown in Table 4.8 overleaf.

Table 4.8: Major Potential Iron Ore Projects

	Iron Content ROM Ore a/ (%)	Construction Time (years)	Capacity (in mtpy)
Producer/Project			
A. Expansions			
Brazil			
a. CVRD-Carajas	+66	2	15
b. MBR-Aquas Claras/Mutuca/Pico	+67	2	10
Sub-total			25
South Africa-ISCOR		2-3	5
Sweden-LKAB	62	2-3	5
Australia-Mt. Newman-Hamersley	62-63	3	5
Sub-total			40
B. Replacements			
Australia - Cliffs Robe River-West Angela	64	3	15
West Africa			
Liberia-LAMCO Western Area	52	2-3	8
Mauritania-SNIM-Guelbs II	34	3	6
Sub-total			29
C. Greenfield Projects			
Australia:			
a. Goldsworthy-Area C	61.6	3	12
b. CSR-Yandicoogina	NA	3-4	15
c. CRA/Hanwright-Marandoo	62.6	3-4	13
d. BHP-Deepdale	55	3	15
e. CRA/China - Channar	64	2	10
Sub-total			65
India:			
a. Barajamda Sector (partly exp.)	+58	3-5	5
b. Bailadila Sector (partly exp.)	+58	3-5	5
Sub-total			10
Saudi Arabia - Wadi Sawawin	NA	3-4	10
West Africa			
a. Gabon/SOMIFER-Belinga	63.9	3-4	10
b. Guinea-MIFERGUI-Nimba	66	2-3	10
c. Ivory Coast-COMIFERCI-Klahoyo	34	3-4	12
d. Liberia-LISCO-Wologisi	38	3-4	5
e. Senegal-MIFERSO-Faleme	58.5	3	12
Sub-total			49
TOTAL			203

a/ Run of Mine (ROM)

Source: World Bank, Industry Department.

4.15 Since the projected supply capacity deficit in 1995 base case would be only 15 mtpy, not more than one or two projects 7/ have a realistic chance to be implemented during the next 10 years. If the low case materializes, there is probably no need for another project before the turn of the century. In the high case, a project is required already around 1990. Which projects will eventually be implemented is difficult to predict but some necessary conditions for implementation of a new iron ore export project with reference to the base case are discussed below.

4.16 One condition is that the project has financially strong and competent sponsors which are prepared to underwrite the project risks with adequate equity commitments and which are capable to advance the project in the face of over-capacity through the early 1990s. Without such sponsors, a project will have difficulty establishing itself as a credible future source of supply and hence attracting the necessary loan financing and commitments from potential customers.

4.17 The projected supply capacity/demand balance for the next 10 years suggests that iron ore prices are unlikely to increase in real terms. The second condition, therefore, is that a new project will require a favorable cost structure compared with existing producers in order to have an acceptable financial and economical viability. To achieve this the project must have definite cost related advantages including inter alia economy of scale, low stripping ratio, ample reserves of high grade ore and simple or no processing to arrive at competitive products. Foreign exchange policies of the producer country as well as tax and royalty regimes should create an operating environment at least equal to industry averages. Port facilities that can accommodate larger ships, say up to at least 150,000 DWT, will contribute to obtaining more competitive freight rates and hence higher fob prices. High investment requirements in infrastructure which drive up investment cost per ton of capacity and expensive overhead structures for management and marketing are factors detrimental to implementation prospects.

4.18 A third condition is product acceptability to the consumers. The product should in general have a high iron content (65-66% Fe), a low content of impurities, i.e., silica, alumina and phosphorous and a low moisture content to keep down transportation costs per iron unit. The metallurgical properties must be well defined through thorough testing in laboratory scale as well as full scale. Pricewise, pellets and good lumpy ores can be expected to obtain a premium over sinter fines and concentrates.

4.19 A fourth condition is steel company support. This support has to be tangible and go beyond longterm contracts in order to confirm a project's compatibility with the steel companies' supply strategy. The credibility of longterm contracts has been eroded greatly in recent years and more tangible steel company commitments in form of loans, loan guarantees, equity participations and similar instruments will probably be necessary to provide satisfactory assurances to investors that production will be lifted. Whether such commitment for a project can be obtained is

7/ No distinction has been made here between expansion-, replacement- and greenfield-projects.

influenced by general supply/demand perceptions that the steel companies have, by their supply diversification objectives, and the credibility the project enjoys as a potential competitive and reliable source of supply.

4.20 The above conditions required of a viable project and the expected absence of real term iron ore price increases suggest that no new greenfield iron ore export project will be implemented during the next 5-10 years. It is more likely that established ore producers expand and/or replace capacity to cover any new demand in the market. Supply deficits of short duration, caused by natural disasters, strikes, political instability, etc., may occur and temporarily effect prices, at least in the spot market. However, based on past experience the ore producers will be responding to short-term price/market changes with marginal investments only. Major investment decisions are not likely to be taken until a supply deficit occurs of such a magnitude that a sustained upward trend in real prices is established.

4.21 The broad conclusion of the cases examined is that there is only likely to be a requirement for one or two iron ore projects during the next decade. However, investment decisions in the iron ore sector as in other industrial sectors will be made on the basis of perceptions regarding changing market circumstances which by their nature will be different in different regions and for different producers. Thus, while the paper attempts a carefully evaluated perspective for the future, the many elements of uncertainty associated with the assumptions regarding economic circum- stances, steel market developments and industry decisionmaking, must be recognized.

ANNEX

INPUT COEFFICIENTS OF IRON ORE PER TON OF CRUDE STEEL EQUIVALENT

1. Most iron ore is converted into iron. Currently, two reduction methods are employed to produce iron. The more common and traditional method is to reduce iron ore into pig iron in blast furnaces and the newer method is to convert it into directly reduced (DR-) iron in solid forms. Although the latter method is becoming popular, it accounts for only 3% of total iron-making at present. Almost all of iron (pig iron or DR-iron) is then converted into steel. 8/ However, a substantial amount of steel is also produced from iron and steel scrap (ferrous scrap). This makes projections of demand for iron ore complicated.

2. To project demand for iron ore, the following formula that links iron ore demand to crude steel production was established:

$$O = \frac{1}{1-o} Y B (1-a)$$

where:

O = ratio of iron ore consumption to crude steel production,

a = ratio of steel production by electric arc furnaces to total steel production,

B = amount of pig iron required to produce one ton of steel produced by basic oxygen furnace,

Y = amount of iron ore required to produce one ton of pig iron,

o = ratio of iron ore for non iron-making uses plus waste to total iron ore consumption.

Iron ore requirements for DR-iron were treated separately from the above formulation because of the limited quantities involved.

3. There are three major steel-making processes--electric arc furnace (EAF), basic oxygen furnace (BOF) and open hearth furnace (OHF). The obsolete OHF process has been replaced by BOF and EAF in most countries over the last decade and the remaining OHF processes will phase out in the next few years. Thus, the percentage share of EAF alone sufficiently represents the furnace-type production in steel-making. This ratio (a) is important because the use of pig iron and scrap in steel-making differs significantly between the EAF and BOF processes. While EAF relies mostly on scrap for its raw material, the scrap ratio in the BOF ranges from zero

8/ Some iron is used for purposes other than steel-making, such as casting. The percentage of iron for non-steel-making is estimated at 2-4%.

Source: World Bank, Economic Analysis and Projections Department.

(in some cases) to 0.3 (in U.S.). The current ratio in Japan is about 0.08 for the large integrated producers. 9/ Throughout the 1970s, the percentage share of EAF steel to total steel increased because the OHF process was replaced partly by the EAF process (Table A). Furthermore, in recent years because of low prices of ferrous scrap, production in EAF mini-mills (based on scrap) has increased, particularly of light non-flat products such as concrete-reinforcing bars, merchant bars and light section. Simultaneously steel production at large-scale integrated mills, mostly based on the BOF process, has been stagnating. As a result, the percentage share of EAF steel to total steel production further increased.

4. In the 1985-95 projection period, the ratio (a) is assumed to remain at the same levels as in 1985, except for the United States. The stability of this factor for the EC-9, Japan and other countries is based on the role of the scrap price. The expansion of EAF steel production in recent years, which was initially prompted by low scrap prices, has increased demand for scrap and, thus, scrap prices. (In fact, a slight upturn in steel production since late 1983 has increased scrap prices by almost 50% in many countries other than the United States). These higher scrap prices should reduce the advantages of EAF producers vis-a-vis BOF producers, returning to the initial equilibrium. In addition, many producers face rising electricity tariffs which also reduces the advantages of EAF vis-a-vis BOF. Thus in the EC-9, Japan and other countries, it seems that the EAF ratio has reached an equilibrium level. This ratio will however, still increase in the United States, which has an abundant supply of scrap.

5. Let us turn to the second factor (B), the use of pig iron per ton of steel produced in BOF. In the BOF process, the scrap ratio changes among the major regions, depending upon established steel-making practices and availability of ferrous scrap. Japan has the highest ratio and the United States the lowest among the major steel producing regions. The assumed stability of this factor in each region throughout the projection period is based on the role of the scrap price in determining the use of pig iron in BOF.

6. The third factor (Y), the quantity of iron ore required to produce a ton of pig iron, depends upon the iron content of ores and the efficiency of ore treatments. As a result of the increase in the production of high-grade iron ore in Australia and Brazil, the average iron ore grade in the world has risen from about 48% in 1960 to about 58% in 1980. 10/ Furthermore, the increased use of agglomerated ores (that is, sinter and pellets) has also improved the efficiency of blast furnaces. The improved ore grade and increased use of ore treatments contributed to a decrease in the ratio of total iron ore consumption to pig iron production.

9/ The scrap ratio is defined as the ratio of scrap to total feed (pig iron plus scrap) for steel-making. Scrap may be substituted by DR-iron in both processes.

10/ These figures are derived from Statistisches Bundesamt, Eisen und Stahl (various issues).

7. The fourth factor (o), represents the ratio of iron ore for uses other than iron-making plus wastes to total iron ore consumption. By far the largest use of iron ore is in iron-making; about 2-3% of total consumption is used for non-iron-making purposes, which include uses in manufacturing of cement, special high density concrete pigments, and magnetic concentrates. 11/ Also included are wastes, loss of moisture and statistical discrepancies.

TABLE - A -- Coefficients of Demand for Iron Ore Relating to Crude Steel Production: United States, EC-9 and Japan, 1970-95

	US				
	ACTUAL		PROJECTED		
Coefficient	1970	1980	1985	1990	1995
a	0.15	0.30	0.34	0.38	0.40
B	0.78	0.84	0.85	0.87	0.87
Y	1.58	1.44	1.47	1.47	1.47
o	0.08	0.08	0.08	0.05	0.05
O	1.12	0.92	0.89	0.84	0.81

	EC-9				
	ACTUAL		PROJECTED		
Coefficient	1970	1980	1985	1990	1995
a	0.15	0.24	0.25	0.25	0.25
B	0.87	0.90	0.91	0.92	0.91
Y	1.90	1.63	1.50	1.47	1.45
o	0.04	0.04	0.04	0.04	0.04
O	1.46	1.15	1.06	1.05	1.03

	JAPAN				
	ACTUAL		PROJECTED		
Coefficient	1970	1980	1985	1990	1995
a	0.18	0.25	0.25	0.25	0.25
B	0.88	1.00	1.01	1.01	1.01
Y	1.52	1.54	1.47	1.47	1.45
o	0.02	0.02	0.02	0.02	0.02
O	1.12	1.18	1.13	1.13	1.12

Source: World Bank, Economic Analysis and Projections Department.

11/ A small amount of iron ore is also used in steel-making as a coolant bin asic oxygen furnaces. For our purpose, this can be included in uses for iron-making.

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