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RAW MATERIAL DEMAND IN THE JAPANESE STEEL INDUSTRY

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ABSTRACT

In iron production, it is general procedure for ore which contains a large percentage of iron to be melted at high temperatures in order to remove impurities and oxygen. The raw materials which are used to make iron include: iron ore or steel scrap, coking coal, limestone,and small amounts of supplementary materials such as manganese and chromium ores.

In this paper, the three basic raw materials, iron ore, scrap,and coking coal,are discussed.

After looking at the relationship between iron production and raw materials in Chapter 1, Chapter 2 explains the supply and demand structure of the iron ore, scrap and coking coal markets and recent trends within each market. The volume of iron ore consumption has been increasing rapidly since the 1960s. After the oil shock, however, it has remained low because of decreased demand for iron and steel. Scrap supply is increasing in general, particularly from domestic sources. The supply and demand trends in coking coal are almost the same as in iron ore.

Chapter 3 attempts to examine the future levels of supply and demand for the materials used to produce iron and steel. More specifically, the supply and demand levels for these materials are projected for the fiscal year 1995. Assuming that the method used for making iron, by using converter and electric furnaces, does not change, the level of demand for the three raw materials used for iron steel production will be: iron and steel ore, 98,520,000 tons; scrap, 30,180,000 tons; and coking coal, 63,520,000 tons. The import share by source of supply in these materials will probably not change significantly over the medium term. However, if steel firms gain access to relatively cheap and stable sources of supply as a result of efforts such as developing new sources of coal, procurement from these sources will in the long term reduce the amount of coking coal purchased from other suppliers.

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CONTENTS

Introduction

The production of iron basically involves the melting of high-iron content iron ore at high temperatures and the removal of impurities found in the ore and oxygen, resulting in pure molten iron. Principle raw material inputs can be divided into iron ore or scrap, the main sources of iron, coke (coking coal) which is the heating source and reducing agent, and finally limestone and other materials used in smaller quantities, such as manganese and chromium ores.

This paper focuses on the most basic of the raw materials used in steel production -- iron ore, scrap, and coking coal. The main objectives of the paper are as follows. First, the paper seeks to analyze the relationship between the input of raw materials and steel production, by focusing on the types and forms of steel raw materials. Second, the paper discusses the structure of supply and demand for steel raw materials, including recent trends such as changes in production shares of converter and electric furnace steel, and their consumption of scrap, and trends in the import of raw materials from various sources. Third, the paper looks at future trends in the supply and demand for steel raw materials in Japan, including a forecast of supply and demand up to 1995.

1. Steel-related Raw Materials

Japanese steel producers currently use two basic methods to produce steel, the blast furnace/converter method and the electric furnace method. In the conventional blast furnace method, coke derived from coking coal serves as the heat source and reducing agent to reduce iron ore in blast furnaces, and the resulting pig iron is then refined in converters to produce molten steel.

In contrast, electric furnaces use mostly steel scrap, which is melted and refined using electrodes. The blast furnace/converter method can also use crude oil as a fuel in place of coke, but because of the explosion of world oil prices following the oil shocks, Japanese firms have stopped using oil in their blast furnaces and have shifted to "all coke" operations. Oxygen, tar and fine coals are also used.

1-1 Iron Ore

The term iron ore encompasses a variety of types of ores, including magnetite, hematite, and limonite, and also a variety of grades, with ores that contain more than 63 percent iron referred to as "high-grade ores" and those with less than 63 percent considered to be "low-grade ores."

The shape and size of the iron ore lump is extremely important in the operation of the blast furnace, so the iron ore is first ground into a powder and then formed into lumps of between 6 and 30 mm before being charged into the furnace. If fine ores are charged directly into the furnace the flow of gasses is obstructed, which may damage the furnace, so fine ores must first be sintered or pelletized.

1-2 Steel Scrap

Steel scrap is divided according to quality, size and shape, and includes types such as heavy scrap, press scrap, and shredder scrap. Scrap is also classified according to whether it is obtained domestically or as an import. Domestic scrap is further divided into two categories: "home" or "return" scrap, which is derived from yield losses in the production of steel or from the processing of steel into semi-finished products, and "obsolete" or "purchased" scrap (used scrap purchased on the market). Obsolete scrap is further divided into scrap produced as the result of the fabrication of steel (cutting, etc.) into finished products, known as industrial scrap, or recovered from the scrapping of discarded steel-bearing products, such as automobiles, known as reclaimed scrap. The source of steel scrap yields major differences in the quality of the scrap, with scrap obtained directly from steel making operations of higher purity than scrap recycled from finished steel goods.

- Domestic Scrap
  - Home or Return scrap
  - Obsolete or purchased scrap
    - Industrial scrap
    - Reclaimed scrap
- Imported Scrap

1-3 Coking Coal (Coal)

1-3-1 Coking Coal

Coking coal normally refers to coal used as a raw material to produce coke, so is not a term stemming from the properties of the coal itself. In order to produce high quality coke for charging into blast furnaces it is critical that the coal have high caking properties and that it have limited amounts of ash, sulfur, and phosphorus. Steam coals, used mostly for such applications as power generation, have insufficient caking properties. Although most of the coal used for steel making has high caking properties (known as caking coal), the consumption of lower grade coals lacking sufficient caking properties has increased due to recent advances in briquette forming and coal blending techniques. Especially recently, the line dividing steam coal and coking coal has become blurred, and both types of coal are now used. The subsequent tightening of market conditions due to the increase in demand for steam coal has had an effect on the supply and demand and price of coking coal.

1-3-2 Coke

Coke used in steel making is charged into the blast furnace along with iron ore, and serves three critical functions in the steel making process: as an energy source to melt the iron ore, as a reduction agent to reduce the iron, and to provide porosity for the flow of oven gasses. The reason to first convert the coal into coke before charging into the furnace is that, first, unprocessed coal would likely break apart in the furnace, thus interfering with the steel making process, and second, because steam coal cannot generate sufficient amounts of heat. Although coke is used in other applications, coke used for steel making must be high in strength, be of uniform size, and have a low ash and sulfur content. Further, reserves of caking coals are not plentiful and are higher in price than non-caking coals, so recent research on formed coke has concentrated on the latter.

1-3-3 Coke Production

Coke is formed basically by drying heavy coking coal. The basic coke production method entails sealing slack produced from crushed coking coal into coke ovens, which are composed of coke oven chambers, firing, and regenerative chambers. The coke is dried for between 16-18 hours at temperatures reaching 1000 to 1300 degrees, then pushed out of the oven and cooled. Cooling methods in the past have used mostly water, but recently coke dry quenching (CDQ) techniques using inert gasses have come into use, representing an improvement in terms of pollution and energy conversation.

2. Supply and Demand for Steel-Related Materials

2-1 Recent supply and demand trends

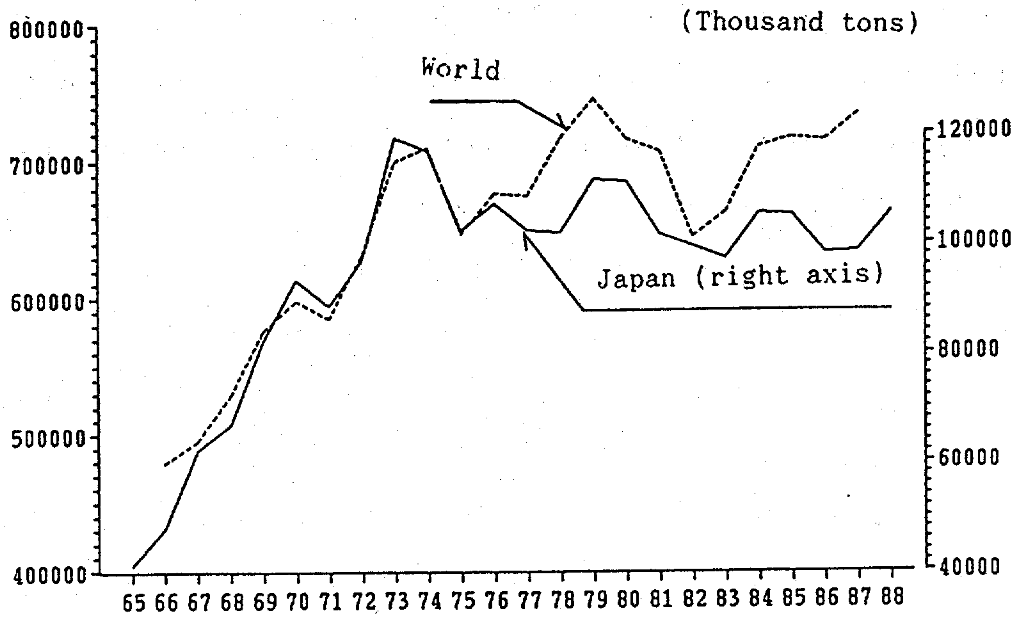
2-1-1 Trends in supply and demand for iron ore

There is a close relationship between crude steel output and the consumption of iron ore. Rapidly expanding demand for steel in Japan in the early 1960's, naturally led to increasing output of crude steel (Figure 1). Subsequently, steel demand leveled off following the oil shocks, and has remained flat until recently. As the ratio of blast furnace/converter steel is high in Japan, the consumption of iron ore essentially follows trends in crude steel output (Figure 2).

Virtually 100% of the iron ore consumed by the steel industry is imported. Japan at one point relied mainly on Indian and Southeast Asian ores, but as domestic output expanded Japanese steel makers made efforts to develop new large-scale sources of supply, particularly in Australia and Brazil. From 1970, when Australian and Brazilian ores came on stream, imports from these two grew rapidly, and in 1988 accounted for 42.5 percent and 22.6 percent of Japan's imports, respectively. Adding imports from India it these figures, the three countries supply more than 80 percent (82.7%) of Japan's iron ore imports (Figure 3).

Iron ore prices (CIF) increased following the oil shock and remained high through 1982, but the subsequent fall in demand has led to declining prices since the beginning in 1983. In the 1988 negotiations over iron ore import prices, the price of fine ore, the benchmark ore, was about 4% less than the year before, despite the recent recovery in steel output. Although the FOB price fell in 1988, the CIF price at the end of 1988 was about even with the 1987 price due mostly to increases in the cost of freight.

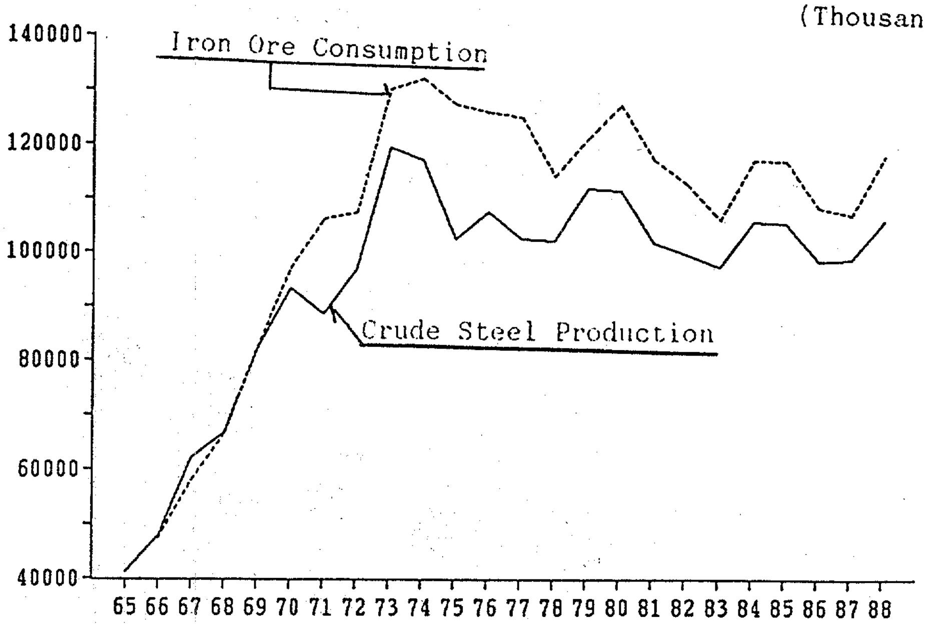
Figure 1. World and Japanese Production of Crude Steel



Source: IISI estimates

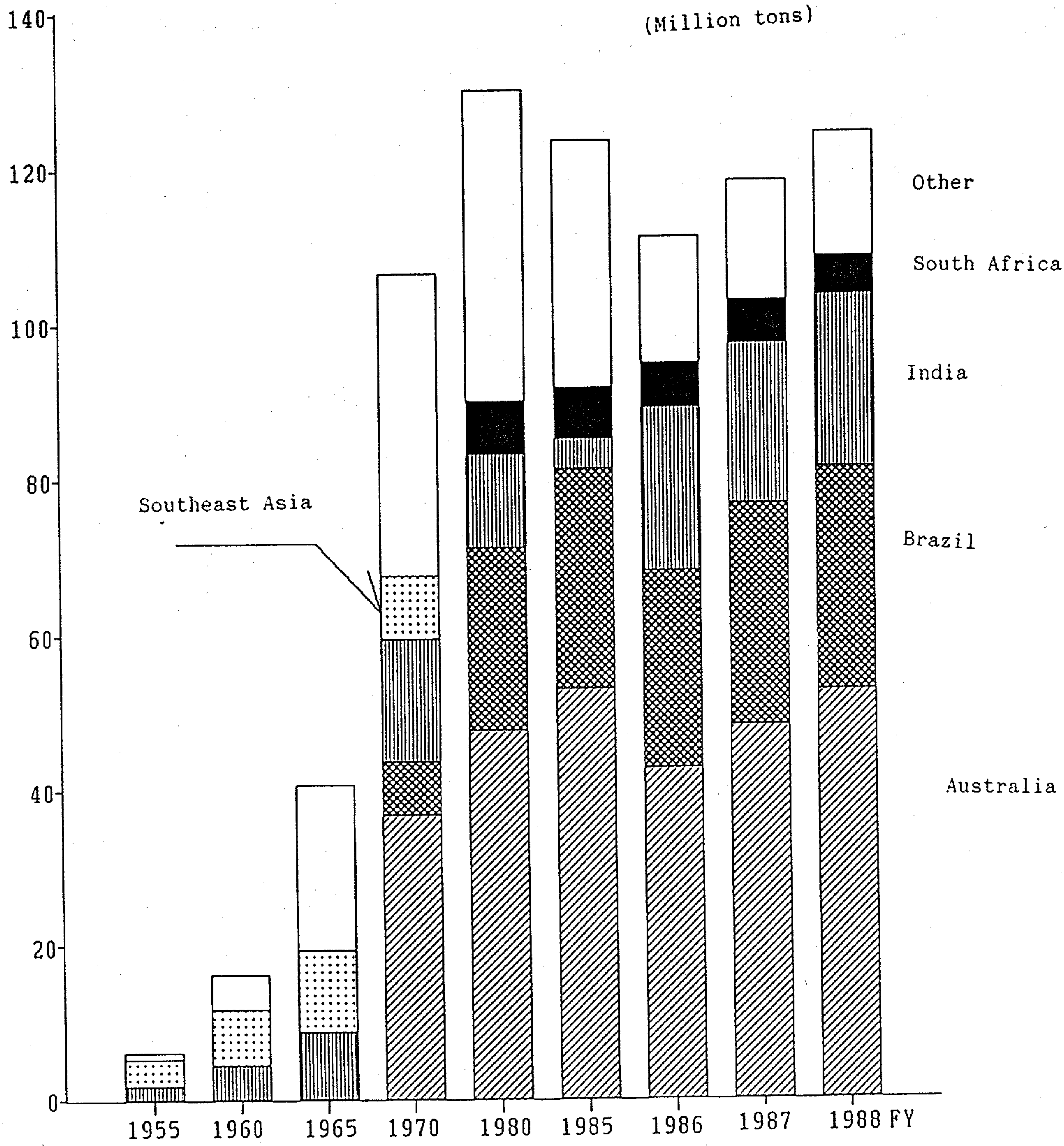
Figure 2. Japan's Production of Crude Steel and Consumption of Iron Ore

(Thousand tons)



Source: "Yearbook of Iron and Steel Statistics," MITI

Figure 3. Imports of Iron Ore, by Country



Source: "Trade Statistics" (Ministry of Finance)

2-1-2 Supply and demand for steel scrap

The total amount of available scrap has continued to increase, but imports have been declining for a number of years. This is because domestic supplies of obsolete scrap have naturally increased as the Japanese economy has become more advanced and begins to mature. As these scrap reserves increase, the domestic generation of scrap also increases.

Imports of scrap in 1988 totaled 1.24 million tons. This represents a 76.7 percent reduction compared to imports in 1970 due to the increase in the supply of domestically generated scrap (Table 1).

The actual supply of domestic scrap basically depends on changes in available steel reserves. As long as Japan's steel reserves continue to increase, the generation of scrap will also increase.

Table 1. Trends in Domestically Supplied and Imported Steel Scrap

(Million tons)

Year	Total	Domestic	Imported	United States
1970	42.28	36.96	5.32	4.23
1980	45.10	42.11	2.99	2.46
1985	46.57	42.99	3.58	2.11
1986	42.49	39.77	2.72	1.18
1987	45.15	42.57	2.58	1.12
1988	47.01	45.77	1.24	0.38

Source: "Steel Statistics Handbook" (JISF)

2-1-3 Coking Coal

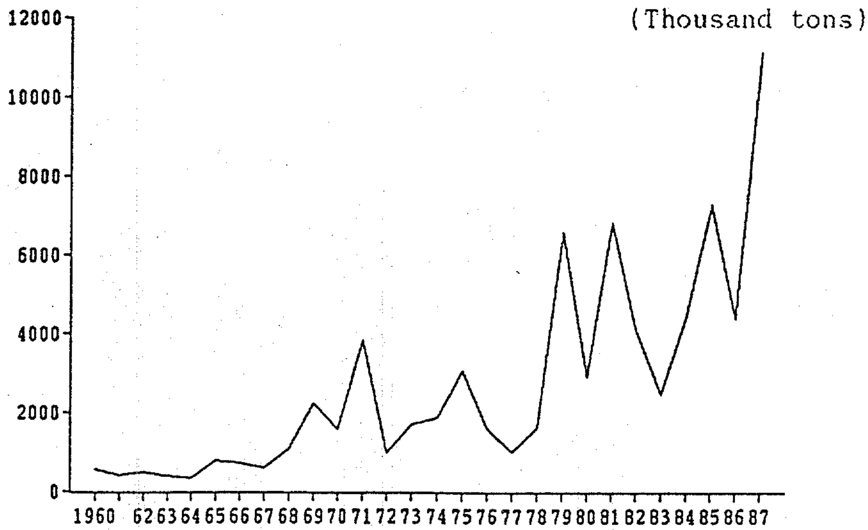
As was seen in the case of iron ore, demand for coking coal for blast furnaces grew as Japan's steel production grew in the 1960's, with imports exploding after 1970. The beginning of imports of Australian coal, from new mines developed between 1960 and 1965, led to changes in the structure of supply. Subsequent increases in imports of Australian coal, as well as increasing purchases of Canadian coal, led to a significant drop in the import share of relatively high-priced US coal.

However, after 1980 country-by-country shares of imported coking coal have remained relatively stable. Although US coal is slightly more expensive, it has been able to maintain a certain share of the Japanese market because it is perceived as a relatively stable source of supply, allowing Japan's steel output a certain amount of flexibility in terms of supply.

Australia's increasing share of imports since the 1970's was due to the opening of newly developed coal mines, but frequent coal strikes have damaged the perceived stability of this source of supply. As one illustration, losses in shipments of coal due to coal mine strikes in New South Wales have not only increased in the 1980's, but also the range of fluctuation has become more volatile (Figure 4). Thus, despite expanding demand for coal, Australia's relative share has slipped. Total consumption of coking coal in 1988 reached 65.7 million tons, an increase of 7.6%, or 5 million tons over the year before, while imports increased by 9.9% to 65.9 million tons, or 6.5 million tons higher than 1987. However, because of frequent coal-related labor disputes imports from Australia grew by a mere 1.6%, or 400,000 tons, ending up at the 26.4 million ton mark. In contrast, Canadian coal increased by 2.84 million tons (up 19.4%) to 17.4 million tons, while US coal increased by 3.3 million tons (up 39%) to reach the 11.8 million ton mark (Figure 5).

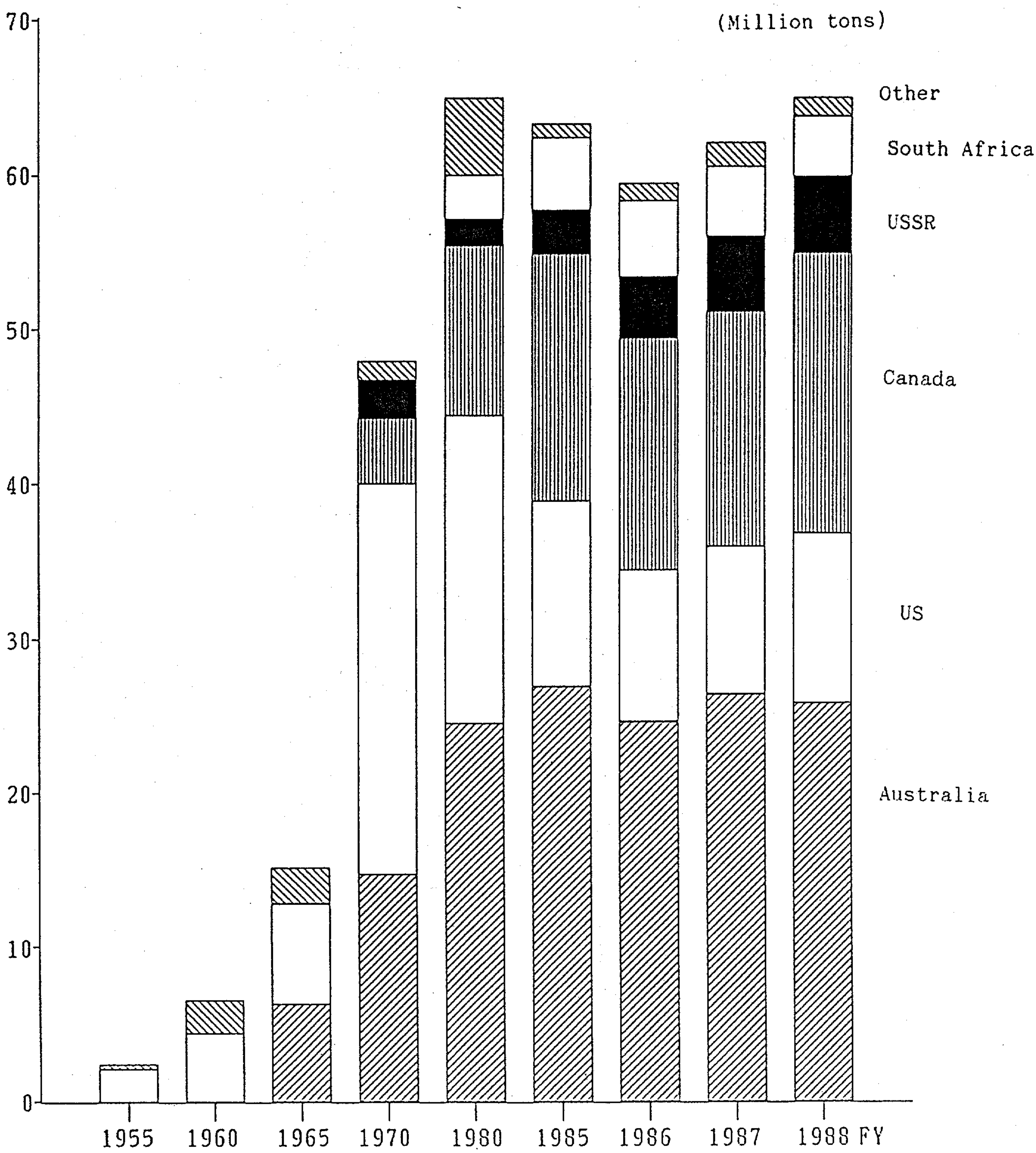
Coking coal prices increased following the oil shock up until 1982, but the subsequent world-wide decrease in demand for steel caused a long-term

Figure 4.
Lost Shipments of Coking Coal Due to Strikes (New South Wales)



Source: "Black Coal in Australia, 1987-88," Joint Coal Board.

Figure 5. Trends in Imports of Coking Coal, By Major Supplier



Source: "Trade Statistics" (Ministry of Finance) price decline. However, the 1988 price negotiations for imported coking coal, and particularly the negotiations over non-fine coking coal prices, were long and protracted, due in part to the recent recovery of domestic demand for coal. Negotiations dragged on until July, finally resulting in an average 7 percent increase in imported coal prices (FOB). The CIF price for coking coal thus rose due to the general rise in FOB prices, the shift in procurement from lower priced Australian coal to higher priced American coal, and the rise in freight rates for steel materials, a part of the general rise in shipping rates due to increased world-wide economic activity.

In the future, if global economic conditions remain strong and international shipments continue to expand, there is the possibility that increasing demand for steel will bring about even higher freight prices.

3. Outlook for future supply and demand for steel materials

3-1 Estimates of consumption of iron ore and steel scrap

It is relatively easy to estimate future demand for iron ore if one has an accurate forecast of future crude steel production. According to the estimates of another paper in this conference, "Japan's Steel Supply and Demand Trends" (Goto and Todo), Japan's total crude steel production in fiscal 1995 should be around 90 million tons. Based on this assumption, we can estimate future demand for iron ore and scrap.

Steel making accounts for the entire consumption of iron ore, so the consumption of iron ore runs parallel to the output of crude steel. In the longer term, technological changes leading to higher yield rates in steel production, or improvements in the quality of iron ore, will have a major impact on raw material consumption. However, the basic technologies in use today, the result of rapid improvements in technology over the last ten years, are now considered mature technologies. Future developments will be limited to improvements in existing technology, rather than fundamental changes, so the steel industry can no longer anticipate explosive improvements in yield rates, energy conservation, or productivity. Further, it will likely take another ten years before new basic technologies such as reduction melting methods are actually adopted, so there should not be any fundamental change in steel making technology between now and 1995 (see the Murase paper on this point).

It is also necessary to consider changes in the shares of crude steel production occupied by converter steel and electric furnace steel. A glance at recent changes in the shares of these two sectors shows that although technological changes and changes in the energy situation led to great changes in the structure of steel production until around 1985, since then the shares of the two steel-making processes have stabilized (Table 2).

Looking at the demand for steel products, electric furnace mills largely produce section steel and small bars for construction purposes, while the integrated steel mills dominate the production of higher quality products such as steel sheets for automobiles, etc. In this sense the two sectors have created a structure of supply well suited to their economic and technological strengths, and as long as there are no major changes in the structure of demand for steel, this relationship should not change. The percent of total crude steel produced by electric furnaces has held steady recently, at 29.7 percent in 1986, 29.8 percent in 1987, and 29.7 percent in 1988 (Figure 6). At least judging from recent trends, as long as the demand for steel remains fairly stable, the share of electric furnace steel should not change dramatically.

Again, based on the assumptions that there will be no fundamental changes in steel making technology and no major shifts in the structure of production, we next estimate future consumption of iron ore and scrap.

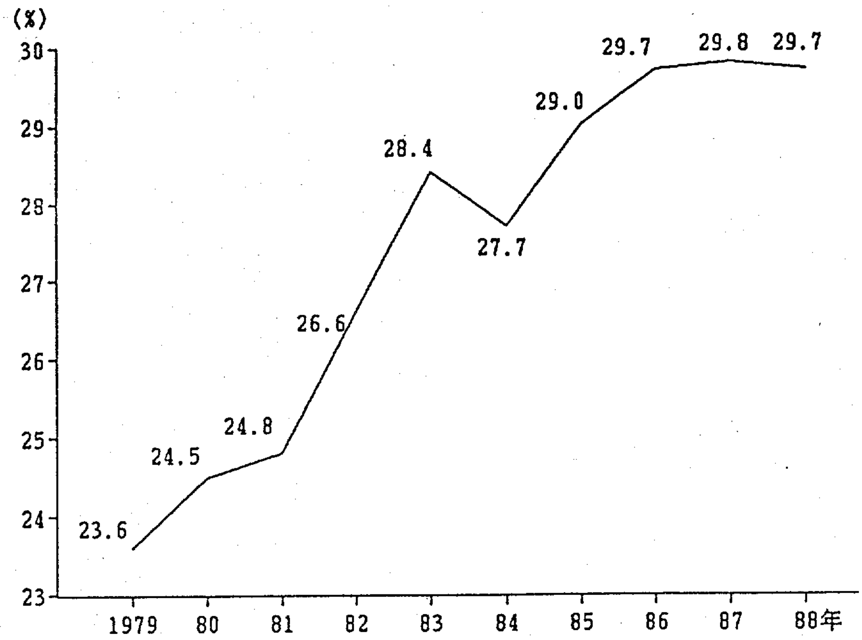
Table 2. Trends in Crude Steel Production, by Technology

(10,000 tons)

	Total	Converter	Electric Furnace	Share of Electric Furnace Production (%)
1979	11175	8537	2638	23.6
1980	11140	8415	2725	24.5
1981	10168	7648	2520	24.8
1982	9955	7306	2649	26.6
1983	9718	6955	2763	28.4
1984	10559	7636	2923	27.7
1985	10528	7478	3050	29.0
1986	9828	6912	2916	29.7
1987	9852	6915	2937	29.8
1988	10568	7425	3143	29.7

Source: "Yearbook of Iron and Steel Statistics," MITI.

Figure 6. The Electric Furnace Share of Crude Steel Output



Source: "Yearbook of Iron and Steel Statistics," MITI.

It is first necessary to discuss the consumption of raw materials in 1988. Total crude steel output in 1988 was 105.68 million tons, of which converter steel accounted for 74.25 million tons, and electric furnaces accounted for the remaining 31.43 million tons (Figure 7). The consumption of iron ore reached 115.69 million tons, while the input of steel scrap totalled 35.44 million tons.

If we assume that steel production in 1995 will be 90 million tons, this would represent 85.16 percent of production in 1988. Assuming this ratio also applies to raw material consumption, steel producers will consume 98.52 million tons of iron ore and 30.18 million tons of steel scrap (Table 3).

3-2 Estimates of Coking Coal Consumption

The estimate of coking coal consumption is based on the assumption that there will be no major changes in the structure of raw material inputs. In 1988 the consumption of coking coal by the steel industry was 63.52 million tons. Using the same assumptions and method as for the iron ore estimate, if crude steel production is 90 million tons in 1995, then coking coal consumption should be 85.16 percent of 1988 consumption, or 54.1 million tons.

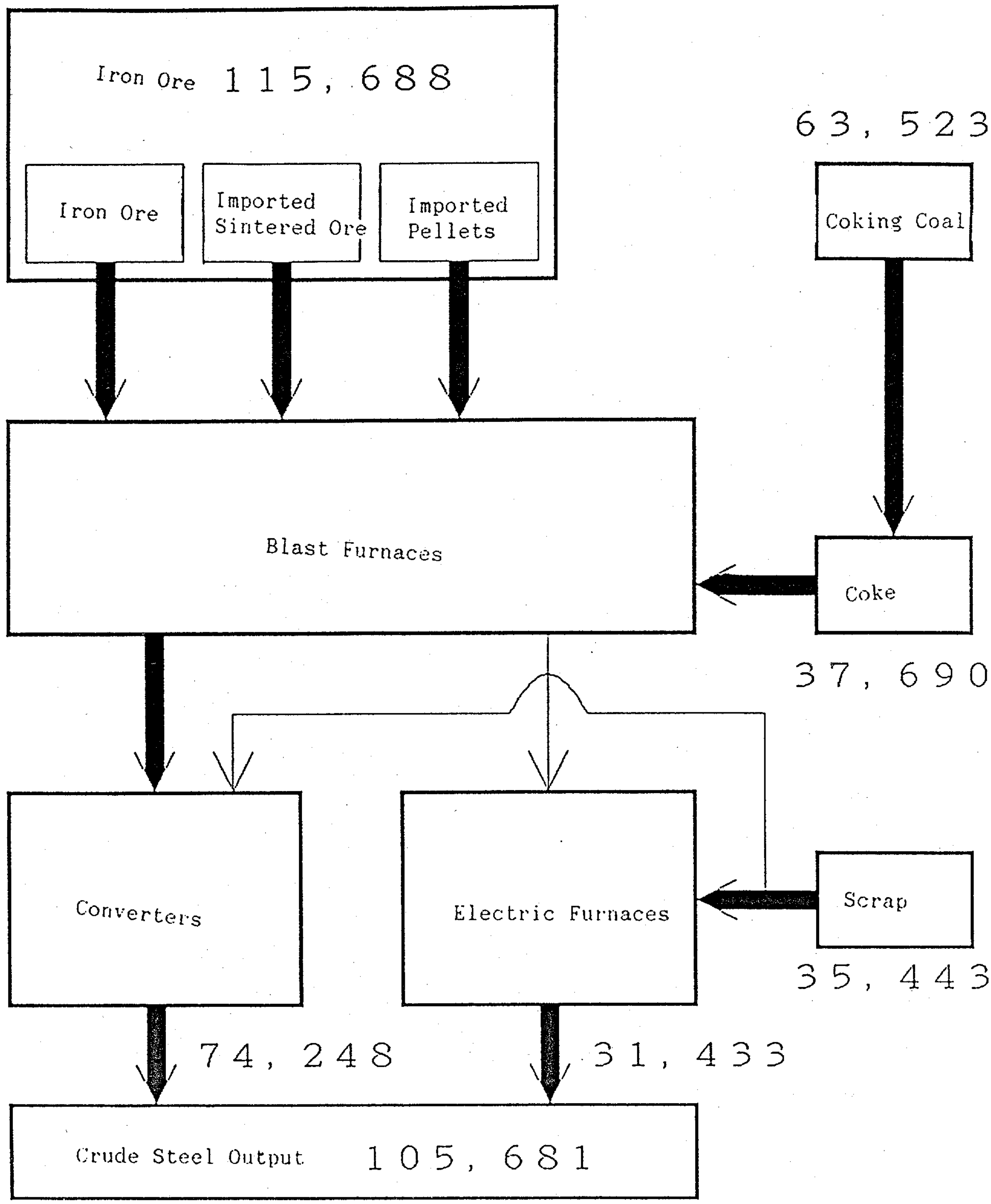
3-3 Estimates of Imports from Various Suppliers

Forecasts of consumption in 1995 call for 98.52 million tons for iron ore and 54.1 million tons for coking coal. As Japan relies on imports for virtually all of these materials, the question is from what sources these materials will be purchased. The choice of raw material supplier is a critical element of the corporate strategies of Japan's steel producers since it has an effect on direct production costs. Steel firms are interested mostly in low-cost and stable sources of supply.

As can be seen in trends in the procurement of iron ore over the past ten years, shown in Figure 3, the pattern of procurement should remain stable

Figure 7. Structure of Consumption of Raw Materials for Steel Making, 1988

(Thousand tons)



Source: "Yearbook of Iron and Steel Statistics," MITI.

Table 3. Steel Raw Material Consumption

(Thousand tons)

	Iron Ore	Scrap	Coking Coal	Crude Steel Output
1980	127012	36190	64836	111395
1985	116717	36692	66102	105279
1988	115688	35443	63523	105681
1995	98520	30183	54096	90000

Notes:

1. Total imports and domestic production
2. Iron ore includes imported pellets and sintered ores
3. 1995 figures are estimates

Source: "Yearbook of Iron and Steel Statistics," MITI.

through 1995, as long as there are no major changes in the political situations of the supplying countries. Similarly, for coking coal, as seen in medium-term import trends shown in Figure 5, the structure of procurement should remain fairly stable.

However, it is possible that in the long-term both supply and demand for coking coal will change significantly. On the one hand, demand for low quality, low cost, non-fine coking coal is expanding rapidly due to developments in steel making technologies. Furthermore, the distinction between coking coal and steam coal will be further blurred in the long term if the reduction melting method currently being developed proves to be technologically and economically feasible and is adopted widely. In terms of supply, although the increase in supply relative to demand for coal after 1982 and the subsequent drop in prices caused projects to develop new sources of coal to be postponed or canceled, the increase in demand for coal from 1988 has led to renewed investment activity in existing coal mines and the development of new mines, both centering on steam coal. If steel firms gain access to relatively cheap and stable sources of supply as a result of these efforts, procurement from these sources will in the long term reduce the amount of coking coal purchased from other suppliers.