the overall industrial structure, its structure is still variable and will change in line with the change in overall industrial structure.

In the total aluminum demand in Japan, the domestic demand has an overwhelmingly large share of over 90%. The export accounts for less than 10%, remarkably small compared to those of the United States and Europe. However, analysis of interindustry relations shows that, out of the final demand calculated based on the national income, about 20% of the demand for primary aluminum is ultimately induced by export demand. In other words, aluminum products have recently been used as parts of passenger car, color television set, etc., and their contribution to these exports supported strongly the export-oriented industries. The future aluminum demand structure in Japan may be more closely connected to these technology intensive industries.

III. Factors of Changes in Aluminum Demand

Factors affecting developments and changes of aluminum demand are analyzed below. Some of the important points are summarized in order to understand aluminum demand trend.

1. Relation with Competitive Materials

Typical competitive materials with aluminum are steel, copper, plastic and lumber. Steel and plastic are competitive with aluminum as material of machinery parts. Copper is competitive with aluminum as material for electric wire. Wood and steel are competitive as materials for building materials. There are a limitless number of other competitive materials, such as tin, zinc, cement, graphite fiber, titanium and composite materials.

Considering physical properties, as Table C-2 shows, there is no other material whose production requires as much energy as aluminum. Aluminum requires about twice the energy of steel billet and about seven times that of polyethylene in terms of $kcal/cm^3$. Aluminum is an extremely luxurious metal in this respect.

However, there is no other single material with the superior lightweightness, corrosion resistance, thermal conductivity, electrical conductivity, moldability, etc. than aluminum. Because of these superior properties, very little energy is required to produce final product, for example, a container from aluminum. Especially when aluminum is recycled, this advantage is even greater.

Table C-2 Energy Requirements in the Production of Basic Materials*

Material	Density g/cm^3	Oil equivalents by weight: TOE/t for feedstock	TOE/t for conversion	Total TOE/t of basic material	Total TOE/t equivalent: k cal per in^3	k cal per cm^3
Aluminum	2.7	-	5.6	5.6	2,600	158
Steel billet	7.8	-	1.0	1.0	1,340	82
Tinplate	7.8	-	1.25	1.25	1,680	102
Copper billet	8.9	-	1.2	1.2	1,840	112
Polystyrene	1.07	1.3	1.88	3.18	585	36
Polyvinyl chloride	1.38	0.55	1.4	1.95	465	28
Low density polyethylene	0.92	1.11	1.13	2.24	360	22
High density polyethylene	0.96	1.13	1.2	2.33	385	24
Polypropylene	0.90	1.17	1.38	2.55	390	24
Glass bottle	2.4	-	0.45	0.45	186	11
Paper and board	0.8	-	1.1	1.1	148	9.3
Cellulose film	1.45	-	4.4	4.4	1,100	70

* Based on UK operating data. TOE/t = tonnes of oil equivalent per tonne; k cal = kilocalories (1 k cal = 3.9683 BTU)
BTU: British Thermal Unit

Source: AME

Table C-3 Energy consumed in the Production of various Containers

Container	BTU per container
Tinplate can	2,915
Bi-metallic can	8,415
Returnable glass bottle	25,975
Non-returnable glass bottle	12,980
Aluminum can:	
100% primary aluminum	6,106
75% "	4,737
50% "	3,368
25% "	1,998

Source: AME

One reason for marvelous expansion of aluminum consumption after the Second World War was the appreciation of these superior properties of aluminum. A comparison of aluminum growth with those of competitive materials in Fig. C-16 shows the rapid growth of aluminum (1970-80 average annual consumption growth rate of primary aluminum of 4.3%) over copper, steel and zinc. However, even aluminum's rapid growth was behind the explosive growth of plastic (average annual growth rate for the same 1970-80 period of 7.4%).[1)]

In addition to the superior properties, the high growth of aluminum also resulted from its relatively stable price level. Comparing the market price of aluminum with competitive materials is quite difficult. But the examples of the United States (average producer prices of various metals) and Japan are shown in Figs. C-17 and C-18. The aluminum price rised many times in the past. However, these price rises were always accompanied by those of other competitive materials. In other words, the aluminum price, when compared with prices of competitive materials, has been relatively stable until now. For example, aluminum price soared in 1980 as shown in Fig. C-18, but at the same time plastic and lumber prices soared. Needless to say, such relative stability of price has been an important reason behind the rapid growth of aluminum.

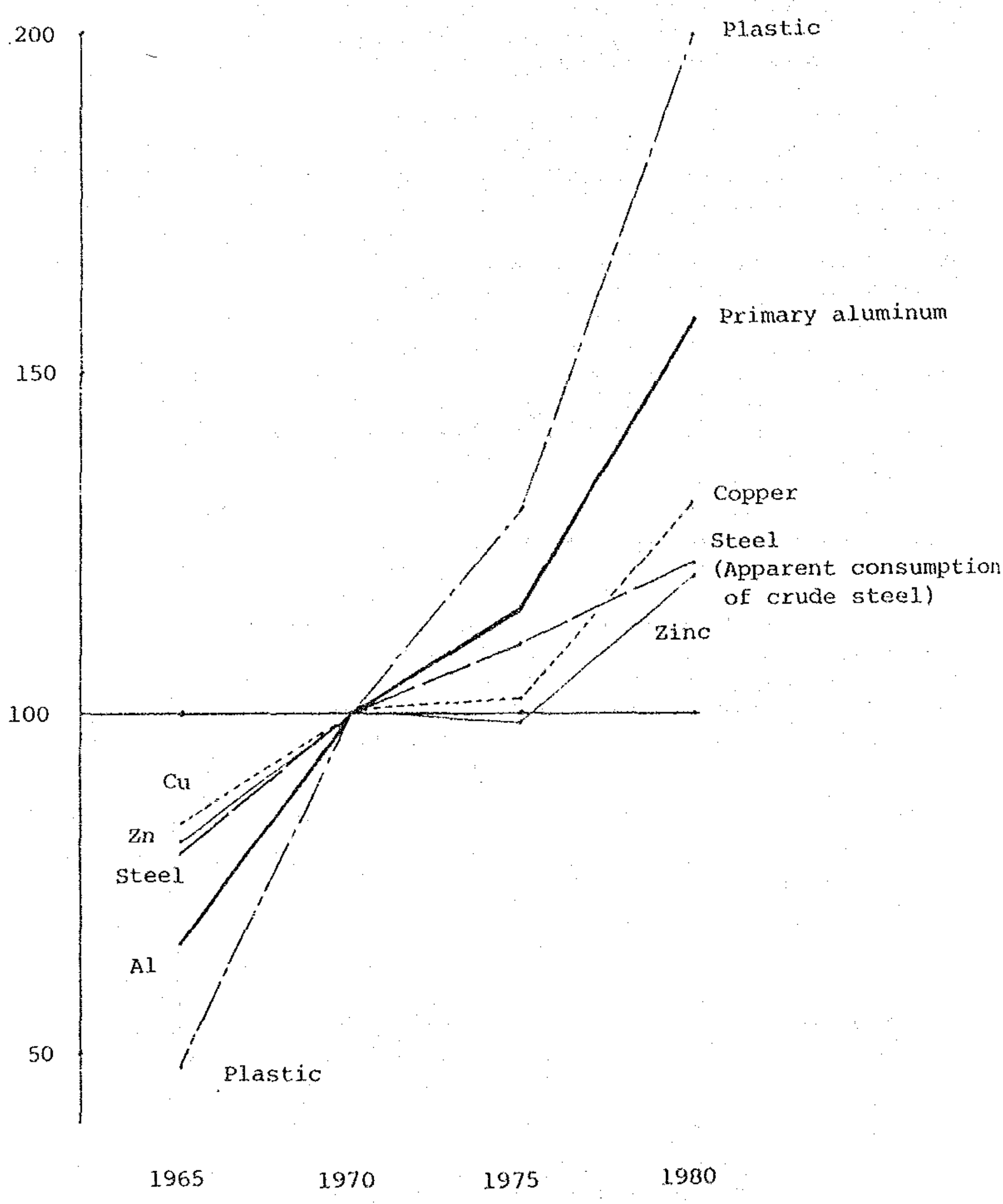
However, the future aluminum position will not be so simple. There was another reason behind faster aluminum growth than competitive materials in the past; i.e. usages of conventional materials had been more or less unchanged and saturated. The recent impressive technology developments in steel and plastic fields, however, have reached the level where the aluminum is surpassed by steel or plastic in properties applicable to relevant markets. Aluminum, in the midst of severe competition with other materials, has gained the market in the past, but such development in other materials will make the aluminum competitiveness more vulnerable in the future.

1) In Japan the growth of aluminum is faster than that of plastic. The consumption growth rates for the competitive materials are were as below. (1970 level: 100)

	1965	1970	1975	1980	1970-80 average annual growth rate
Aluminum a)	33	100	129	180	6.0%
Plastic b)	31	100	101	147	3.9
Crude steel c)	40	100	96	111	1.1
Copper a)	50	100	98	177	5.9
Zinc a)	57	100	89	115	1.4

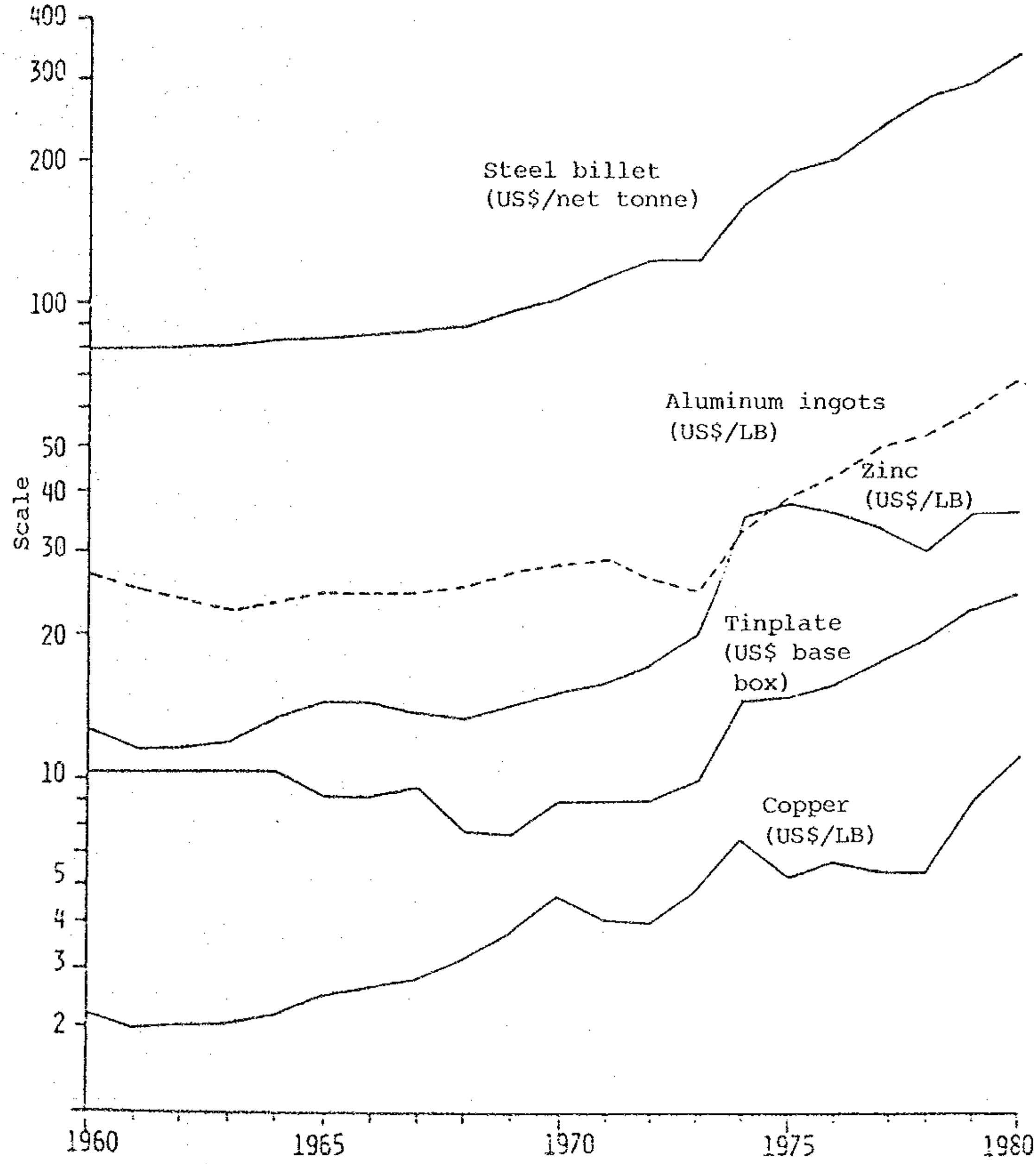
Source: a) Metal Statistics
b) Japan Plastic Industry Association
c) Japan Iron and Steel Federation

Fig. C-16 Development of World Consumption of Primary Aluminum and Main Cmpetitive Materials (1970 level: 100)



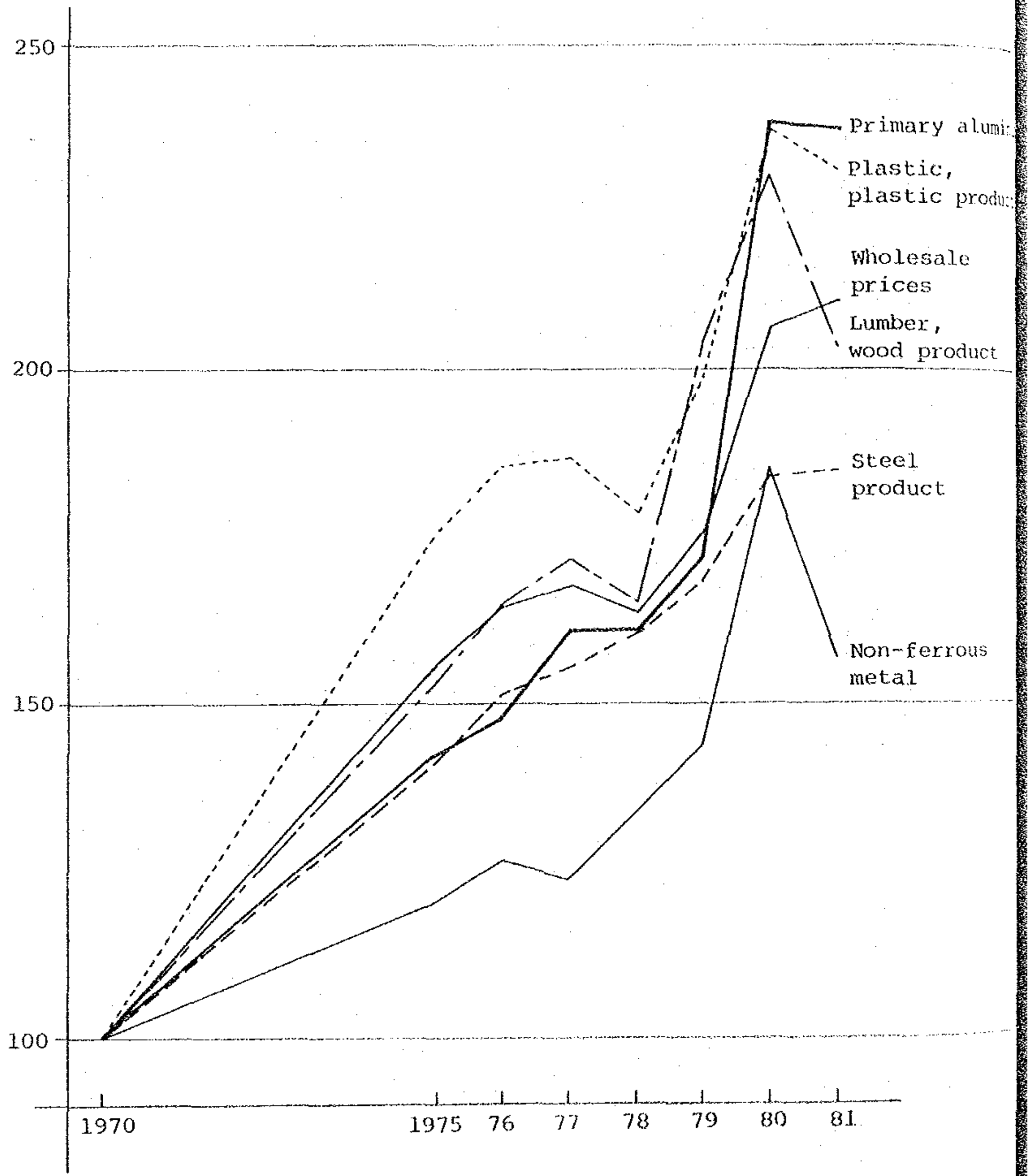
Source: JAF

Fig. C-17 US Producer Prices for Aluminum and Competing Metals



Source: AME

Fig. C-18 Price Trend of Competitive Materials in Japan
(Comparison by price indices; 1970 levels: 100)



Source: JAF

In addition to such competition, aluminum carry a heavier handicap than the other materials, i.e. high energy requirement in aluminum production, as previously mentioned. If the high energy requirement directly results in the relatively high aluminum price, aluminum competitiveness is greatly weakened. Of course, in the short run, the price increase of one material does not directly trigger substitution by other materials. For example, as for the relationship between aluminum consumption growth and price rises in the United States, Fig. C-19 shows that the increase in aluminum prices did not necessarily results in consumption decreases. Over the long run, however, price increases always lead to substitution by other materials. It is difficult to ignore the possibility that there may arise a situation opposite to the past where aluminum has always won the competition with other metals.

In summary, what is more required in aluminum in the future is overall competitiveness including sufficient stability of relative price of aluminum product to overcome the handicap of large energy requirement and technical development to achieve such competitiveness.

2. Development of New Application and Competition of Materials

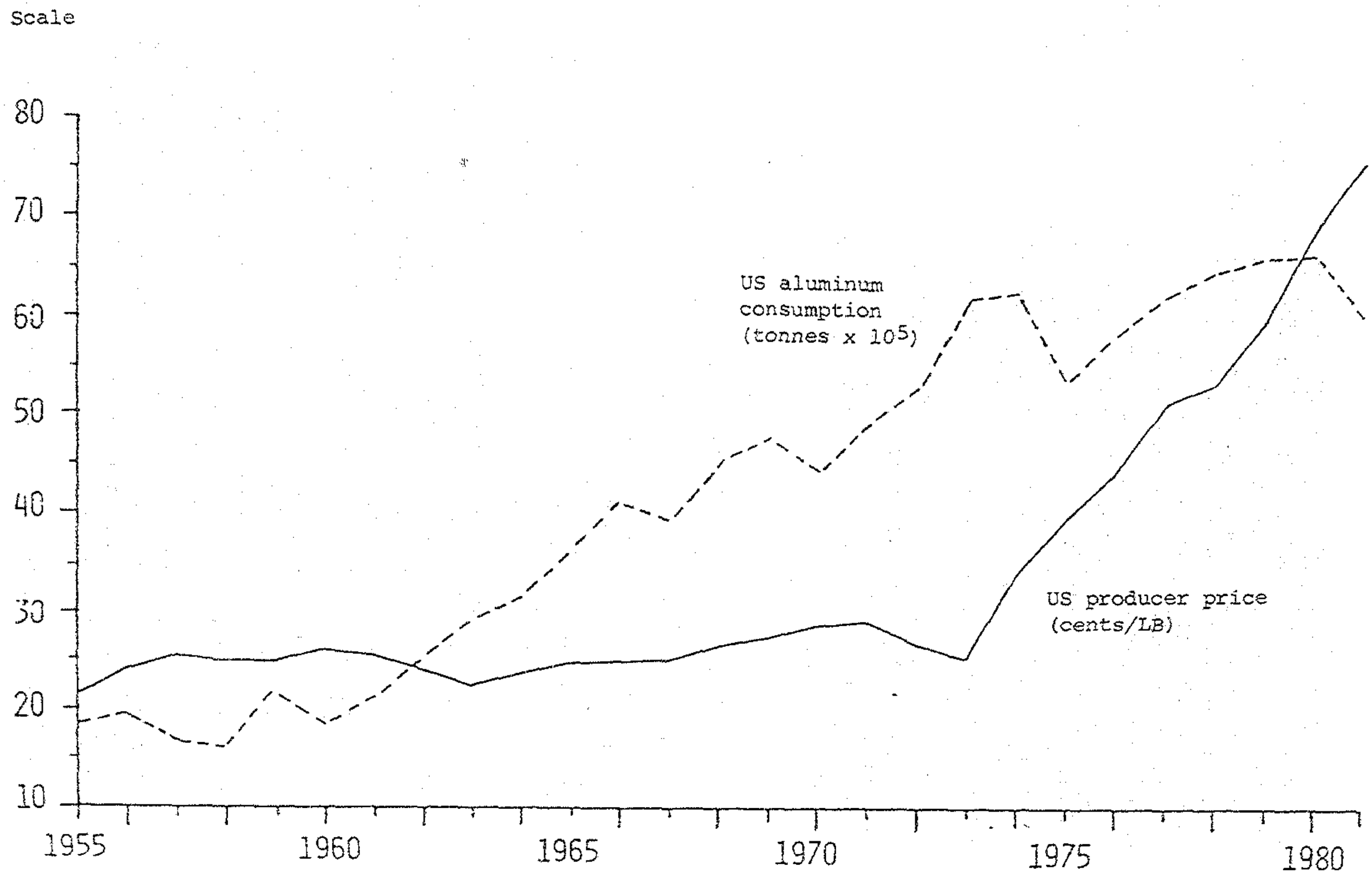
As mentioned above, technical developments to use aluminum as material will be more and more required in the future to meet the market demand. How is this technical development expected to proceed? Though this issue is quite difficult to answer, this section discusses it in the three product fields: automobile, building material and packaging.

In the automobile field, aluminum is used for many parts mainly as casting and die-casting products. Table C-4 shows the aluminum consumption in the automobile industry in the United States and some aluminum parts used for 1982 model cars in Japan. It may be surprising for these examples to indicate that the aluminum technology for new applications has so developed.

It is easily understood that behind wide use of aluminum for parts, there are general progress in design technology, alloy technology, processing technology, surface processing technology, joining technology and so forth, and serious technical efforts to achieve cost reduction. Accordingly, so long as aluminum maintains its relative competitiveness of price against other materials, automobile designs can continue to be made based on aluminum parts in the future. In this case, the automobile industry will remain one of the major markets for aluminum.

In the building material market, aluminum extruded shapes are

Fig. C-19 US Aluminum Consumption and the US Producer Price for Primary Ingot 1955 - 1981



Source: AME

mainly used especially in Japan and Europe and this tendency is likely to remain unchanged in the future. Extrusion process can produce complicated cross-sectional shapes in a single process, which makes the best use of aluminum properties and has limitless chances to develop. Extruded shapes have been used mostly for window sash in office building, housing and store. The recent stagnation in housing construction, however, helped the development of aluminum composite sash as a part of development of new products. The composite sash have multi-functions of heat insulator, sound insulator, rain shutter, netted window and sliding door. Because

Table C-4 Consumption of Metals by the U.S. Automobile Industry in 1979*

Metal	1,000 tonnes
Alloy steel	2,028
Stainless steel	168
Other steel	14,697
Total steel	16,893
Aluminum	1,046
Copper and copper alloys	345
Malleable iron	258
Zinc	277

* Including car, truck, and bus.

Source: American Metal Market, 1981

Examples of aluminum usage in automobile parts (Japanese 1982-model cars)

Note: Not all the parts shown are used in any one car.

Casting/Diecasting

Transmission case, air conditioner compressor case, piston, intake manifold, generator housing, bracket (accessories), brake master cylinder, steering housing, water pump housing, wheel, air pump housing, carbureter body, cylinder head, brake drum, cylinder blocks, windshield wiper motor housing, brake caliper.

Mill Product

Air conditioner condensers, trim material, heater core, air cleaner, linkage component, bumpers (reinforcement, surface), hood, forged wheel, seat, radiator, wheelcap, deck lid, truck frame, load floor, forged piston, door, suspension arm, fender.

they use large extruded shapes, the aluminum consumption per window increases and the use of composite sash compensates for the decreased volume of aluminum consumption caused by the shrinking housing construction. As post window sash market, there are various products such as door, entrance door, gate, fence, terrace, balcony and fitting and they are growing as larger market than window sash. In addition, exterior fitting such as the curtain wall and the solar building (a curtain wall equipped with solar heater) have been developed. The future development of these products including solar product is expected.

Moreover, a wide variety of application will be developed to pool for which aluminum is more suitable than concrete in terms of quality guardrail, watergate, concrete holding frame, and tile holding frame. It may be noted that aluminum pool accounts for about half of the pools recently installed in Japan.1)

In the United States, the colored aluminum sheet is widely used for siding and roofing which is not common in Europe and Japan, where coated steel sheet is relatively cheap. This shows that the area of new aluminum applications will vary according to the situation in each country. The use of extruded shapes as building materials requires mas production of standardized product to reduce cost. In the countries where people do not like standardized product or in the developing countries where the system to standardize the product is still not fully developed, the development of application of extruded shapes may prove a little difficult.

In packaging market, aluminum consumption for beverage can has grown up remarkably as already mentioned. In the United States, about 84% of beverage can is made of aluminum. In Japan, however, there has been outstanding technical development for the "two piece can" with steel body and aluminum lids. Because steel body is cheaper than aluminum one, it is expected that the competition between the all-aluminum can and the two piece can will become more severe. General view is, however, that the easy-open lid aluminum can will certainly survive the competition. On the other hand, in Europe, the demand for all-aluminum can, though expensive, is expected to continue to increase, thanks to their lightness.

All-aluminum can is clearly preferable to composite can from the viewpoints of collecting and recycling. If present all-aluminum can improved to the level where its lid and body were both made of the same aluminum alloy, recycling would be spreading. Technical development in this area is also desirable.2)

1) Of the 1,070 pools installed in 1979, 500 were aluminum pools.
2) Existing aluminum can uses the different alloys for the lid and the body due to the strength requirement. If it becomes possible to use the same alloy for both the lid and the body, then the collected can is directly recycled without intermediate processing.

The growth of composite container of paper and aluminum foil, reduced from the viewpoint of cost saving and function, is also noteworthy. Laminate container, composite of plastic film and aluminum foil, has begun to be used recently for various purposes. As these composite containers are free from waste pollution, do not require collecting and can keep their content fresh, they are well suited to the current needs and their consumption are expected to increase.

In Europe, the rigid foil container, a product between all-aluminum can and composite container, is widely used for medium-term preservation. In Japan, small-volume aluminum beer barrel was recently developed as the new market and attracted much attention. Such new products, if well satisfying the current needs, have much potential to expand demand for them instantly. In this respect the packaging is a hopeful market field for aluminum.[1)]

As shown above, in the packaging field, aluminum application technology has been rapidly developed for the diversification of its usage to meet the needs of different types of contents and purposes.

Such development of aluminum application is always made under the severe competition with other materials. The many new materials developed by recent technological innovations requires further development of aluminum for competing with such materials including the price competition. Materials which are expected to compete with aluminum as structural materials in the future are as follows:

a. High Strength Steel: High strength steel has been used as material for car body by the automobile industry to reduce the weight because high strength steel is mechanically very strong and therefore can produce very thin sheet. The competition in price is intensifying.

b. Plastic: Plastic is very competitive with aluminum in terms of lightweightness. Many engineering plastics with high-strength and high heat resistance have appeared in the market and their growth is outstanding in automotive parts, etc. In the construction, material field, plastic is used for some portion of window sash for which aluminum has been dominantly used.

c. Plastic composite material: It has begun to use plastic composite materials such as glass-fiber reinforced plastic (GFRP) and carbon-fiber reinforced plastic (CFRP) as structural materials for aircraft due to their properties of lightweightness and high strength. They become powerful competitive materials with aluminum.

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1) In the third year (1981) since the first appearance in the market in Japan, about 45 million aluminum barrels were sold and their aluminum consumption reached about 8,000 tonnes.

In addition to the materials shown above, magnesium has been competitive metal with aluminum because of its light weight. When the specific gravity is considered, aluminum has the advantage in relative price compared to magnesium.

Titanium has been used especially for military aircraft requiring high-performance and its consumption is likely to grow together with above-mentioned CFRP.

To compete with these new materials, new application of aluminum is also extensively developed. One possibility is to improve the performance of aluminum alloys with lithium by powder metallurgy to the same level of strength as special steel so that it is used for aircraft body and engine parts. Another possibility is to create aluminum composite materials, fiber reinforced metal (FRM), to be produced by adding to the base material of aluminum alloy the reinforcing materials such as glass fiber, carbon fiber, and boron fiber. There is another aluminum composite material combining aluminum with competitive materials. There are many possibilities in this area.

In summary, the development of aluminum application should be expected to progress by widely cooperating with other competitive materials as discussed in the development of FRM and aluminum-titanium alloy rather than competing with other materials to replace them. If it is achieved, aluminum should develop more widely together with other materials.

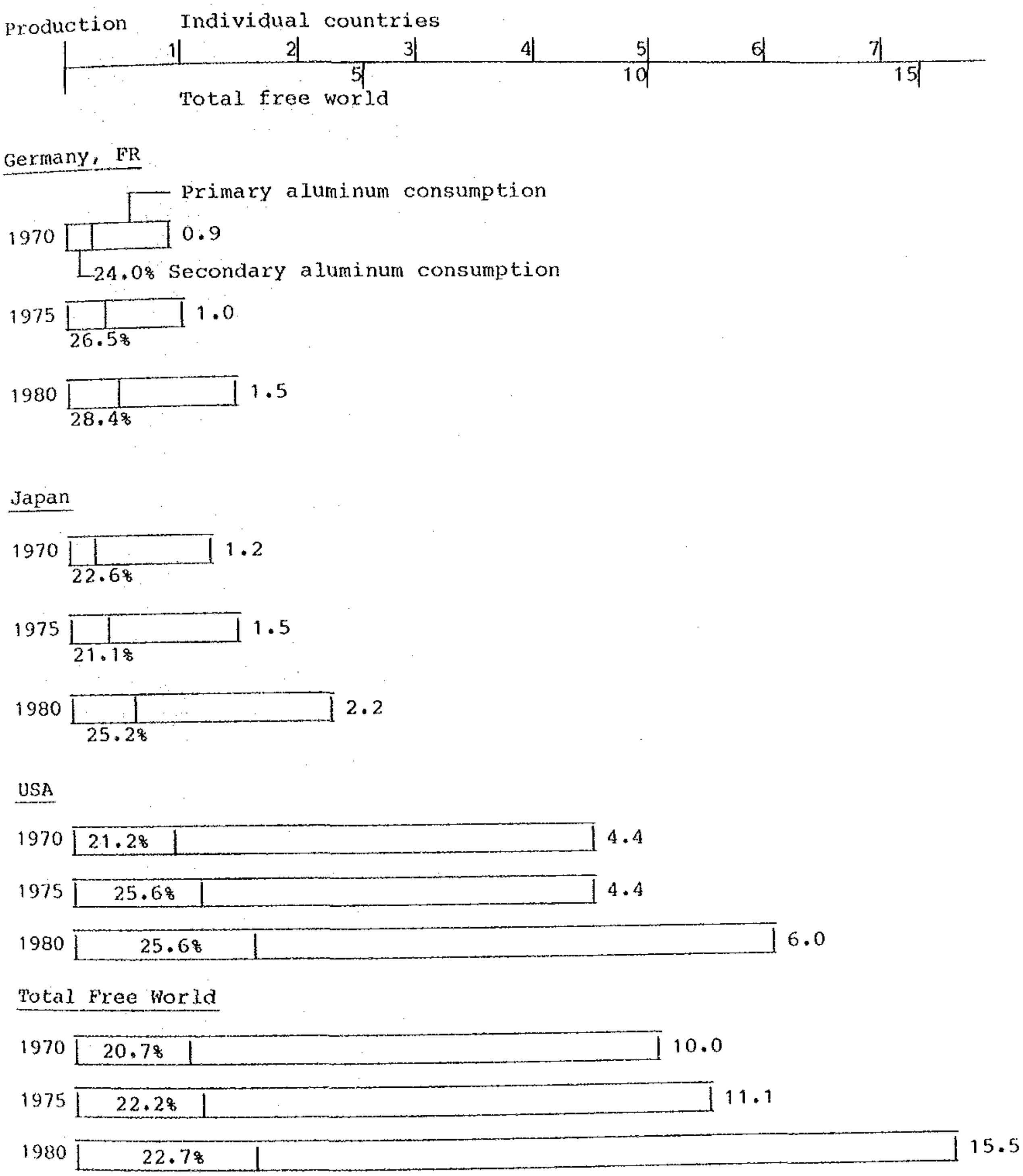
3. Demand for Secondary Aluminum and Primary Aluminum

The fact that the secondary aluminum can be produced with a mere 5% of the energy requirement for the primary aluminum is one basis to claim that aluminum is an energy saving material. However, unlike iron and copper, scrap aluminum cannot be refined in the primary aluminum smelting operation. The refining of scrap aluminum separately also causes the problem that complete removal of impurities is difficult. Although the magnesium, sodium and calcium can be removed by deoxidation, the removal of iron, silicon, copper and manganese requires the same high level of facilities and cost as high purity aluminum production. As a result, secondary aluminum is mainly used by diluting with primary aluminum without refining process.

Even under such limitation, secondary aluminum has cost advantage over primary aluminum and its consumption has been expanding steadily at a faster rate than primary aluminum. This trend is indicated in Fig. C-20, which shows the ratio of secondary aluminum in the total consumption in the three main consuming countries. (Refer to Reference Tables C-5 and C-6.)

Fig. C-20 Share of Secondary Aluminum Consumption in Total Aluminum Consumption

(Million tonnes)



Secondary aluminum has recently displaced primary aluminum for almost all casting and die-casting alloy products for automobile, thanks to the casting technology and the design technique for parts suitable for utilizing secondary aluminum. Therefore primary aluminum alloy has been only used for some important parts for safety such as wheel. In addition, there has been growing a market for precise, light and thin casting product which requires less finishing, through the development of casting and die-casting technologies for cost reduction. It seems certain that the demand for secondary aluminum for casting will increase in the future.

As for aluminum can which has difficulties in collecting, recycling becomes popular as collecting service centers have been established recently. For example, in the United States, used cans equal to about 30% of new aluminum can shipment (equivalent to 360,000 tonnes) were collected at 2,500 service centers in 1981 and, in Japan, used cans equal to 35% of new aluminum can shipment (equivalent to 11,000 tonnes) were collected at 379 service centers and 4 processing centers.

The recycling of aluminum scrap will certainly increase in the future because of its advantage of relatively cheap price and the social requirement for recycling resources. Furthermore, if the technology allowing easy removal of impurities from recycled aluminum is developed, the use of secondary aluminum will be no doubt accelerated.

The expansion of recycling of course results in relative reduction in the demand for primary aluminum. However, it should not mean that the primary aluminum industry opposes the expansion of recycling. On the contrary, the expansion of recycling itself should establish good reputation of aluminum as a low-energy consuming material and increase the total aluminum consumption and this should in turn increase the demand for primary aluminum.

Reference Table C-1 Development in World Primary Aluminum Consumption by Country

(1,000 tonnes)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
E.E.C.	897.7	1,061.3	1,054.0	1,233.5	1,486.8	1,589.6	1,565.9	1,707.0	2,448.9	2,564.3	2,028.8	2,618.5	2,593.6	2,654.0	2,887.9	2,867.9	2,672.2
Germany, FR	387.4	419.5	416.8	539.3	642.3	669.8	684.4	724.4	855.7	872.5	703.7	954.4	912.3	952.3	1,067.8	1,042.3	1,021.8
Belgium-Luxemburg	114.6	149.4	133.2	152.3	166.0	174.9	190.9	200.9	218.6	232.8	178.2	244.2	235.3	256.6	242.0	232.9	215.3
France	248.5	298.3	294.0	293.5	367.1	413.3	377.4	398.3	450.1	480.0	399.2	492.6	533.8	532.8	595.9	600.9	538.7
Italy	128.0	171.0	184.0	217.0	258.0	279.0	254.0	304.0	336.0	375.0	270.0	365.0	382.0	404.0	448.0	458.0	413.0
Netherlands	19.2	23.1	26.0	31.4	53.4	52.6	59.2	79.4	94.3	103.7	77.0	105.8	101.9	94.7	100.1	106.3	72.8
Denmark	7.5	5.9	5.2	7.4	6.9	9.2	9.1	0.7	3.3	3.0	5.0	6.2	6.0	7.3	11.1	14.9	10.9
UK	350.6	362.9	356.6	388.4	387.7	404.2	325.6	408.2	487.8	493.6	392.7	444.5	418.7	402.3	417.6	409.3	330.7
Irish Republic	7.8	10.4	8.4	8.4	8.3	5.1	3.2	3.9	3.1	3.7	3.0	5.8	3.6	4.0	5.4	3.3	3.0
Iceland	-	-	-	-	-	-	0.9	-	-	0.3	0.1	0.1	0.1	0.1	0.2	0.1	0.1
Norway	17.8	26.1	39.3	54.0	68.1	73.4	83.0	97.0	108.0	93.5	92.7	93.1	96.1	84.0	97.5	103.0	111.2
Finland	7.6	11.2	13.6	11.0	14.6	18.7	14.7	15.3	18.5	24.7	18.8	23.3	28.9	21.7	27.0	22.8	29.9
Greece	8.6	10.8	11.1	14.4	15.1	29.3	27.0	28.7	37.3	41.2	39.2	51.0	56.7	68.0	76.5	85.5	66.0
Yugoslavia	57.4	69.0	63.5	61.2	63.3	100.0	71.8	88.7	107.8	125.7	127.7	135.5	153.9	158.8	164.0	170.0*	166.0
Malta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-
Austria	42.0	46.0	50.0	60.0	70.0	75.0	72.7	76.4	86.6	80.8	83.7	106.6	99.9	107.9	111.8	102.4	105.4
Portugal	1.1	0.8	0.6	0.7	0.7	1.7	1.6	2.4	3.9	6.3	4.4	9.3	11.9	20.0	19.1	18.3	41.9
Sweden	44.2	59.6	53.4	62.1	76.4	78.7	79.0	88.5	99.6	114.0	110.0	101.5	92.8	98.0	103.3	100.8	84.4
Switzerland	61.8	65.1	62.7	70.5	81.2	92.3	87.9	102.9	111.5	113.2	84.4	104.6	109.8	105.0	111.3	118.2	107.0
Spain	64.0	84.7	78.2	98.2	128.1	129.1	150.4	172.1	186.1	225.7	216.8	222.5	250.8	235.6	234.8	263.4	201.7
Europe**	1,568.1	1,813.8	1,796.6	2,069.8	2,407.2	2,606.3	2,492.8	2,791.8	3,208.2	3,369.7	2,806.6	3,466.0	3,494.5	3,553.1	3,833.4	3,852.7	3,519.8
Bahrain	-	-	-	-	0.7	2.8	1.5	1.5	0.2	3.1	1.3	2.5	9.4	10.0	11.8	18.1	17.3
Hong Kong	7.6	7.2	9.9	13.5	11.6	15.2	12.5	15.6	15.0	24.0	22.5	18.6	21.1	22.9	24.5	30.1	21.6
India	71.0	93.0	118.5	128.0	114.7	162.0	193.0	172.9	148.5	124.6	145.0	170.0	187.6	205.4	211.9	233.8	249.6
Indonesia	-	-	-	-	-	0.2	0.1	0.3	2.6	4.7	7.0	8.4	11.6	12.3	15.2	14.0*	14.0*
Iraq	-	-	-	-	-	-	-	-	-	0.3	2.5	14.0	10.1	8.0	2.8	14.9	26.4
Iran	3.0	6.1	3.9	5.0	7.6	5.8	5.8	7.0	17.7	26.3	27.3	38.6	43.5	53.4	23.1	22.7	30.1
Israel	6.1	7.0	5.3	10.5	10.9	12.3	14.4	12.0	12.9	25.0	10.4	14.9	20.6	24.2	20.0*	19.3	9.5
Japan	298.3	393.4	496.6	621.1	807.1	911.4	972.9	1,216.3	1,611.8	1,303.0	1,170.6	1,609.6	1,419.6	1,656.1	1,803.4	1,636.8	1,566.6
Korea, Rep. of	3.7	4.7	7.4	8.5	12.6	15.3	17.0	18.5	36.4	25.8	36.1	52.3	75.0	105.8	94.3	86.9	111.6
Lebanon	2.5	8.6	3.7	4.3	7.4	7.7	7.3	9.8	10.0*	14.3	18.6	2.7	15.7	13.4	15.4	4.9	11.7
Malaysia	0.6	1.6	1.5	1.6	1.5	0.2	1.9	5.2	5.4	10.4	5.8	8.1	10.2	14.5	24.1	25.0*	25.0*
Philippines	4.3	7.2	7.5	9.3	10.3	10.5	10.0	11.1	15.3	18.4	8.4	17.2	17.0	16.8	28.4	30.0*	17.0*
Taiwan	13.8	15.1	17.3	20.3	25.5	34.2	30.8	36.9	45.0	36.8	45.7	55.6	68.3	89.9	109.0	120.7	77.8
Thailand	2.4	3.9	4.6	5.2	6.0	8.4	9.4	7.5	14.6	23.1	17.6	25.3	29.3	29.5	34.8	30.6	45.0*
Turkey	5.6	8.2	9.3	13.1	13.3	13.7	27.7	28.7	36.7	52.2	60.1	68.1	78.0	45.0	44.8	45.0	74.6
Other Asia a)	5.1	6.5	15.0	11.2	5.2	11.3	2.9	3.5	6.2	12.0	7.5	7.8	14.8	22.4	23.3	35.2	27.3
Asia**	424.0	556.5	700.5	851.6	1,034.4	1,211.0	1,307.2	1,546.8	1,978.3	1,704.0	1,586.6	2,113.7	2,032.1	2,329.6	2,486.8	2,368.0	2,325.1

Reference Table C-1 (cont'd.)

(1,000 tonnes)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Egypt	5.0	8.3	8.5	8.1	4.6	4.7	11.3	12.0*	13.0*	15.0*	15.0*	20.0*	30.0*	32.0*	35.0*	48.0	45.0*
Cameroon	-	-	6.6	8.4	10.0	11.3	17.5	22.2	16.7	26.6	26.2	27.6	23.2	23.8	26.9	29.5	27.7
S. Africa	20.4	27.3	17.6	24.2	41.2	49.1	51.9	53.8	65.0	60.4	52.2	46.8	52.5	50.9	55.0	77.7	76.8
Other Africa	3.4	7.8	3.1	4.5	5.2	5.5	10.6	9.6	15.4	13.9	20.2	23.5	23.7	26.6	19.2	23.9	28.3
Africa	28.8	43.4	35.8	45.2	61.0	70.6	91.3	97.6	110.1	115.9	113.6	117.9	129.4	133.3	136.1	179.1	177.8
USA	2,852.4	3,281.3	3,119.3	3,587.0	3,705.8	3,488.3	3,927.0	4,298.8	5,076.2	5,127.5	3,265.0	4,490.5	4,756.0	4,978.1	5,017.7	4,473.0	4,140.1
Argentina	36.3	36.9	31.0	40.2	52.6	50.7	59.3	79.4	73.5	82.8	72.9	56.7	62.0	60.5	72.4	69.2	52.5
Brazil	51.6	72.1	78.0	80.5	84.0	83.5	103.4	137.8	156.9	185.3	209.2	215.5	229.5	236.5	257.1	285.0	240.9
Colombia	5.9	8.6	6.7	7.0	8.0	8.9	10.3	9.2	11.9	12.8	8.8	13.9	13.9	17.4	22.3	25.0*	14.2
Canada	182.0	208.0	190.0	203.0	212.0	220.0	258.5	279.0	301.0	358.0	286.0	322.2**	332.4**	338.8	340.0	292.0	299.0
Mexico	20.0	20.7	23.4	22.8	30.8	32.6	36.3	43.4	55.2	67.4	50.9	55.5	52.9	83.3	99.6	110.0*	110.0*
Peru	-	-	-	-	2.9	2.9*	5.0	5.2	6.1	6.8*	7.1	3.7	5.2	5.0*	7.0*	8.0*	10.0*
Venezuela	2.9	1.7	3.5	0.5	7.5	9.9	11.9	14.2	20.6	24.9	39.2	36.2	53.4	69.0	74.0	81.0	73.6
Other America	9.3	10.0	10.7	12.3	10.1	12.9	12.2	13.8	14.1	16.1	14.4	15.2	17.8	15.7	18.0*	25.0*	26.0*
America	3,160.4	3,639.3	3,462.6	3,953.3	4,113.7	3,909.7	4,423.9	4,880.8	5,715.5	5,881.6	3,953.5	5,209.4	5,523.1	5,804.3	5,908.1	5,368.2	4,966.3
Australia	66.6	75.8	82.5	103.9	107.0	124.3	138.9	116.5	145.9	166.9	133.2	158.8	170.1	183.8	197.9	219.9	234.6
New Zealand	9.1	8.0	10.1	6.9	9.8	13.3	14.7	15.6	29.2	35.4	20.1	27.7	23.3	23.1	25.1	22.8	26.9
Other Oceania	-	-	-	-	-	-	-	-	-	0.3	-	-	0.1	-	-	0.9	0.1
Australia and Oceania	75.7	83.8	92.6	110.8	116.8	137.6	153.6	132.1	175.1	202.6	153.3	186.5	193.5	206.9	223.0	243.6	261.6
Free world	5,257.0	6,136.8	6,088.1	7,030.7	7,733.1	7,935.2	8,468.8	9,449.1	11,187.2	11,293.8	8,613.6	11,093.5	11,372.6	12,027.2	12,587.4	12,011.6	11,250.6
USSR*	971.0	1,044.3	1,146.9	1,212.4	1,230.0	1,330.0	1,395.0	1,445.0	1,480.0	1,550.0	1,580.0	1,690.0	1,760.0	1,830.0	1,865.0	1,850.0	1,860.0
Albania*	-	-	0.5	0.5	0.6	0.6	0.6	0.8	0.8	1.0	1.0	1.2	1.2	1.5	1.6	2.0	2.0
Bulgaria	4.5	10.0	16.5	17.5	14.0	16.5	25.2	30.5	35.0	36.0	38.0	40.0*	45.0*	47.0*	48.0*	50.0	50.0
German DR*	140.0	140.0	150.0	150.0	150.0	155.0	160.0	170.0	180.0	200.0	200.0	210.0	215.0	225.0	230.0	230.0	240.0
Poland	58.0	60.0	90.0	105.0	120.0	120.0	117.0	125.0	134.0	134.0	138.0	145.0	149.0	160.0	170.0*	160.0*	142.0
Romania*	31.0	27.0	24.0	27.0	30.0	40.0	40.0	70.0	90.0	120.0	120.0	130.0	149.0	146.5	152.0	145.0	140.0
Czechoslovakia	51.0	55.0	68.0	86.0	110.0	107.0	117.0	130.0	140.0	150.0	136.0	124.0	125.0	131.8	125.0	120.0*	125.0
Hungary	36.7	45.4	62.1	71.6	79.8	91.8	128.2	123.0	137.3	155.8	166.0	170.4	168.6	169.8	166.4	165.8	143.0
China*	95.0	95.0	130.0	160.0	200.0	225.0	245.0	295.0	370.0	400.0	440.0	470.0	510.0	560.0	580.0	550.0	560.0
Other Eastern Asia*	2.0	2.0	3.0	3.0	5.0	5.0	5.0	7.0	10.0	15.0	20.0	22.0	30.0	30.0	35.0	35.0	35.0
Cuba	0.3	0.2	1.1	0.1	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.5
C.P. Economies	1,391.5	1,478.9	1,692.1	1,833.1	1,940.4	2,091.8	2,233.9	2,397.3	2,578.1	2,762.8	2,840.0	3,003.6	3,153.8	3,302.6	3,374.2	3,309.0	3,298.5
World total	6,648.5	7,615.7	7,780.2	8,863.8	9,673.5	10,027.0	10,702.7	11,846.4	13,765.3	14,056.6	11,453.6	14,097.1	14,526.4	15,329.8	15,961.6	15,320.6	14,549.1

* Estimates

** Including secondary aluminum.

Sources: 1965-1969 -- Metal Statistics, 1965-1979 and 1969-1979 yearbooks
1970-1980 -- Metal Statistics, 1970-1980 yearbook
1981 -- Metal Statistics, Preliminary figures

Reference Table C-2 Development in World Primary Aluminum Consumption by Main Regions

	Consumption (1,000 tonnes)											Average annual growth rate (%)						Increase** 70→80
	1960	1965	1970	1974	1975	1976	1977	1978	1979	1980	1981	60→65	65→70	70→75	75→80	60→70	70→80	(1,000 tonnes)
WORLD	4,166.3	6,648.5	10,027.6	14,056.6	11,453.6 (13,202.4)*	14,097.1	14,526.4	15,329.8	15,961.6	15,320.6 (15,277.1)*	14,549.1	9.80	8.57	2.70 (5.66)*	5.99 (2.96)*	9.18	4.33	5,293.6 (100)
Free World	3,237.3	5,257.0	7,935.2	11,293.8	8,613.6 (10,333.6)	11,093.5	11,372.6	12,027.2	12,597.4	12,011.6 (11,949.9)	11,250.6	10.18	8.56	1.65 (5.42)	6.88 (2.95)	9.38	4.23	4,076.4 (77)
Developed countries	3,122.5	4,996.9	7,412.7	10,441.2	7,733.9 (9,432.2)	10,121.6	10,248.8	10,783.9	11,272.5	10,575.8 (10,496.7)	9,641.7	9.86	8.21	0.85 (4.94)	6.46 (2.16)	9.03	3.62	3,163.1 (59.8)
North America	1,642.7	3,034.4	3,708.3	5,485.5	3,551.0 (4,616.4)	4,812.7	5,088.4	5,316.9	5,357.7	4,765.0 (4,779.9)	4,216.9	13.06	4.09	-0.86 (4.48)	6.06 (0.70)	8.48	2.54	1,056.7 (20)
Europe	1,278.6	1,568.1	2,606.3	3,389.7	2,806.6 (3,220.8)	3,466.0	3,494.5	3,553.1	3,833.4	3,852.7 (3,735.3)	3,519.8	4.17	10.70	1.49 (4.33)	6.54 (3.01)	7.38	3.99	1,246.4 (23.5)
Japan	150.5	298.3	911.4	1,303.0	1,170.8 (1,361.1)	1,609.6	1,419.9	1,656.1	1,803.4	1,636.8 (1,668.9)	1,566.6	14.66	25.03	5.14 (8.35)	6.93 (4.16)	19.73	6.03	725.4 (13.7)
Australia, New Zealand, and S. Africa	50.7	96.1	166.7	263.0	205.5 (233.9)	233.3	246.0	257.8	278.0	321.3 (312.6)	338.4	13.64	14.21	1.94 (4.61)	9.35 (5.97)	13.92	5.58	134.6 (2.5)
Developing countries	114.8	260.1	522.5	852.6	879.7 (901.4)	971.9	1,123.8	1,243.3	1,314.9	1,435.8 (1,453.2)	1,608.9	17.77	14.97	10.98 (11.52)	10.29 (10.02)	16.36	10.64	913.3 (17.2)
Africa	2.7	8.4	21.5	55.5	61.4 (62.7)	71.1	76.9	82.4	81.1	101.4 (94.5)	101.0	25.48	20.58	23.35 (23.87)	10.55 (8.55)	23.06	16.78	79.9 (1.5)
Middle East	n.a.	17.2	42.3	121.2	120.2 (127.4)	140.8	177.3	154.0	117.9	124.9 (137.5)	169.6	-	19.72	23.23 (24.67)	0.77 (1.54)	-	11.44	82.6 (1.6)
Asia	47.9	108.5	257.3	279.8	295.6 (312.9)	363.3	434.9	519.5	565.5	606.3 (586.9)	588.9	17.77	18.85	2.81 (3.99)	15.45 (13.41)	18.31	8.95	349 (6.6)
Latin America	64.2	126.0	201.4	396.1	402.5 (398.4)	396.7	434.7	487.4	550.4	603.2 (634.3)	749.4	14.44	9.83	14.85 (14.62)	8.43 (9.75)	12.11	11.59	401.8 (7.6)
The centrally planned economies	929.0	1,391.5	2,091.8	2,762.8	2,840.0 (2,868.8)	3,003.6	3,153.8	3,302.6	3,374.2	3,309.0 (3,327.2)	3,298.5	8.42	8.49	6.31 (6.52)	3.10 (3.01)	8.46	4.69	1,217.2 (23)
USSR	632.0	971.0	1,330.0	1,550.0	1,580.0 (1,606.7)	1,690.0	1,760.0	1,830.0	1,865.0	1,850.0 (1,858.3)	1,860.0	8.97	6.49	3.51 (3.85)	3.21 (2.95)	7.72	3.36	520 (9.8)
China	90.0	95.0	225.0	400.0	440.0 (436.7)	470.0	510.0	560.0	580.0	550.0 (563.3)	560.0	1.09	18.82	14.36 (14.18)	4.56 (5.22)	9.60	9.35	325 (6.1)

* Figures in brackets for 1975 and 1980 are average of three years including the preceding and succeeding year. Because of extraordinary in consumption, if 1975 is used as the base year, the 75-80 growth rate, for example, is 5.99%. If the average figure is used for 1975, the revised growth rate is 2.96%.
** Figures in brackets are the % contribution to the total increase.

Source: JAF

Reference Table C-3 Trend of World GDP and GDP Elasticity of the Growth of Primary Aluminum Consumption

	GDP (1975 value)											GDP elasticity of the growth of primary aluminum consumption					
	GDP (billion $)					Average annual growth rate (%)											
	1960	1965	1970	1975	1980	60→65	65→70	70→75	75→80	60→70	70→80	60→65	65→70	70→75	75→80	60→70	70→80
WORLD	3,078.6	3,981.6	5,145.6	6,283.8	7,615.4	5.28	5.26	4.08	3.92	5.27	4.00	1.86	1.63	0.66 (1.39)*	1.53 (0.76)*	1.74	1.08
Free World	2,550.8	3,290.1	4,197.9	5,008.0	6,030.5	5.22	4.99	3.59	3.79	5.11	2.69	1.95	1.72	0.46 (1.51)	1.82 (0.78)	1.84	1.15
Developed countries	2,146.2	2,771.3	3,500.9	4,067.4	4,825.5	5.25	4.79	3.05	3.48	5.02	3.26	1.88	1.71	0.28 (1.62)	1.86 (0.62)	1.80	1.11
North America	1,009.6	1,259.5	1,489.8	1,690.3	2,000.0	4.52	3.42	2.56	3.42	3.97	2.99	2.89	1.20	- (1.75)	1.77 (0.20)	2.14	0.85
Europe	934.6	1,194.4	1,503.2	1,736.3	2,009.8	5.03	4.71	2.93	2.97	4.87	2.95	0.83	2.27	0.51 (1.48)	2.20 (1.01)	1.52	1.35
Japan	136.8	233.4	393.2	501.9	657.9	11.28	11.00	5.00	5.56	11.14	5.28	1.30	2.28	1.03 (1.67)	1.25 (0.75)	1.77	1.14
Australia, New Zealand, and S. Africa	65.3	84.1	114.8	138.9	157.7	5.19	6.42	3.89	2.57	5.80	3.23	2.63	2.21	0.50 (8.51)	3.64 (2.32)	2.40	1.73
Developing countries	404.6	518.8	697.0	940.6	1,205.0	5.10	6.08	6.18	5.08	5.59	5.63	3.48	2.46	1.78 (1.86)	2.03 (1.97)	2.93	1.89
Africa	74.0	91.6	118.7	149.5	191.4	4.36	5.32	4.72	5.07	4.84	4.89	5.84	3.89	4.95 (5.06)	2.08 (4.11)	4.76	3.43
Middle East	63.8	89.5	131.4	199.1	256.2	7.00	7.98	8.67	5.17	7.49	6.91	-	2.47	2.68 (8.69)	0.15 (0.30)	-	1.66
Asia	123.6	151.8	196.6	246.7	321.7	4.20	5.31	4.65	5.45	4.75	5.05	4.23	3.55	0.60 (0.86)	2.83 (2.46)	3.85	1.77
Latin America	142.2	185.9	250.3	345.3	435.7	5.36	6.13	6.65	4.76	5.74	5.70	2.69	1.60	2.23 (2.20)	1.37 (2.05)	2.11	2.03
The centrally planned economies	527.8	691.5	647.7	1,275.9	1,584.9	5.55	6.51	6.13	4.43	6.03	5.28	1.52	1.30	1.03 (1.06)	0.70 (0.68)	1.40	0.89
USSR	263.5	357.7	504.7	649.5	777.2	6.30	7.13	5.17	3.66	6.72	4.41	1.42	0.91	0.68 (0.74)	0.88 (0.81)	1.15	0.76
China	122.7	155.3	222.4	315.3	428.4	4.83	7.45	7.23	6.32	6.13	6.78	0.23	2.53	1.99 (1.96)	0.72 (0.83)	1.57	1.38

* The figures in brackets were obtained based on the average of three years for 1975 and 1980 including the *preceding and succeeding year* (See Reference Table C-2).

Sources: GDP -- Japan Economic Research Center
Elasticity Calculation -- JAF

Reference Table C-4 World Aluminum Consumption per Capita

(AA method) (kg)

Countries (Ranked as per '81 figures)	1960	1965	1970	1975	1980	1981	Increase (kg) 60 →70	60 →75	75 →80	70-80 average annual growth rate (%)
USA	10.8	18.6	20.4	20.4	25.8	25.4	1.8	0	5.4	2.4
Germany, FR	7.2	9.1	13.7	14.6	22.0	20.3	4.6	0.9	7.4	4.9
Japan	2.0	3.9	11.2	12.2	20.8	19.1	7.3	1.0	8.6	6.4
Norway	6.0	5.3	14.1	19.8	22.7	18.9	8.8	5.7	2.9	4.9
Australia	5.3	7.4	10.9	11.7	17.6	18.7	3.5	0.8	5.9	4.9
Canada	5.2	9.7	11.7	12.9	16.1	16.4	2.0	1.2	3.2	3.2
Switzerland	6.7	10.3	13.7	10.1	17.1	15.4	3.4	-3.6	7.0	2.2
Sweden	5.3	10.0	14.5	18.1	15.6	15.4	4.5	3.6	-2.5	0.7
Iceland	2.0	4.2	3.5	7.5	9.9	12.7	-0.7	4.0	2.4	11.0
Italy	2.9	3.6	7.7	6.9	15.9	12.3	4.1	-0.8	9.0	7.5
Austria	n.a.	5.3	8.3	11.1	12.5	12.0	3.0	2.8	1.4	4.2
France	4.9	5.5	8.8	9.3	13.7	11.8	3.3	0.5	4.4	4.5
Singapore	n.a.	n.a.	n.a.	3.5	9.1	11.5	-	-	5.6	-
Saudi Arabia	n.a.	n.a.	n.a.	1.3	11.2	11.4	-	-	9.9	-
Netherlands	2.5	2.9	5.7	8.3	12.3	9.5	2.8	2.6	4.0	8.0
New Zealand	n.a.	4.8	8.7	6.8	7.8	9.3	3.9	-0.9	1.0	-1.1
UK	7.8	9.2	11.1	9.8	9.8	9.0	1.9	-1.3	0	-1.2
Belgium	2.9	3.6	5.9	7.5	9.3	7.3	2.3	1.6	1.8	4.7
Finland	n.a.	4.4	7.6	9.7	7.8	7.3	3.2	2.1	-1.9	0.3
Taiwan	0.5	1.0	2.2	3.1	6.1	6.6	1.2	0.9	3.0	10.7
Greece	n.a.	1.3	2.7	4.4	9.1	5.9	1.4	1.7	4.7	12.9
Bahrain	n.a.	n.a.	n.a.	11.3	9.2	5.4	-	-	-2.1	-
Spain	1.0	2.2	3.2	5.3	6.4	5.1	1.0	2.1	1.1	7.2
Portugal	n.a.	1.0	1.5	1.2	3.5	4.9	0.5	-0.3	2.3	8.8
S. Africa	n.a.	1.6	2.9	2.8	4.5	4.5	1.3	-0.1	1.7	4.5
Israel	n.a.	2.4	5.5	n.a.	'77 9.4 n.a.	n.a.	3.1	-	-	-
Venezuela	1.1	1.0	1.1	2.8	n.a.	n.a.	0.1	1.7	-	-
Ireland	n.a.	n.a.	2.1	1.9	4.4	4.1	-	-0.2	2.5	7.7
Mexico	n.a.	0.8	1.4	1.6	2.5	2.9	0.6	0.2	0.9	6.0
Brazil	0.5	0.6	1.1	2.4	1.9	2.4	0.5	1.3	0.5	10.2
Cameroon	n.a.	n.a.	n.a.	3.1	'79 4.7 n.a.	n.a.	-	-	-	-
Iran	0.2	0.2	0.8	1.4	n.a.	n.a.	0.6	0.6	-	-
Argentina	n.a.	2.0	2.7	3.8	2.2	1.9	0.7	1.1	-1.6	-2.0
Turkey	n.a.	0.2	0.4	1.7	1.0	1.0	0.2	1.3	-0.7	9.6
Panama	0.2	1.0	1.1	1.2	0.9	1.0	0.1	0.1	-0.3	-2.0
Philippines	n.a.	0.1	0.2	0.4	n.a.	n.a.	0.1	0.2	-	-
Indonesia	n.a.	0.0	0.2	1.3	'79 0.6 n.a.	n.a.	0.2	1.1	-	-
El Salvador	n.a.	n.a.	n.a.	0.2	0.2	0.3	-	-	0	-
Nicaragua	n.a.	n.a.	0.5	0.6	n.a.	n.a.	-	-	-	-

n.a. : not available

Note : Converted to kilograms from pounds in the original source.

Source: A.A. Statistical Review, 1981

Reference Table C-5 Development in Free World Secondary Aluminum Production by Country

(1,000 tonnes)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
EC	318.4	345.3	353.7	411.9	495.8	508.9	534.0	576.2	896.2	923.0	796.6	976.5	1,057.5	1,074.3	1,096.6	1,096.6	1,062.8
Germany, FR a)	202.9	196.7	185.5	231.9	271.3	258.5	275.7	294.0	328.4	324.1	285.5	344.6	390.1	412.6	423.6	405.1	397.5
Belgium-Luxemburg	3.2	2.5	1.5*	2.2	2.7	2.0	2.2	2.9	7.1	5.9	2.7	2.6	3.6	1.1	2.0*	-	-
France	50.2	59.6	62.7	73.6	88.1	87.4	97.8	111.9	123.5	127.5	107.1	143.7	154.3	160.8	165.7	170.0	169.8
Italy	61.0	85.0	102.0	102.0	128.0	154.0	150.0	164.0	192.0	209.0	151.0	198.0	225.0	222.0	245.0	266.0	250.0
Netherlands	1.1	1.5	2.0	2.2	5.5	7.0	8.3	3.4	23.6	31.3	34.3	38.5	40.6	44.6	46.6	53.7	57.3
Denmark	4.5*	7.8	7.1	7.5*	7.5*	7.3	7.5	9.3	9.1	9.6	8.5	10.8	11.9	10.7	10.1	11.2	9.1
UK	178.0	183.6	178.6	188.0	209.5	201.4	181.6	184.8	189.3	188.9	176.2	205.8	200.9	193.8	176.7	162.1	148.0
actual scrap used by manufacturers	11.5	15.9	14.3	16.1	15.1	19.5	24.5	31.0	23.2	26.7	31.3	32.5	31.1	29.3	26.9	28.5	31.1
Norway b)	3.2	3.1	3.4	3.4	4.1	4.2	4.0	4.4	4.7	4.3	4.0	3.9	4.0	4.0	3.6	4.5	2.9
Finland	2.2	2.8	3.3	3.4	3.5	3.5	4.3	5.0	4.9	5.3	4.5	6.1	7.4	7.0	8.0	9.0	10.0
Yugoslavia									0.2	1.5	2.0	15.1	21.0	19.8	21.8	23.4	24.1
Austria c)	3.8	4.8	5.4	5.6	6.6	7.2	7.1	6.3	8.6	7.2	6.2	8.5	10.6	9.3	8.7	14.3	13.0
Portugal							1.2	1.5	1.6	2.1	2.0	2.0	2.0	3.1	3.0*	3.0*	3.0
Sweden	10.0	11.0	13.0	16.8	19.0	20.0	20.0	22.0	24.0	24.7	23.0	24.0	24.5	24.6	24.6	24.5	24.7
Switzerland	13.0	13.5	13.0	14.5	16.8	15.0	13.5	13.9	16.6	17.2	15.6	17.8	20.1	17.9	19.3	19.9	20.4
Spain	12.0	14.0	14.3	19.0	25.0	27.0	29.0	32.0	37.0	46.0	34.5	40.0	40.3	39.1	42.0	38.5	34.5
Europe	556.6	601.8	606.1	686.2	802.9	814.0	826.7	886.4	993.8	1,031.3	888.4	1,093.9	1,187.4	1,199.1	1,227.6	1,233.7	1,195.4
Iran						1.0	1.0	1.0	1.0	6.4	15.4	6.5	5.0	5.0*	3.0*	2.0*	3.0*
Japan	123.7	140.5	181.2	226.6	281.1	322.1	349.2	411.9	536.9	517.3	424.0	525.9	574.5	635.6	746.5	788.9	814.7
Korea, Rep. of												0.3	1.0	2.5	4.3	3.7	4.8
Taiwan						3.1	3.2	4.0	13.2	8.2	5.9	6.2	8.7	9.5	13.8	19.2	20.0*
Other Asia*	15.0*	20.0*	22.0	25.0*	25.0*	18.0	20.0	20.0	20.0	22.0	20.0	23.0	24.0	22.0	23.0	22.0	24.0
Asia	138.7	160.5	203.2	251.6	306.1	344.2	373.4	436.9	571.1	553.9	465.3	561.9	613.2	674.6	790.6	835.8	866.5
S. Africa						4.0*	5.0*	5.0*	5.0	5.5	5.5	4.8	9.6	10.2	10.4	27.2	28.0*
Other Africa*						3.0	3.0	3.5	3.5	4.0	4.5	5.0	6.0	6.0	6.0	6.5	8.0*
Africa	5.0*	7.0*	6.0*	7.0*	7.0*	7.0	8.0	6.5	8.5	9.5	10.0	9.8	15.6	16.2	16.4	33.7	36.0

Reference Table C-5 (cont'd.)

(1,000 tonnes)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
USA d)	774.3	832.8	821.5	935.3	1,066.8	937.1	1,003.8	1,021.5	1,127.2	1,163.0	1,121.3	1,334.5	1,456.0	1,517.7	1,612.1	1,576.7	1,601.2
Argentina						11.6	13.6	18.2	16.9	19.4	16.4	9.5	8.8	8.0	9.8	7.0	5.0
Brazil e)	3.0	4.1	3.7	4.4	6.5	8.0	10.5	13.0	18.5	22.4	20.6	28.4	33.5	49.2	53.9	46.7	37.3
Canada	21.4	27.7	31.2	32.0	32.3	31.8	33.7	31.8	36.3	29.9	38.9	40.0	49.3	74.8	78.7	65.1	65.0
Mexico						7.0	5.8	7.8	9.3	10.1	9.3	9.8	7.4	12.3	14.9	17.1	20.3
Venezuela						-	-	-	-	1.3	0.6	1.8	1.3	10.0	9.2	15.0*	30.0*
Other America*	4.0	6.0	6.0	6.0	6.0	2.0	2.0	2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.0	4.0	5.0*
America	802.7	870.6	862.4	977.7	1,111.5	997.5	1,069.4	1,094.3	1,210.2	1,248.6	1,209.6	1,426.5	1,558.3	1,675.0	1,781.5	1,731.0	1,763.9
Australia						18.6	20.4	19.8	28.7	36.3	25.3	33.3	24.6	24.4	30.5	36.7	44.4
New Zealand						1.3	1.5	1.7	1.9	2.1	1.2	1.5	1.8	1.5	2.0	2.0	2.0
Australia and Oceania	8.0	10.0	10.0	10.0	12.0	19.9	21.9	21.5	30.6	38.4	26.5	34.8	26.4	25.9	32.5	38.7	46.4
Free World Countries	1,511.0	1,549.9	1,687.7	1,932.5	2,239.6	2,182.6	2,299.4	2,447.6	2,814.2	2,881.7	2,599.8	3,126.9	3,400.9	3,590.8	3,848.6	3,872.9	3,908.1

a) Including production in West Berlin.
b) *Super purity* aluminum from scrap is excluded.
c) Production of remelted aluminum only. In addition, there *is a production of* secondary aluminum, which may not have been from scrap at all, but from primary aluminum including *some runaround* scrap.
d) Recovery from domestic and imported scrap, incl. direct use by manufacturers.
e) May include some double *countings, beginning* in 1974.
* Estimates

Sources: 1965-69 MS 1965-75 yearbook
1970-79 MS 1970-80 "
1980,81 MS preliminary figures

Reference Table C-6 Development of World Aluminum Consumption by Country a)

(1,000 tonnes)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
EC	1,202.0	1,381.6	1,405.7	1,649.8	1,938.4	2,039.3	2,061.4	2,230.6	3,297.7	3,373.8	2,768.8	3,494.7	3,550.7	2,669.4	3,918.3	3,906.7	3,673.9
Germany, FR	558.5	595.5	587.2	748.6	878.1	881.0	918.3	969.6	1,140.8	1,145.5	957.4	1,263.7	1,251.6	1,336.4	1,487.2	1,455.0	1,418.5
Belgium-Luxemburg	117.8	151.9	134.7	154.5	168.5	176.9	193.1	203.8	225.7	238.7	180.9	246.8	238.9	257.7	244.0	232.9	215.3
France	310.4	357.6	374.8	386.5	456.3	491.6	475.2	510.2	584.6	596.7	513.0	629.3	675.6	583.0	754.7	753.2	694.2
Italy	195.0	252.0	281.0	323.0	382.0	420.0	402.0	458.0	532.0	579.0	445.0	590.0	636.0	568.0	731.0	789.0	715.0
Netherlands	20.3	24.6	28.0	37.2	53.5	59.8	72.8	89.0	114.6	120.1	93.8	130.2	142.5	138.7	146.7	160.0	130.1
Denmark	12.0	13.7	12.3	14.9	14.4	16.5	16.6	10.0	12.4	12.6	13.5	17.0	17.9	18.0	21.2	26.1	20.0
UK	528.7	538.5	530.8	578.7	596.2	602.9	513.3	608.0	687.6	681.2	565.2	617.7	588.2	567.6	535.5	490.5	414.8
Norway	21.0	29.2	42.7	57.4	72.2	77.6	87.0	103.1	115.4	109.3	99.7	98.1	100.1	88.0	101.1	122.9	114.1
Finland	10.1	14.0	16.9	14.4	18.1	22.2	19.0	19.3	23.4	30.0	23.3	29.4	36.3	28.7	35.0	34.2	39.9
Greece	8.6	10.8	11.1	14.4	15.1	29.3	27.0	28.7	37.3	41.2	39.2	51.0	56.7	68.0	76.5	85.5	66.0*b)
Yugoslavia	57.4	69.0	63.5	61.2	75.0	100.0	71.8	88.7	108.0	127.2	137.5	150.6	174.9	178.6	185.8	191.6	190.1
Austria	45.8	50.8	55.4	65.6	76.6	82.2	79.8	82.7	95.2	87.5	89.5	114.6	109.9	117.4	120.8	116.4	114.4
Portugal						1.7	2.8	3.9	5.5	8.4	6.4	11.3	13.9	23.1	22.1	30.4	44.9
Sweden	54.2	70.6	66.4	78.9	95.4	108.0	105.5	110.5	123.6	149.9	136.8	139.0	114.6	102.3	127.3	127.9	109.1
Switzerland	74.8	78.6	75.7	85.0	98.0	106.8	99.4	112.9	123.1	126.5	92.1	113.9	120.8	114.8	122.1	129.9	116.9
Spain	76.0	98.7	92.7	117.2	153.1	156.1	179.4	204.1	223.1	262.7	252.4	266.7	290.8	272.8	275.6	304.7	236.2
Other Europe	9.0	11.2	9.0	9.2	9.1	5.1	4.1	3.9	3.1	4.0	3.1	5.9	3.7	4.1	5.5	3.7	3.1
Europe	2,099.6	2,366.7	2,382.2	2,746.7	3,161.6	3,347.7	3,267.1	3,606.4	4,155.4	4,320.5	3,648.8	4,475.2	4,572.4	4,667.2	4,990.2	5,053.9	4,642.6
Japan	403.8	503.4	629.9	813.4	1,034.6	1,177.6	1,254.5	1,534.8	1,975.1	1,638.3	1,484.0	1,958.2	1,811.0	2,096.1	2,279.4	2,193.8	2,216.6
Other Asia*	145.0	185.0	225.0	255.0	245.0	320.0	360.0	335.0	400.0	440.0	460.0	540.0	650.0	710.0	730.0	750.0	810.0
Asia	549.8	688.4	854.9	1,068.4	1,279.6	1,497.6	1,614.5	1,869.8	2,375.1	2,078.3	1,944.0	2,498.2	2,461.0	2,806.1	3,009.4	2,943.8	3,026.6
S. Africa						53.1	56.9	58.8	70.0	65.9	57.7	51.6	62.1	61.1	65.4	104.9	104.8
Other Africa*						24.0	42.0	47.0	49.0	60.0	65.0	75.0	80.0	90.0	90.0	110.0	110.0
Africa	33.8	50.4	41.8	52.2	68.0	77.1	98.9	105.8	119.0	125.9	122.7	126.6	142.1	151.1	155.4	214.9	214.8

Reference Table C-6 (cont'd.)

(1,000 tonnes)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
USA	3,626.7	4,114.1	3,940.8	4,522.3	4,772.6	4,425.4	4,930.8	5,320.3	6,203.4	6,290.5	4,386.3	5,825.0	6,212.0	6,495.8	6,629.8	6,030.5	5,757.3
Argentina						62.3	72.9	97.6	90.4	102.2	89.3	66.2	59.7	59.4	76.5	66.5	57.5
Brazil	54.6	76.2	81.7	84.9	90.5	104.6	127.4	160.1	187.8	228.7	251.2	258.9	292.3	300.5	338.2	331.1	280.4
Canada	203.4	235.7	221.2	235.0	244.3	251.8	292.2	310.8	337.3	387.9	324.9	362.2	380.7	413.6	418.7	376.6	348.0
Mexico						39.6	42.1	51.2	64.5	77.5	60.2	65.3	60.3	95.6	114.5	129.8	128.7
Venezuela						9.9	11.9	14.2	20.6	26.2	39.8	38.0	54.7	79.0	83.2	96.0	103.6
Other America*	78.4	84.5	79.4	93.6	120.0	30.0	30.0	30.0	35.0	40.0	30.0	35.0	40.0	40.0	50.0	50.0	55.0
America	3,963.1	4,510.5	4,323.1	4,935.8	5,227.4	4,923.6	5,507.3	5,984.2	6,939.0	7,153.0	5,181.7	6,650.6	7,099.7	7,483.9	7,710.9	7,080.5	6,730.5
Australia and Oceania	83.7	93.8	104.0	123.8	129.7	157.5	175.5	153.6	205.7	241.0	179.8	221.3	219.9	232.8	255.5	283.6	308.0
Free world	6,729.0	7,709.8	7,706.0	8,926.9	9,866.3	10,003.5	10,663.3	11,719.8	13,794.2	13,918.7	11,077.0	13,971.9	14,495.1	15,341.1	16,121.4	15,576.7	14,922.5
C.P. Economies	1,650.0	1,775.0	2,000.0	2,200.0	2,500.0	2,500.0	2,780.0	2,890.0	3,020.0	3,550.0	3,500.0	3,750.0	3,900.0	4,100.0	4,175.0	4,135.0	4,115.0
Total World	8,379.0	9,484.8	9,706.0	11,126.9	12,366.3	12,503.5	13,443.3	14,609.8	16,814.2	17,468.7	14,577.0	17,721.9	18,395.1	19,441.1	20,296.4	19,711.7	19,037.5

a) Primary and secondary, including direct use of scrap by manufacturers, if available.
b) Greece joined the EC in 1981.
* Estimates

Source: Same as Reference Table C-5

Reference Table C-7 Development of Demand in Six Countries by Aluminum Product

(1,000 tonnes)

	1965	1970	1975	1980 Germany, FR	1980 France	1980 Italy	1980 UK	1980 4 European countries Total	1980 USA	1980 Japan	1980 Total	Average annual growth rate (%) 65→70	70→75	75→80	65→80	70→80
[Figures in brackets are share in total (%).]																
A Rolling	2,863 (42.9)	3,235 (42.9)	3,213 (42.3)	611 (45.1)	301 (39.9)	219 (27.8)	197 (39.3)	1,328 (39.1)	3,109 (56.2)	507 (22.5)	4,944 (44.2)	2.5	0	9.0	3.7	4.3
B Extrusion	1,470 (22.0)	1,729 (23.0)	1,940 (25.6)	321 (23.7)	125 (16.5)	224 (28.4)	147 (29.4)	817 (24.1)	1,249 (22.6)	914 (40.6)	2,980 (26.7)	3.3	2.3	9.0	4.8	5.6
C Electric wire	595 (8.9)	653 (8.7)	632 (8.3)	71 (5.3)	132 (17.4)	25 (3.2)	38 (7.6)	266 (7.8)	347 (6.3)	175 (7.8)	788 (7.0)	1.9	-0.6	4.5	1.9	1.9
D Forging	95 (1.4)	76 (1.0)	62 (0.8)	15 (1.1)	4 (0.6)	1 (0.1)	3 (0.6)	23 (0.7)	60 (1.1)	3 (0.1)	86 (0.8)	-4.4	-4.0	6.8	-0.7	1.3
E Casting	1,514 (22.7)	1,726 (22.9)	1,647 (21.7)	321 (23.8)	190 (25.1)	295 (37.4)	102 (20.3)	908 (26.7)	717 (12.9)	639 (28.4)	2,264 (20.2)	2.7	-0.9	6.6	2.7	2.8
F Powder and paste	139 (2.1)	112 (1.5)	98 (1.3)	14 (1.0)	4 (0.5)	24 (3.1)	14 (2.8)	56 (1.6)	53 (0.9)	13 (0.6)	122 (1.1)	-4.2	-2.6	4.5	-0.8	0.8
Total	6,676 (100)	7,531 (100)	7,592 (100)	1,353 (100) (12.1)	756 (100) (6.8)	788 (100) (7.0)	501 (100) (4.5)	3,398 (100) (30.4)	5,535 (100) (49.5)	2,251 (100) (20.1)	11,184 (100) (100)	2.4	1.1	8.1	3.5	4.0
(Foil)	403	491	474	118	23	38	40	219	377	87	683	4.0	-0.7	7.6	3.6	3.3

Note: 1965 including Austria; 1970 including Austria and Switzerland; 1975, 80, for only 6 countries. For 1965, 70, 75, national breakdowns are not available. Foil is included in Rolling. 1975 and 1980 are actual figures, not the revised figures mentioned in Reference Table C-2 etc. The same alphabetical letters shown at the left end of this table are used in Figure C-9 for each aluminum product.

Source: OECD NFMS, each year's yearbook; Growth rate and percentages were calculated by the writer.

Reference Table C-8 Development in Demand in Six Major Countries by Usage

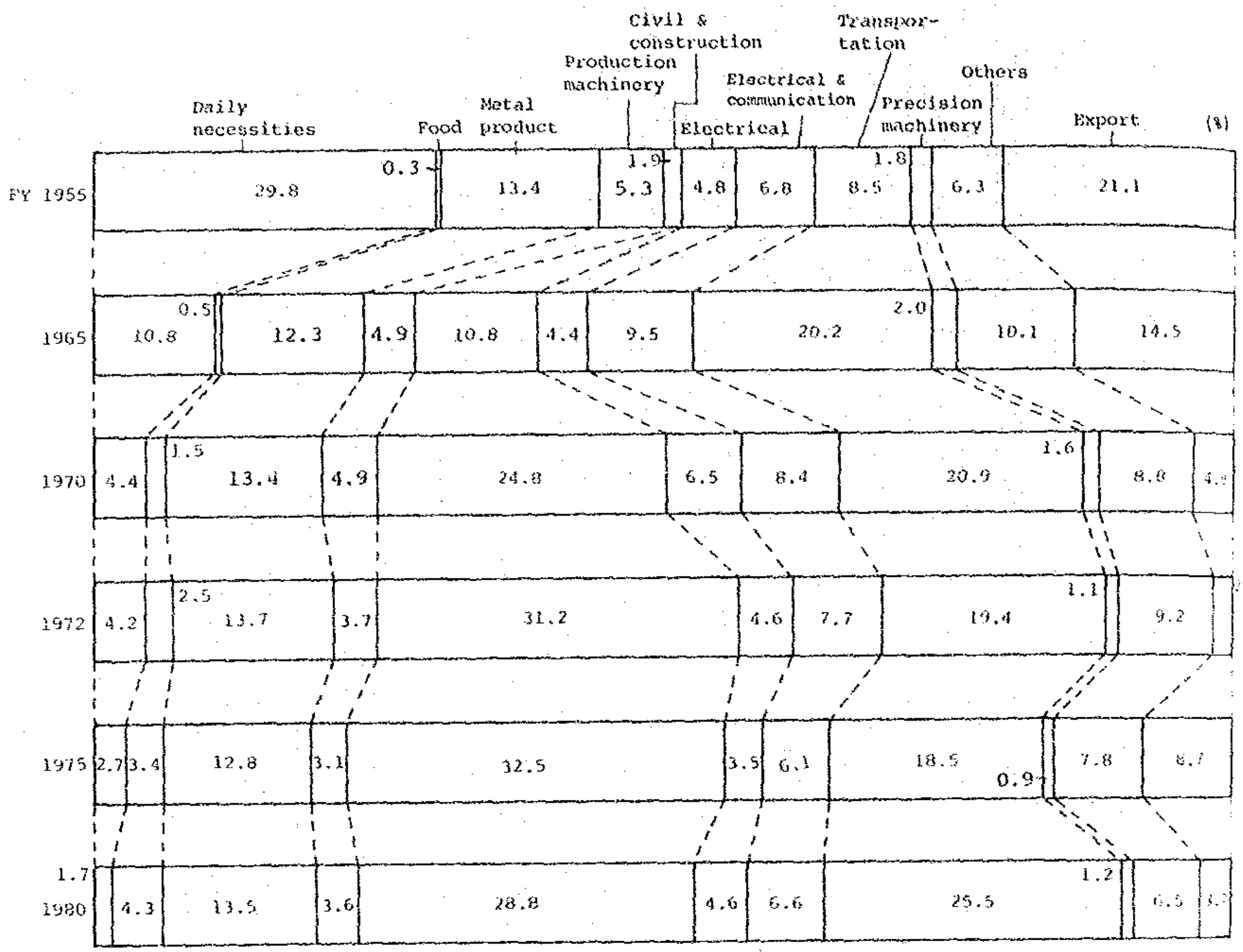
(1,000 tonnes; Figures in brackets are % share of total)

	1965				1970				1975				1980				Average annual growth rate 65 → 80			70 → 80			
	Europe	USA	Japan	Total	Europe	USA	Japan	Total	Europe	USA	Japan	Total	Europe	USA	Japan	Total	Europe	USA	Japan	Europe	USA	Japan	Total
A. Transportation	431 (29.1)	872 (23.6)	86 (22.6)	1,389 (25.0)	600 (27.0)	734 (16.0)	257 (21.5)	1,591 (19.9)	539 (22.5)	816 (18.1)	313 (21.2)	1,668 (19.9)	742 (21.7)	1,048 (16.3)	582 (25.2)	2,372 (19.5)	3.7	1.2	13.6	2.1	3.6	8.5	4.7
B. General machinery	122 (8.2)	214 (5.8)	27 (7.0)	363 (6.5)	147 (6.6)	251 (5.5)	74 (6.2)	472 (5.9)	142 (5.8)	261 (5.9)	60 (4.1)	463 (5.5)	183 (5.4)	299 (4.6)	106 (4.6)	588 (4.8)	2.7	2.3	9.5	2.2	1.8	3.7	2.2
C. Electrical and communications	173 (11.7)	467 (12.6)	44 (11.7)	684 (12.3)	258 (11.6)	574 (12.5)	156 (13.1)	988 (12.3)	235 (9.8)	513 (11.4)	123 (8.3)	871 (10.4)	278 (8.1)	603 (9.4)	226 (9.8)	1,107 (9.1)	3.2	1.7	11.4	0.7	0.5	3.8	1.7
D. Civil and construction	128 (8.6)	824 (22.3)	45 (11.8)	997 (17.9)	235 (10.6)	1,006 (21.9)	298 (25.0)	1,539 (19.2)	310 (13.0)	1,009 (22.4)	517 (35.0)	1,836 (21.9)	486 (14.2)	1,165 (18.1)	732 (31.7)	2,383 (19.6)	9.3	2.3	20.4	7.5	1.5	8.9	4.5
E. Food, refrigeration, agriculture, and chemical industries	34 (2.3)	55 (1.5)	13 (2.3)	102 (1.8)	52 (2.3)	37 (0.8)	30 (2.5)	119 (1.5)	34 (1.4)	45 (1.0)	28 (1.9)	107 (1.3)	40 (1.2)	87 (1.4)	35 (1.5)	162 (1.3)	1.2	3.1	7.1	-2.6	8.9	1.6	3.1
F. Packaging	115 (7.8)	298 (8.0)	12 (2.3)	425 (7.6)	178 (8.0)	666 (14.5)	41 (3.4)	885 (11.1)	201 (8.4)	907 (20.2)	71 (4.8)	1,179 (14.1)	259 (7.6)	1,512 (23.5)	134 (5.8)	1,905 (15.7)	5.5	11.4	17.4	3.8	8.5	12.6	8.0
G. Office goods & daily necessities	96 (6.5)	317 (8.6)	64 (18.2)	477 (8.6)	134 (6.0)	349 (7.6)	92 (7.7)	575 (7.2)	197 (8.2)	263 (5.9)	83 (5.6)	543 (6.5)	225 (6.6)	344 (5.3)	123 (5.3)	692 (5.7)	5.8	0.5	4.5	5.3	-0.2	2.9	1.9
E. Powder and paste	21 (1.4)	27 (0.7)	1 (0.2)	49 (0.9)	25 (1.1)	90 (2.0)	5 (0.5)	120 (1.5)	16 (0.7)	42 (0.9)	8 (0.5)	66 (0.8)	15 (0.4)	48 (0.7)	9 (0.4)	72 (0.6)	-2.3	3.9	16.9	-4.4	-6.0	6.1	-4.8
3. Steel, other metal and others	195 (13.2)	362 (9.8)	62 (16.7)	619 (11.2)	294 (13.3)	352 (7.7)	187 (15.7)	833 (10.4)	298 (12.4)	276 (6.1)	204 (13.8)	778 (9.3)	429 (12.6)	340 (5.2)	279 (12.1)	1,048 (8.6)	5.4	-0.6	10.6	3.8	-0.3	4.1	2.3
H. Export	166 (11.2)	264 (7.1)	27 (7.2)	457 (8.2)	300 (13.5)	527 (11.5)	53 (4.4)	880 (11.0)	423 (17.7)	371 (8.2)	70 (4.8)	864 (10.3)	759 (22.2)	995 (15.5)	83 (3.6)	1,837 (15.1)	10.6	9.2	7.6	9.7	6.6	4.6	7.6
Total	1,481 (100)	3,700 (100)	381 (100)	5,562 (100)	2,223 (100)	4,586 (100)	1,193 (100)	8,002 (100)	2,395 (100)	4,503 (100)	1,477 (100)	8,375 (100)	3,416 (100)	6,441 (100)	2,309 (100)	12,166 (100)	5.7	3.8	12.8	4.4	3.4	6.8	4.3

Note: All European figures are four-country total of the Federal Republic of Germany, the United Kingdom, France and Italy. The same alphabetical letters shown at the left end of this table are used in Fig. C-15 for each usage. 1975 and 80 figures are actual values, not the revised figures.

Source: OECD NFMS, each year's yearbook; Growth rate and percentages were calculated by the writer.

Reterence Fig. C-1   Development of Demand Structure by Aluminum Usage in Japan



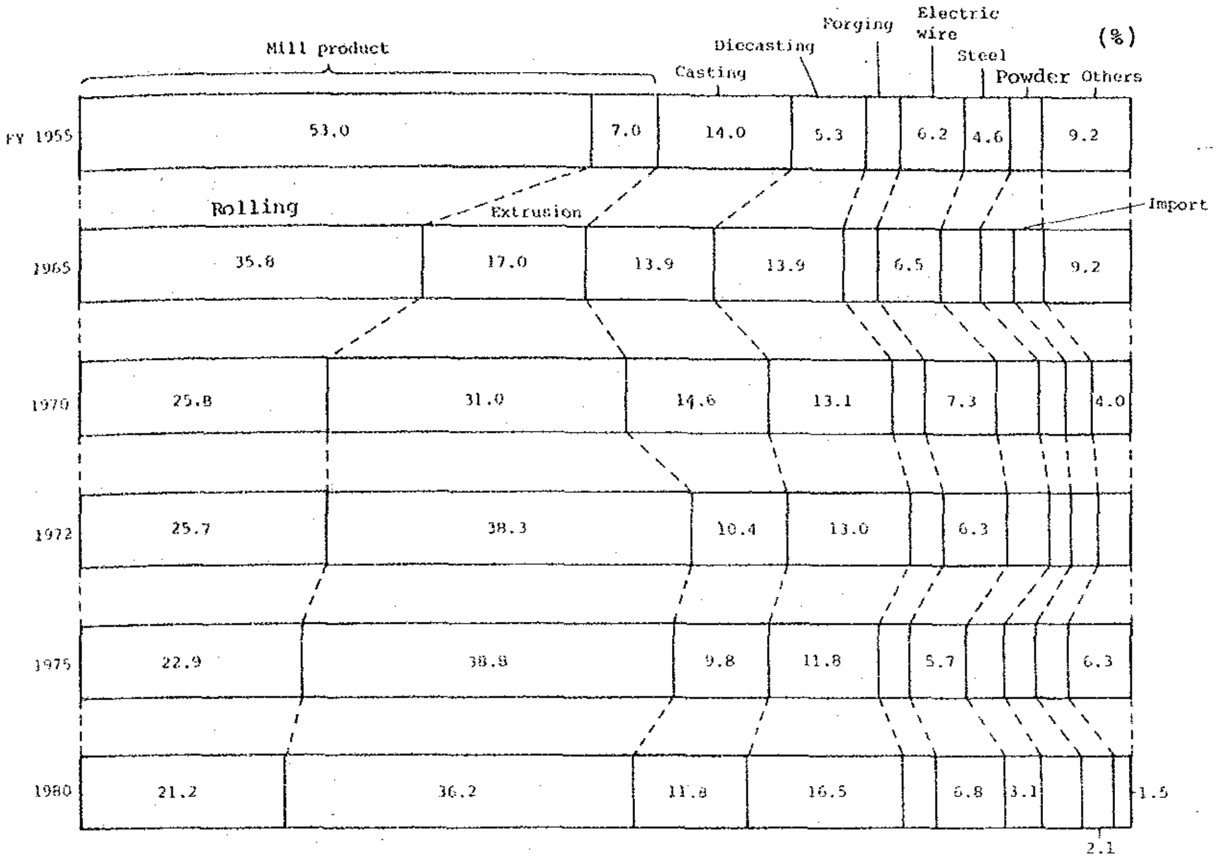
Average annual growth rate (%)	Daily necessities	Food	Metal products	Production machinery	Civil & construction	Electrical	Electrical & communication	Transportation	Precision machinery	Others	Export	Total demand
1980/1965	-1.5	28.3	12.3	9.3	19.1	11.9	8.9	11.3	7.8	8.4	1.8	[illegible]

Note: 1) "Others" are total of those demand which share in total were less than 1 % as of 1979. (Chemical industries, tobacco, ship, aircraft and others)

2) These data are for fiscal years and categories are different from OECD statistics.

Source: JAF, <u>The Aluminum Industry Statistics, Monthly Bulletin and Yearbook</u>

Reference Fig. C-2   Development of Demand Structure by Aluminum Product in Japan

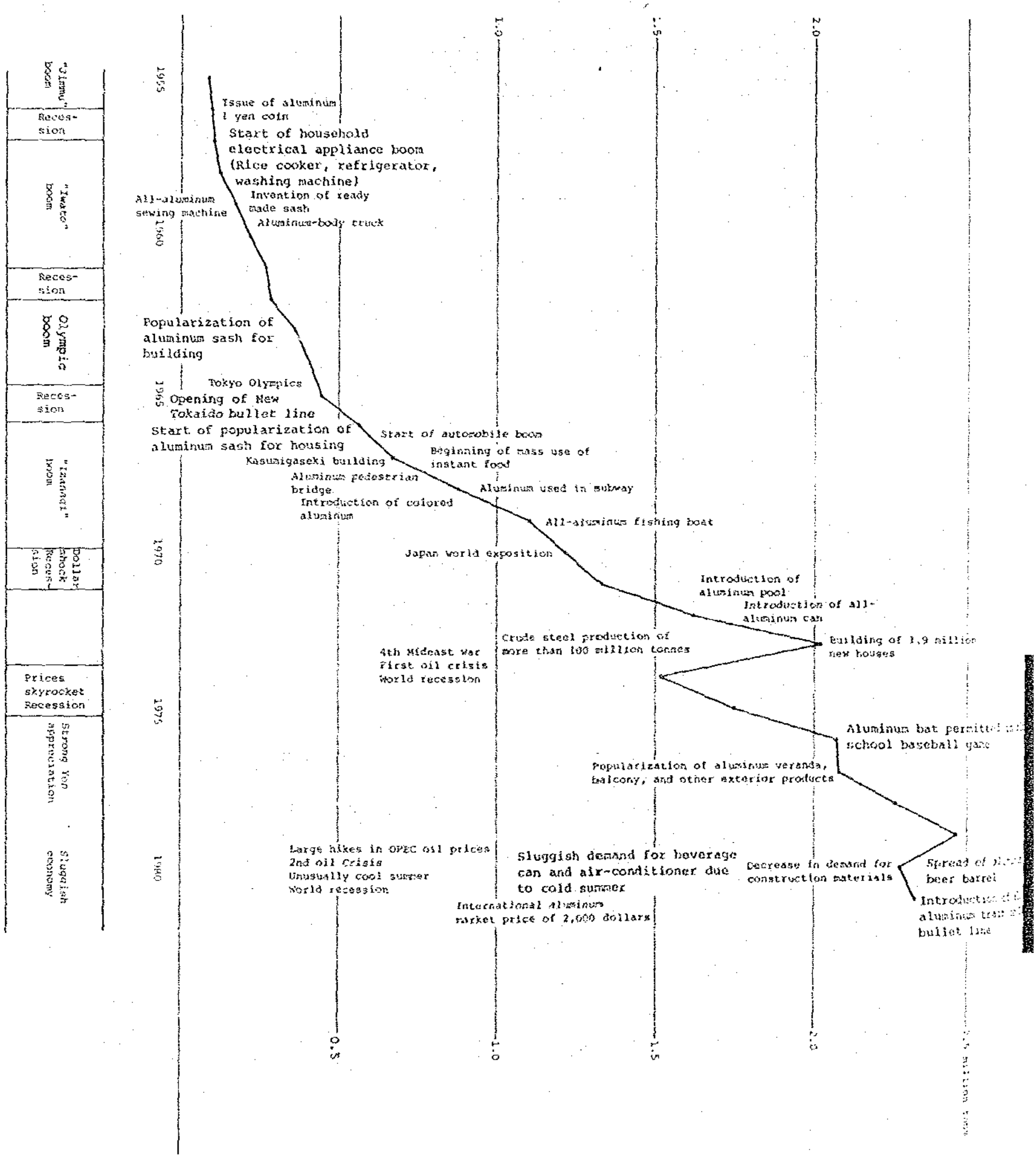


Average annual growth rate (%)	Mill product	Rolling	Extrusion	Casting	Diecasting	Forging	Electric wire	Steel	Powder	Import	Others	Total demand
1980/1965	12.2	7.7	17.3	10.3	12.8	7.2	11.9	12.4	17.0	23.0	-7.2	11.5

Notes: 1) These data are for fiscal years and categories are different from OECD statistics.
2) "Others" include bus bar, export and others.

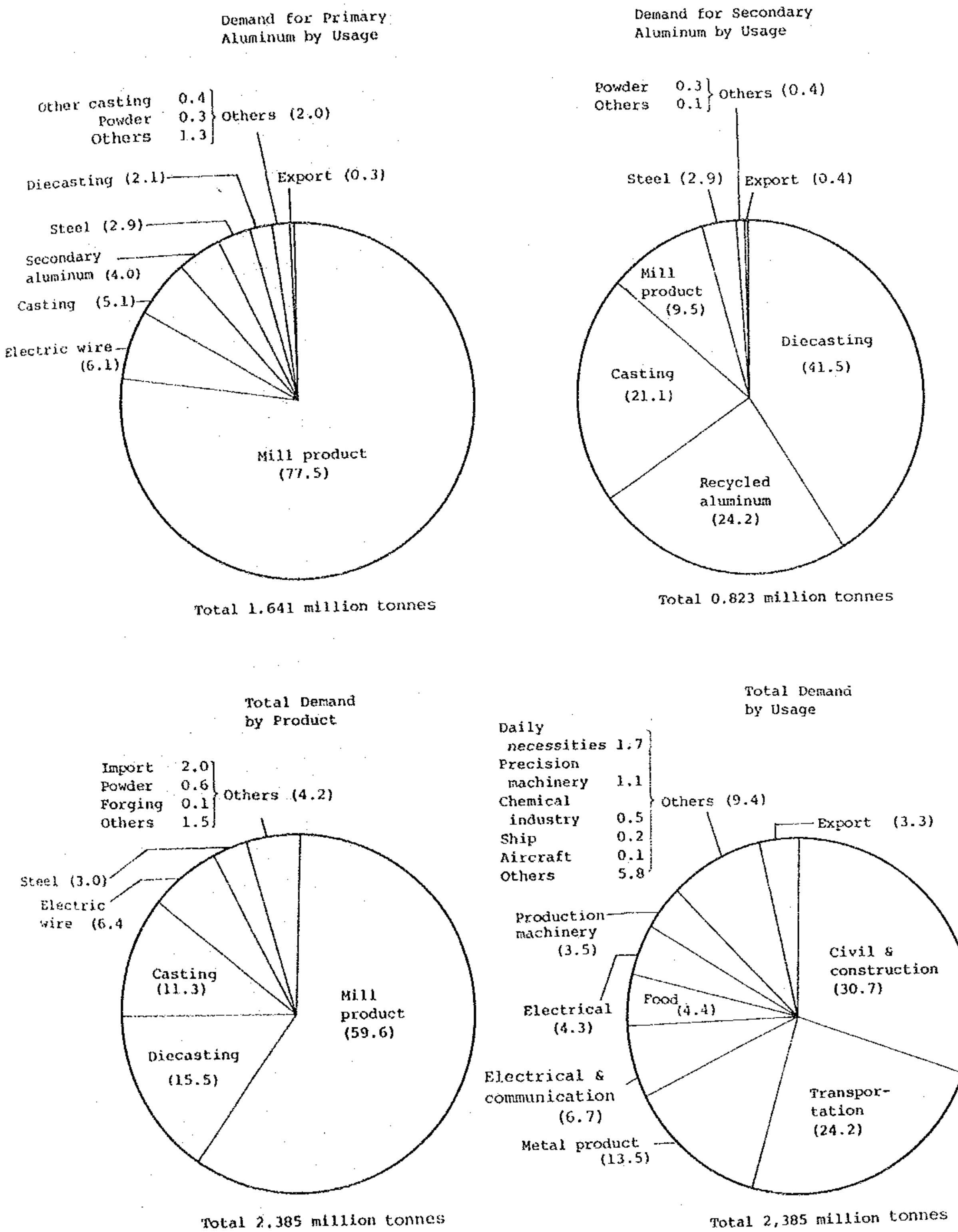
Source: JAF, The Aluminum Industry Statistics, Monthly Bulletin and Yearbook

Reference Fig. C-3 Development of Total Demand for Aluminum in Japan



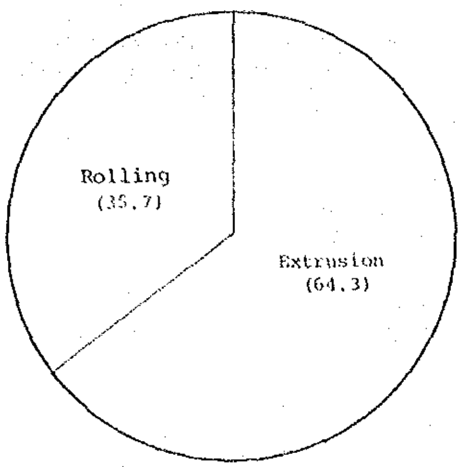
Reference Fig. C-4 Demand Structure for Aluminum in Japan (1980)

Source: JAF



Reference Fig. C-4 (cont'd.)

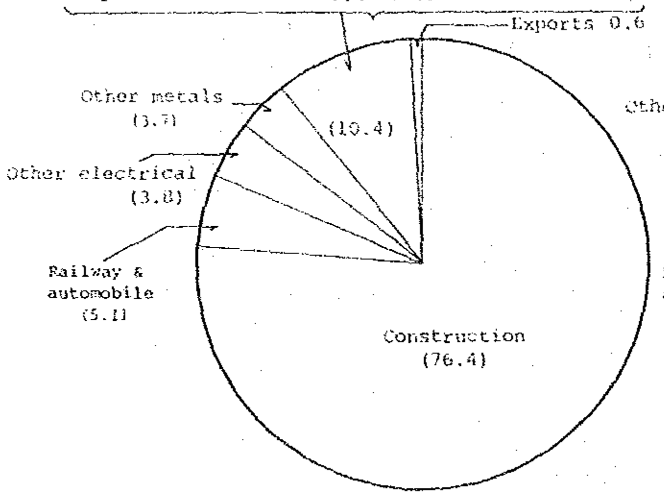
Composition of Mill Product



Total 1,421 thousand tonnes

Mill Product-Extrusion by Usage

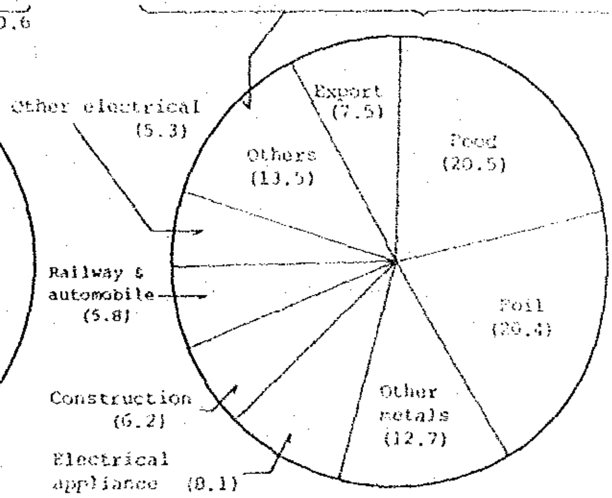
Other machinery	1.6	Food	0.2
Precision machinery	1.5	Chemical industries	0.1
Electrical appliances	1.4	Aircraft	0.1
Daily necessities	0.2	Tobacco	0.1
Ship	0.2	Others	5.0



Total 914 thousand tonnes

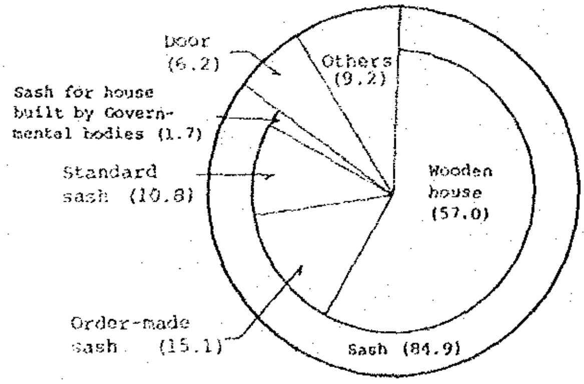
Mill Product-Rolling by Usage

Daily necessities	4.7	Ship
Other machinery	1.4	Aircraft
Chemical industries	0.8	Tobacco
Precision machinery	0.5	Others



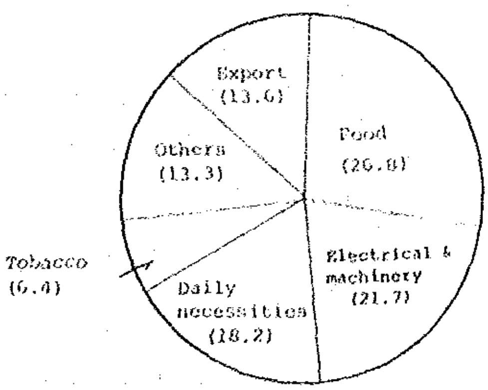
Total 507 thousand tonnes

All Aluminum Building Materials by Usage



Total 571 thousand tonnes

Aluminum Foil by Usage



Total 87 thousand tonnes

Reference Fig. C-4 (cont'd.)

Special Classification of Usage of Mill product (1980)

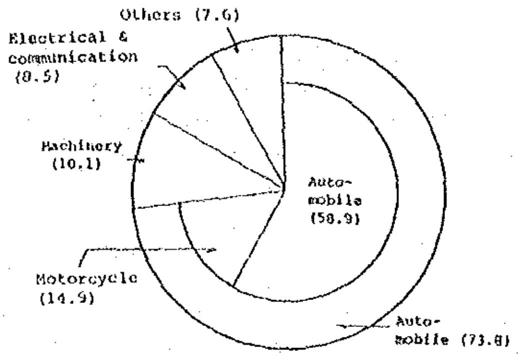
	Special classification	Quantity (tonne)	Ratio (%)	
			Rolling	Extrusion
Food	Can: Body material	36,000	100	-
	End or tab material	52,800	100	-
	Packaging, container	16,100	91	9
	Other food industry	500	53	47
	Subtotal	105,400	98	2
Tobacco	Tobacco industry	60	7	93
Chemical industries	Petroleum and petro-chemical industry	2,300	97	3
	Other chemical industry	3,100	61	39
	Subtotal	5,400	76	24
Daily necessities	Kitchen utensil	22,500	99	1
	Others	3,500	51	49
	Subtotal	26,000	92	8
Foil	Foil mill	103,400	100	-
Other metals	Furniture, fixture and exhibition material	12,900	6	94
	Kitchen equipment	1,700	70	30
	Gas and oil equipment	2,600	72	28
	Sporting and leisure goods	5,700	43	57
	Building fitting, rivet, etc.	800	29	71
	Nameplate	13,000	96	4
	Printing block	22,600	100	-
	Slug	12,100	99	1
	Others	26,700	39	61
	Subtotal	98,100	65	35
General electrical appliance	Refrigerator and freezer	7,800	70	30
	Associated equipment with refrigerator and freezer	11,000	34	66
	Fin	22,300	96	4
	Other electrical appliances	12,700	83	17
	Subtotal	53,800	77	23
Other electrical	Electronics & communication:			
	Audio	31,000	33	67
	Communication	8,600	33	67
	Lighting	3,200	75	25
	Distribution			
	Distribution equipment and appliance	6,900	64	36
	Bus bar and bus duct	5,100	45	55
	Other electrical	7,600	63	37
	Subtotal	62,400	44	56

Reference Fig. C-4 (cont'd.)

	Special classification	Quantity (tonne)	Ratio (%) Rolling	Ratio (%) Extrusion
Ship	Ship	3,500	55	45
Aircraft	Aircraft	1,600	39	61
Railway, automobile & others	Railway	8,200	52	48
	Automobile	41,100	40	60
	Container	14,500	18	82
	Bicycle	8,400	45	55
	Others	3,900	51	49
	Subtotal	76,100	38	62
Precision machinery	Optical machinery	12,700	10	90
	Other precision machinery	3,000	34	66
	Medical and scientific instrument	600	49	51
	Subtotal	16,300	16	84
Other machinery	Production machinery	4,200	41	59
	Other machinery	11,400	38	62
	Agriculture, forestry and textile machinery	6,200	16	84
	Fishing machinery	100	43	57
	Subtotal	21,900	32	68
Construction	Sash: Wooden house	423,100	-	100
	Non-wooden house	157,100	1	99
	Door	32,800	6	94
	Other building materials:			
	Interior	13,900	25	75
	Exterior	42,700	29	71
	Others	43,800	17	83
	Civil facilities	15,900	26	74
	Subtotal	729,300	4	96
Others	Other manufacturing	8,700	53	47
	Wholesale and retail (Unknown user)	35,300	55	45
	Maintenance	300	16	84
	Others	30,400	15	85
	Subtotal	74,700	38	62
Domestic total		1,377,960	34	66
Export		42,900	88	12
Grand total		1,420,860	36	64

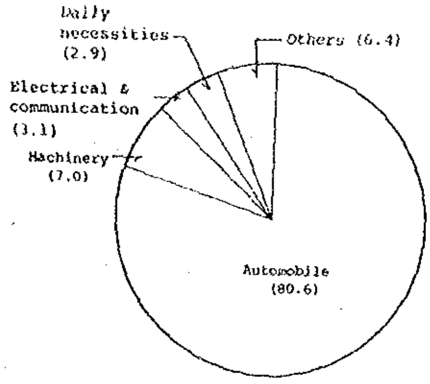
Reference Fig. C-4 (cont'd.)

Diecasting Product by Usage



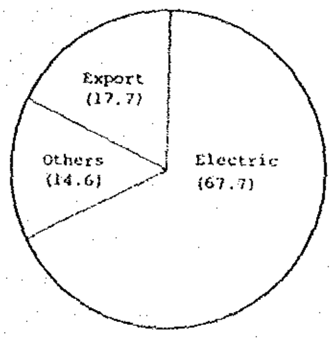
Total 369 thousand tonnes

Casting Product by Usage



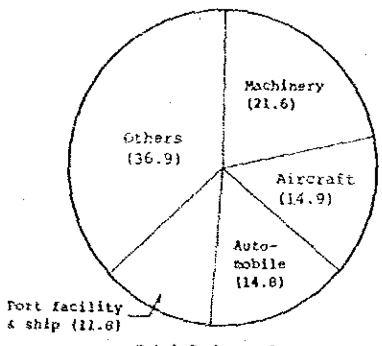
Total 270 thousand tonnes

Aluminum Electrical Wire by Usage



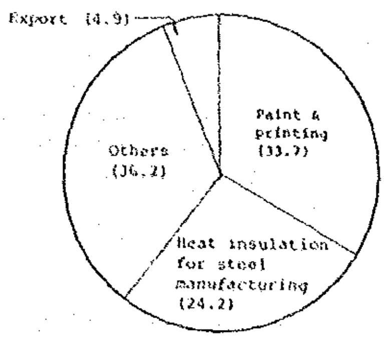
Total 153 thousand tonnes

Forging by Usage



Total 2 thousand tonnes

Powder by Usage



Total 13 thousand tonnes

D. PRICE

I. Development of Price of Aluminum

As has been explained, aluminum demand has grown with remarkable speed in the past. Needless to say, the fundamental reasons for the growth were the superior properties of aluminum as a basic material and, at the same time, the long-term price stability or its reliability as such a material.

During the early stage of the development of the aluminum industry, successive entries and consequent increase in production led to excess supply during recessions. As a natural result, the European and American producers, suffering from sluggish market prices, have formed a number of international cartels before the Second World War, with the aim of stabilizing prices and markets.

As a legacy of that tradition, even after the war, a system was set up in which the international price was virtually decided by the list prices [1] announced by ALCOA and ALCAN. According to ALCOA, the ideal price level is the one which realizes a before-tax return of 20% on investment, using an average utilization of total plant capacity of 70%.

The list price decision system set up by the Major Producers as above is fundamentally based on cost principles, and their justification for the policy is made on the grounds that because the aluminum industry is typically capital-intensive and requires large amount of investment, reinvestment will not be possible, unless a reasonable margin is assured and that an ample supply of aluminum supported by the reinvestment and its stable price will bring about expansion in demand.

As a result of the policy and the system being effective after the Second World War, aluminum prices did not follow inflation but remained stable even during some periods of tight supply and demand. Afterwards, however, due to a drastic rise in energy cost from around the first oil crisis, the list price also rapidly increased but the list price and the system had continued to operate effectively at least up until around 1978. Fig. D-1, which compares ALCAN list price developments with the growth of consumption of primary aluminum, clearly shows this situation.

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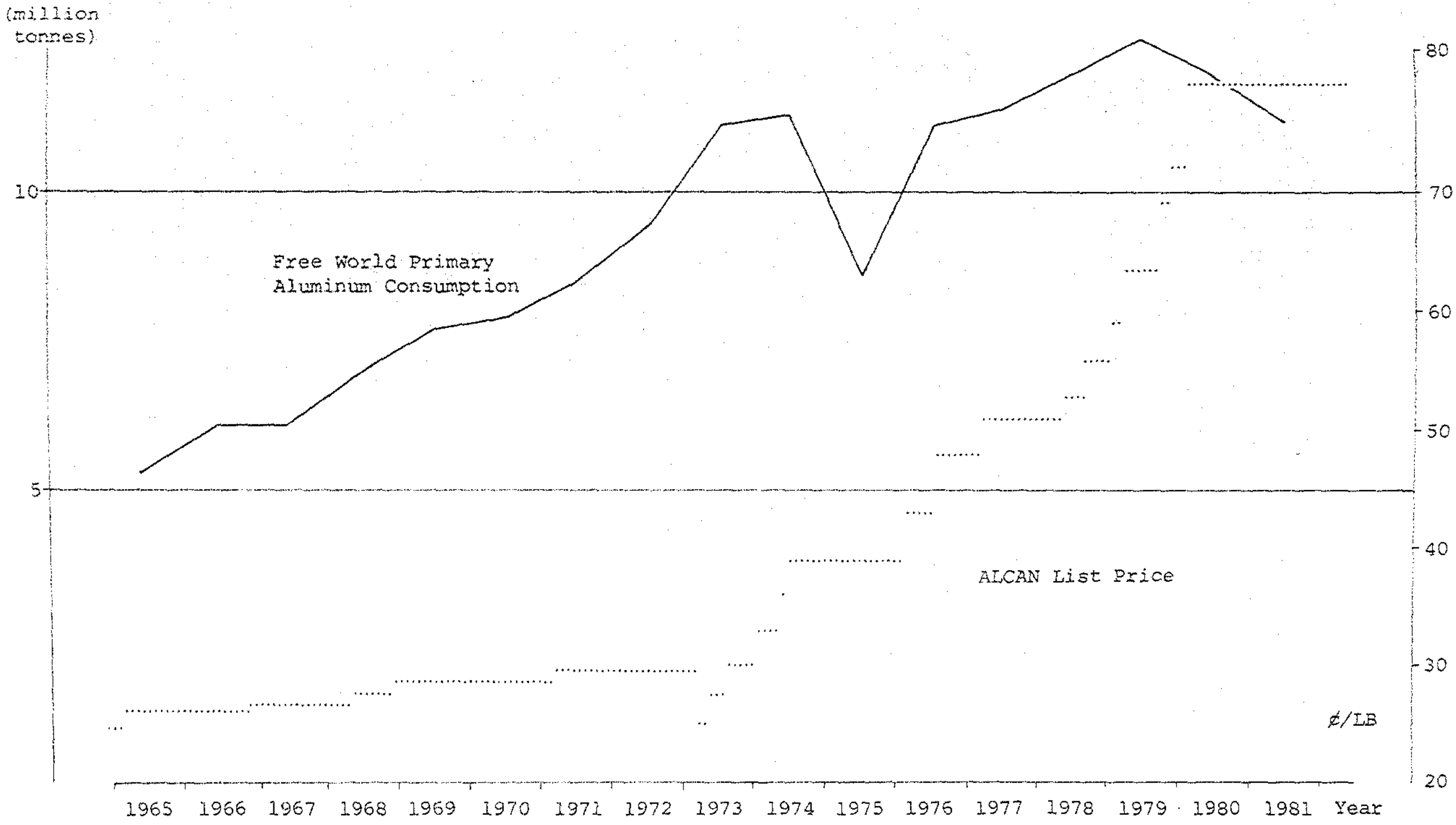
1) ALCOA has announced the U.S. domestic list price. For the international price ALCAN's list price for export has been used as a benchmark.

Fig. D-1 Development in Free World Primary Aluminum Consumption and Alcan List Price



However, in recent years, with the undercurrents of changes in the structure of the aluminum industry and the big fluctuation in aluminum demand, the said situation changed completely when primary aluminum was listed on the London Metal Exchange.

II. Formation and Fluctuation of Market Oriented Prices

1. Listing Aluminum on the LME

The move to list aluminum on the LME 1) began in the early 1960s. Why the LME so sticked to listing aluminum on the market is not clear. However, general view on probable reason for it is not that the LME regarded aluminum as a market commodity, but that the LME, once the center of the world commodities trade, faced with its declining position in recent years, planned to restore its position by listing aluminum on the market.

On the other hand the view of the Major Producers on the matter was as follows. Because the aluminum industry is overwhelmingly capital-intensive, it is structurally different from all the other non-ferrous metal industries. The structure of the industry is so inherently integrated very solidly unlike other industries such as copper, lead and zinc that LME function will play little role. And unlike grains, coffee, etc., it is not influenced by weather or by the timing of the harvest, so there is no need to hedge the risk of transaction. Furthermore, aluminum is not a homogeneous product which is an indispensable condition for commodity transaction. Aluminum customers do not want a Massel type ingot (sow) or T-slab whose place of origin is unclear and whose quality is inferior. Instead, they want products like billet or slab. Accordingly commodity exchanges will not be able to meet diverse requirements of the customers. However, the most fundamental problem in their view is that price fluctuations incurred by excess speculation discourage producers from making investment and make the stable supply of products insecure. Thus, the Major Producers concluded that aluminum should not be listed on the LME.

Unlike the Major Producers, however, newcomer producers and producers of developing countries, without secure buyers, had to entrust metal merchants with the sales. Furthermore, there was support by profit takers who are interested in speculating on the floaters. The LME, with the objective of creating a free market of aluminum, finally succeeded in listing aluminum on the market in October, 1978.

1) London Metal Exchange

While during the first week on the market, a mere 1,500 tonnes of aluminum was traded, the volume of trading increased instantly and in two months sizable trading of over 80,000 tonnes was made. Just at that time, because the world economy was booming and aluminum consumption was rising (Refer to Fig. D-1), the spot market prices in each country, led by the LME, began to skyrocket. The market price, which started at about $1,200/T when the market opened and had stayed below the ALCAN list price, easily exceeded the list price in January, 1979 and as a result of continuous monthly increases finally hit the $2,000/T mark in January, 1980. During this time, soaring energy prices had pushed up the ALCAN list price in steps, but the tempo of rise in the LME price far outpaced. In this situation, the countries tendering primary aluminum to the LME, originally limited to India, Egypt, etc. has become worldwide and even floaters from the centrally planned economies have become subject to speculation. The actual volume of trading using the LME price as reference has recently reached a scale of 200,000 to 300,000 tonnes per month and the LME itself has come to hold over 200,000 tonnes of inventory.[1)]

In this way, the views of the Major Producers that the function of the LME would not have the similar influence on the aluminum market as on copper, lead, and zinc markets have proved wrong. The spot market price, led by the LME has come to have a substantial effect on the composition of the market price for aluminum.

2. Recent Price Development

The highest price of aluminum at the LME on cash deal was recorded at $2,130/T in February, 1980. This price was amazingly higher by $500/T than that month's ALCAN list price of $1,600/T. However, after peaking then the spot prices have suddenly begun to tumble down. The market price continued to decline month after month. In the middle of 1980 it wobbled around the then ALCAN list price of $1,750/T and in November, 1980 passed down the $1,500/T mark, and still continued to fall without stopping. Then in April of 1982 the $1,000/T level was finally busted and now is stuck on

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1) However, the volume of speculative transaction on the LME has fluctuated violently from day to day. For example in November and December of 1982 there were some daily transactions exceeding 100,000 tonnes as primary aluminum. However, the figure is total amount of speculative transaction and does not represent actual transactions. After the price is decided by between producers and customers referring to the LME market price as an indicator, the actual amount of transaction is finalized as physical trading, which is currently estimated to be staying at the level of 200,000 to 300,000 tonnes per month.

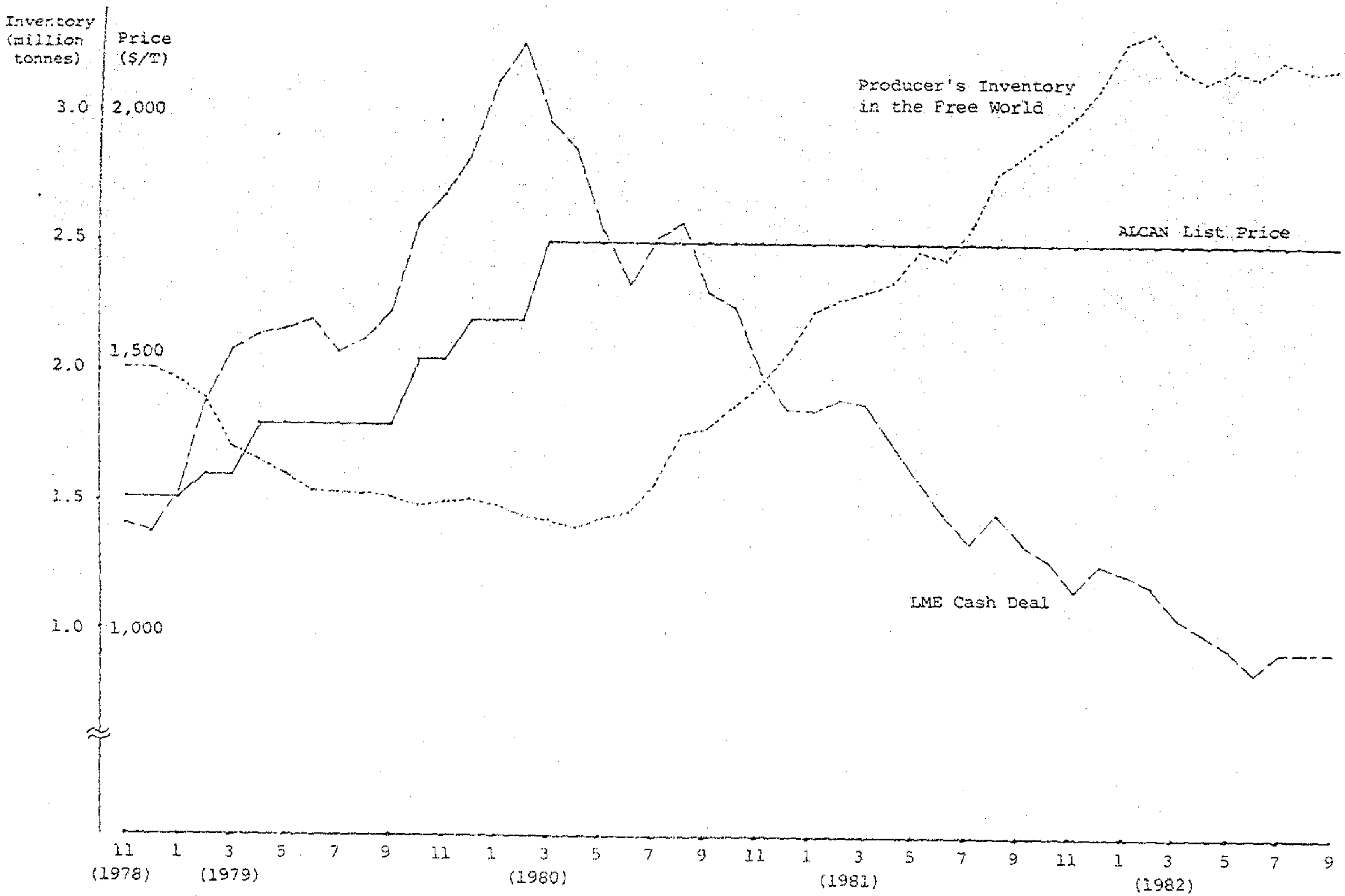
that level. The price tag of $1,000/T is half of the peak price and over $700/T below the current ALCAN list price, a frightfully low price. Fig. D-2 clearly shows the wild fluctuations of the spot market price of aluminum, since it was listed on the LME. Table D-1 gives the actual price development in figures.

Table D-1 Alcan List Price and London Metal Exchange Cash Deal Price and Changes in Free World Producer's Inventory

Year/ Month	ALCAN list price ($/T)	LME cash deal ($/T)	Free world producer's inventory (1,000 T)	Year Month	ALCAN list price ($/T)	LME cash deal ($/T)	Free world producer's inventory (1,000 T)
'78/10	1,253	1,135	4,078	'80/10	1,750	1,626	3,677
11	1,253	1,204	3,984	11	1,750	1,501	3,831
12	1,253	1,185	3,980	12	1,750	1,433	3,962
'79/ 1	1,253	1,265	3,932	'81/ 1	1,750	1,430	4,148
2	1,300	1,442	3,843	2	1,750	1,451	4,223
3	1,300	1,541	3,654	3	1,750	1,445	4,283
4	1,400	1,570	3,621	4	1,750	1,367	4,339
5	1,400	1,579	3,523	5	1,750	1,296	4,472
6	1,400	1,598	3,424	6	1,750	1,231	4,436
7	1,400	1,534	3,408	7	1,750	1,174	4,632
8	1,400	1,561	3,446	8	1,750	1,232	4,851
9	1,525	1,615	3,395	9	1,750	1,169	4,898
10	1,525	1,783	3,357	10	1,750	1,139	4,944
11	1,525	1,837	3,367	11	1,750	1,082	5,023
12	1,600	1,915	3,415	12	1,750	1,129	5,062
'80/ 1	1,600	2,055	3,372	'82/ 1	1,750	1,113	5,166
2	1,600	2,130	3,349	2	1,750	1,088	5,178
3	1,750	1,977	3,312	3	1,750	1,028	5,069
4	1,750	1,927	3,297	4	1,750	997	5,054
5	1,750	1,776	3,346	5	1,750	972	5,091
6	1,750	1,668	3,384	6	1,750	918	5,003
7	1,750	1,759	3,470	7	1,750	958	5,063
8	1,750	1,785	3,646	8	1,750	958	5,040
9	1,750	1,655	3,634	9	1,750	958	4,997

Note: London Metal Exchange prices as appear in MW. London Metal Exchange transactions are in £/T but have been converted into $/T. The ALCAN list price has been in US$/T from September 1978 but before then it was in ¢/LB.
Free world producer inventory are from IPAI Statistics.

Fig. D-2 Development of ALCAN List Price, LME Cash Deal and Free World Producer's Inventory



Source: Reference Table D-1

Why did such a drastic fall in prices occur?

The first reason is, needless to say, the simultaneous appearance of the recession in the worldwide economy from the second half of 1980. In particular, the stagnation of automobile and housing industries in the United States, a major consuming country, as seen in Section B, turned this former aluminum importing country into an exporter and was a reason for the drastic loosening of supply and demand.

The second reason, again as seen in Section B, is deeply related to structural changes in the aluminum industry. Namely, the flow of primary aluminum from those plants which try to continue production, irrespective to market conditions, gave rise to a large excess supply. Surplus from the centrally planned economies is another cause for this. The USSR and the East European countries are reportedly planning to sell metal, both primary and secondary aluminums, in order to obtain purchasing currency for foodstuff made necessary by recent poor harvests.

On the other hand, buyers do not have enough money for piling inventory during this low-price period. An example of this is Japan, which exerts a substantial influence as a major purchasing country on the LME price. Japanese importers, suffering from the fall in product demand, are put in such a position that they cannot buy, even if they want to.

The said supply and demand situation is clearly shown by the free world producer's inventories. The spot price surely reflects the supply and demand situation sensitively. Refer to Fig. D-2 again and it is clearly shown that inventories and the market price have a distinct negative correlation. Between 1.7 million and 2.0 million tonnes of inventory is usually considered as proper level for free world producer's inventories. Increases in these inventories exceeding the said level has brought about successively falling market prices. As a result of the continuous high inventory level of about 3.1 million tonnes now, far above the proper level, the market price inversely continues to wallow at about $1,000/T.

Aluminum does not have the political downward price rigidity like oil prices. And now, coupled with the alleviation of supply and demand, the spot market prices, led by the LME, have gradually come to dominate the market, forcing the ALCAN list price into a nominal benchmark. Even ALCAN itself has now been put into a position in which it has to decide its sale price taking the spot market price into account.

In terms of the level of production cost, there are no plants that can make a profit at a sale price of about $1,000/tonne, unless electricity costs are politically undervalued. Because of this situation, for the 3rd quarter of 1982, all the six world major aluminum producers reported losses, including ALCAN which has been regarded as the most advantageous company in terms of production cost, being located in an advanced country with hydropower.[1)]

However, even if the current situation as above arose after aluminum was listed on the LME, it may be unfair to blame market speculation, especially the one at the LME for causes of the situation. Rather, the cause may lie in the struggle for a new development by the aluminum industry, which is caught in the middle of major structural changes.

3. The Orderly price of Aluminum

It is clear that for a typical capital-intensive industry of aluminum the abnormal price fluctuations as above are not desirable at all. If this situation continues unchanged for a long time, aluminum would become a material of the utmost instability and this will prove that one of the views expressed by the Major Producers against listing of aluminum on the LME is correct after all. Now that, however, once powerful Major Producers have lost power to control prices, a classic type of market order will never be restored. As this is the case, what kind of new order will then be sought in the middle of these enormous structural changes?

As an approach to this issue, the following points will be considered.

First, although the international spot markets led by the LME does reflect the actual condition of the international aluminum market to a certain extent, they do not necessarily reflect all of the world aluminum transactions. For example, in the United States and Europe, where vertical integration of the industry is high, the secondary and tertiary products can and actually claim their own prices with little direct influence brought by spot market prices of primary aluminum. In view of the entire volume of world aluminum trade, a large portion of the market is stabilized this way. And this is endorsed by the fact that out of the roughly 12 million tonnes of primary aluminum consumed in the free world these years, the amount of the spot transactions based on the LME is only about 2 to 3 million tonnes (about 20% of the total) annually.

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1) According to the recent news report, a medium-sized smelter in the United States, Revere Copper and Brass Inc., with a production capacity of 185,000 tonnes per year, has filed for reorganization petition in Federal District Court with debts of 240 million dollars due to the worsening aluminum market conditions and high interest rates.

The reason the LME market price has been so influential relates directly to lack of supply flexibility on the part of the aluminum producers. In the past, the Major Producers had the power to control the market and they assumed the function of regulating supply and demand, but now, as a result of losing such power, they have also lost the regulating function as well.

To put it other way, the second point relates to indications of improving supply and demand condition in the near future. Formerly, it was possible to collect returns on large sums of investment during long period due to stable prices, but under fluctuating market prices influenced by relationship between supply and demand, large-scale and thus risky investment will easily be cooled off. Actually, as will be discussed in Section F hereinafter, all plans for new aluminum smelters in the world have been abandoned. As a result, if surplus capacity becomes eliminated, supply and demand will become tight, bringing price rises.

Logically, however, if the sale price exceeds the level justifying construction of new plants, construction of them will be activated to bring increased production and then once again supply and demand may slacken. Of course, price will surely be fluctuating drastically depending on the conditions of supply and demand then.

Consequently the third point relates to indications that aluminum as one of the commodities will become more and more sensitive to market conditions. Thus, if the above is the case, the capital-intensive aluminum industry will all the more be forced to take new countermeasures to cope with the problem.

These countermeasures will certainly urge those producers who are not sensible to supply and demand regulation to reconsider their conducts.

At the same time, the limits of aluminum as a material must be taken into account in discussing the matter. Aluminum has to hold a competitive edge relative to competing materials as seen previously on a constant basis. And if excess price fluctuations continue, aluminum will lose its reliability as a material and be substituted with other materials. The said fact should be noted, since a disorderly pricing has to be avoided by any industry producing materials.

Repeatedly speaking, the competitive power arising from stable prices is the way that allows aluminum to develop as a material over others. The said competitiveness will determine whether aluminum can remain as a metal with development potential as has been the case up to now or will become an unstable commodity subject to market fluctuations. In the course of aluminum price development the points discussed above will be subject to verification one by one.

The fact that a market with a small volume of transaction has such an effect on the industry as a whole indicates that the aluminum industry still is a small-scale industry. Thus, if the size of the entire industry does not increase in the future, price fluctuations will become stracturally inevitable with the industry. However, if the size of the aluminum industry expands over the long term, the influence of spot market prices can be expected to decrease naturally. The joint quest for the orderly price of aluminum by not only primary aluminum producers but also their customers (fabricators), based on the long term prospect as mentioned above, will help to develop the aluminum industry further.

E. TRADE

I. The Flow of World Trade

1. Bauxite

As shown in Fig. E-1, bauxite production increased by about 2.5 times from 37 million tonnes in 1965 to 92 million tonnes in 1980. On the other hand, the total volume of world bauxite exports increased more modestly by about 1.8 times from 20 million tonnes in 1965 to 35 million tonnes in 1980. One reason for this seems to be the intention of exporting countries to export value-added products and another the further development of integration from bauxite to aluminum.

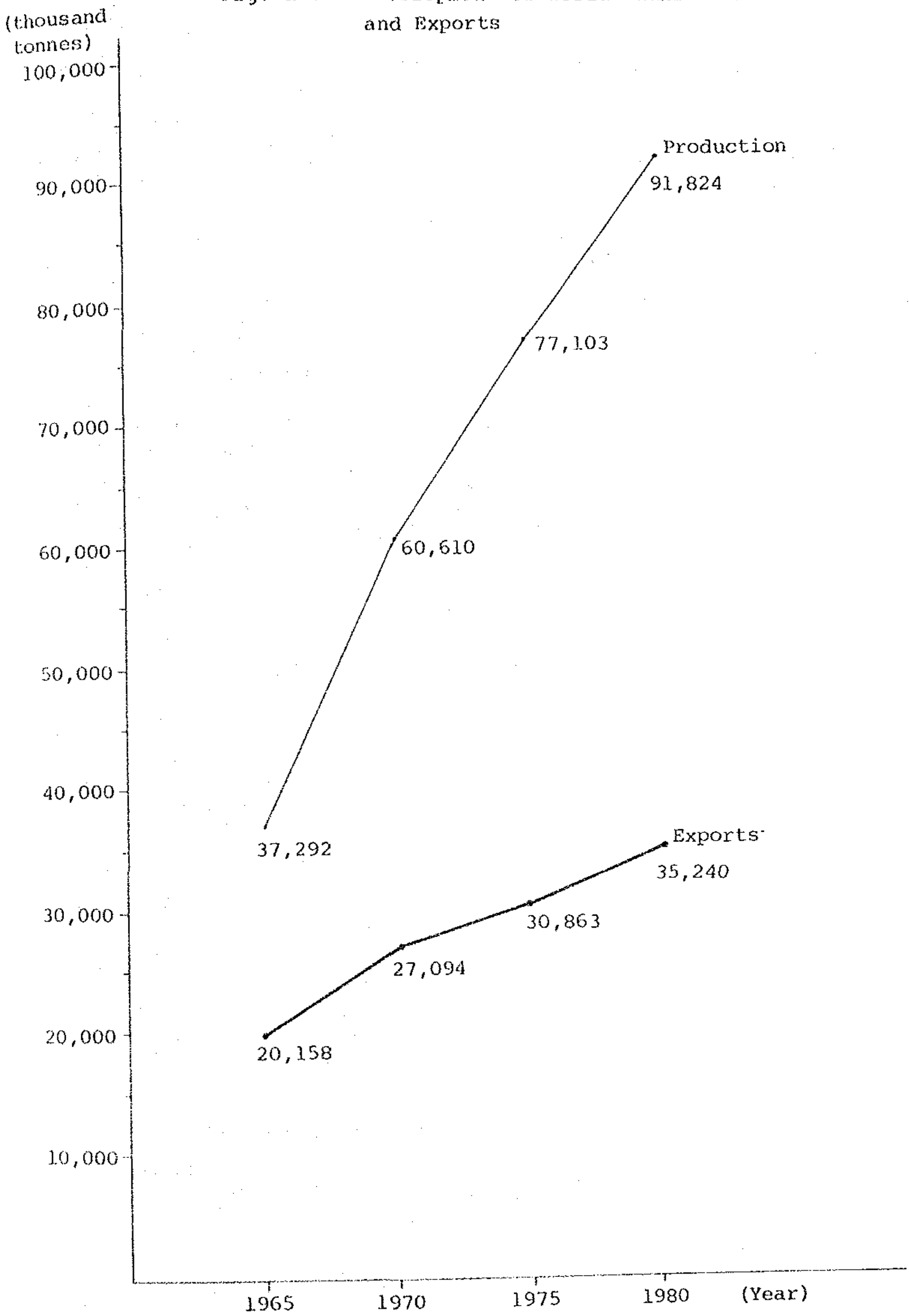
1.1 Bauxite Exporting Countries

The major exporting countries of bauxite are Guinea, Jamaica, Australia, Surinam, Guyana and Indonesia. As Fig. E-2 shows, since 1965 Australia and Guinea have quickly grown into major exporting countries. Australia exported 650,000 tonnes in 1965 and 7,200,000 tonnes in 1980. Guinea, which exported a mere 126,000 tonnes in 1965, exported 9,700,000 tonnes in 1980. These facts conclusively prove the strong competitiveness of both countries.

1.2 Bauxite Importing Countries

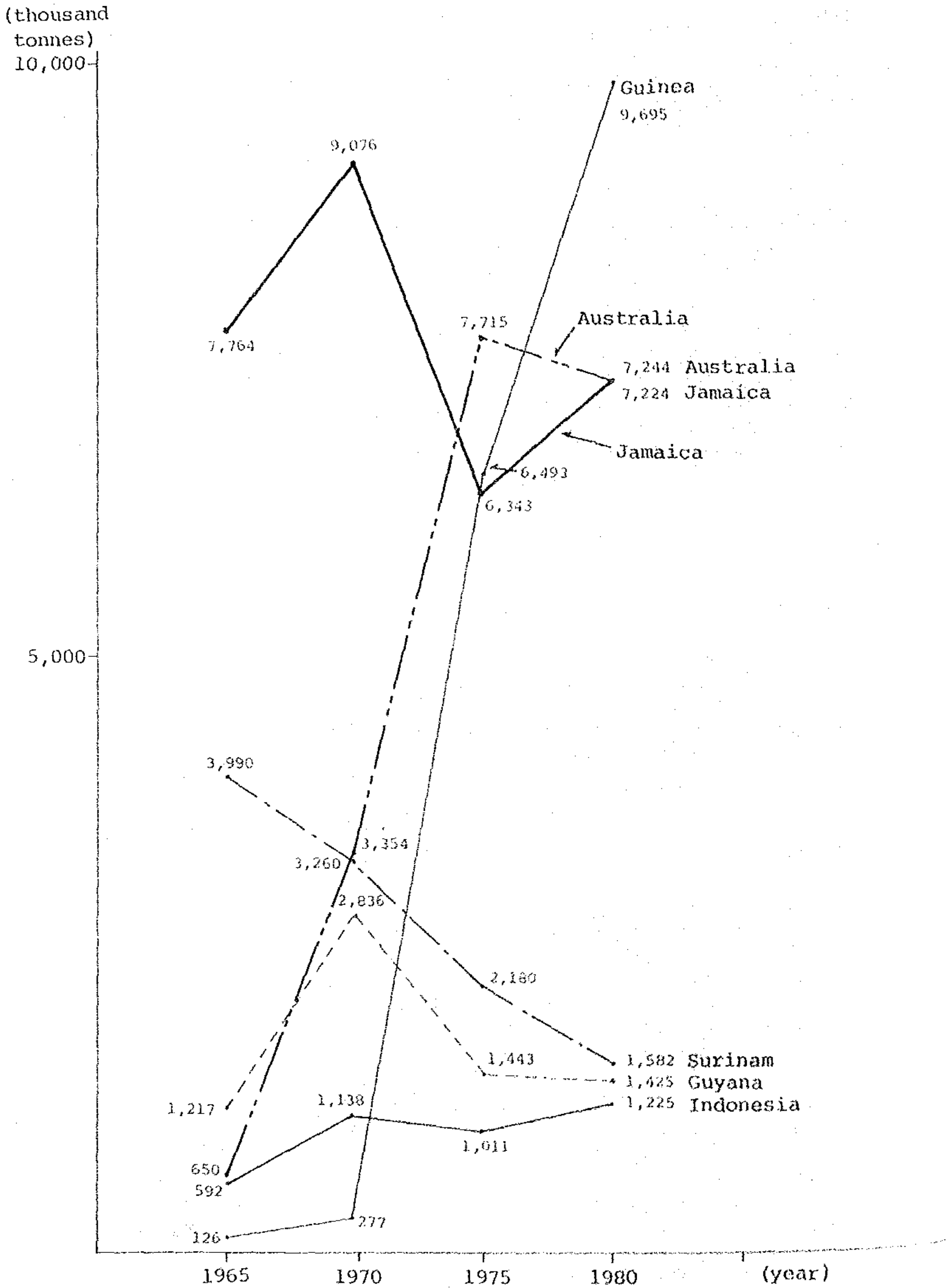
The major bauxite importing countries include the United States, Japan, the Federal Republic of Germany, Canada, etc. As shown in Fig. E-3, the volume of U.S. imports has stayed constant since 1965, which indicates that U.S. imports from overseas have shifted from bauxite to alumina. On the other hand, the volumes of imports by Japan, the Federal Republic of Germany, Canada, etc. have steadily been increased, indicating an increase of domestic production of their alumina. The development of import sources for the United States, the biggest importer as shown in Fig. E-4 shows a fall in import share from the Caribbean nations such as Jamaica and Surinam which were by far the largest sources and shows by contrast the rapid increase in import from Guinea. The said fact is indicative of a switch in policy on raw materials

Fig. E-1 Development of World Bauxite Production and Exports



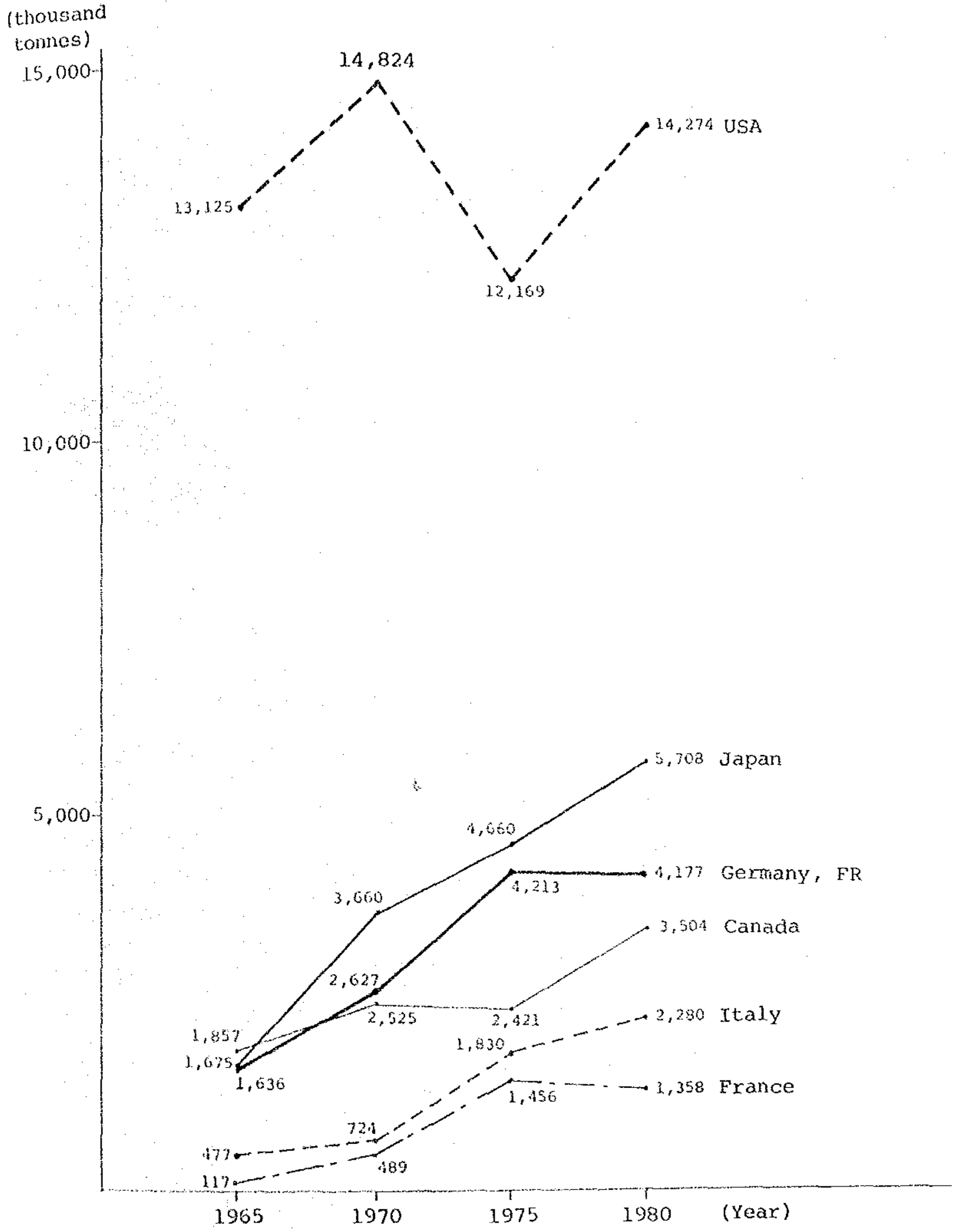
Source: IBA QR., MS

Fig. E-2 Development of Exports by the Major Bauxite Exporting Countries



Source: MS

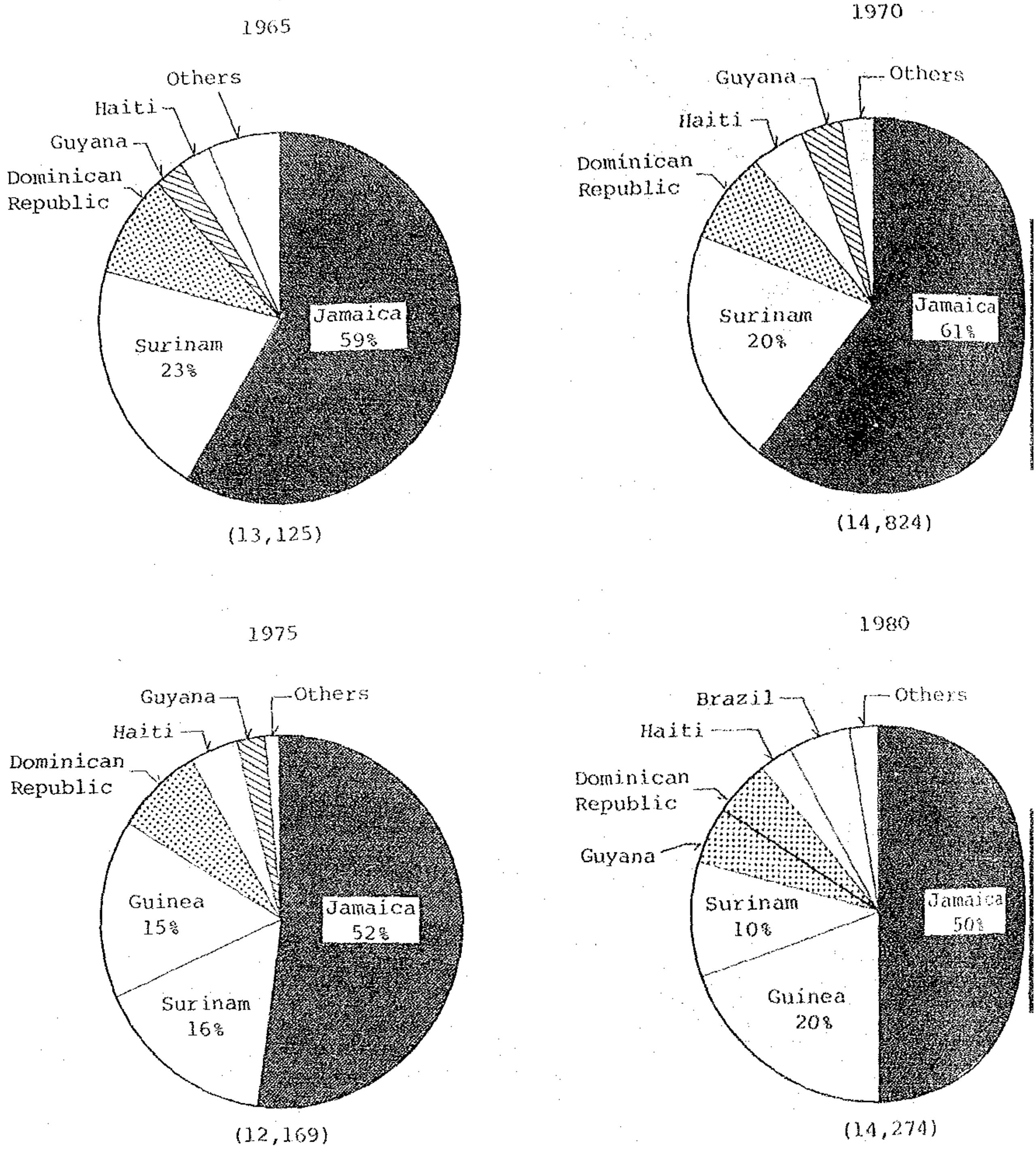
Fig. E-3 Development of Imports by the Major Bauxite Importing Countries



Source: MS

Fig. E-4 Development of Sources of U.S. Bauxite Import

(1,000 tonnes, %)



Source: MS

by U.S. smelters, i.e. an intentional switch from specific import sources of limited number of countries to diverse sources. Reference Fig. E-1 shows the flow of world bauxite trade in 1980.

2. Alumina

As shown in Fig. E-5, alumina production increased by about 2.5 times from 15 million tonnes in 1966 to 35 million tonnes in 1980. On the other hand, alumina exports recorded an increase of about 5.5 times from 2 million tonnes in 1965 to 12 million tonnes in 1980, an increase far exceeding that of bauxite in the same period.

2.1 Alumina Exporting Countries

As shown in Fig. E-6, the major alumina exporting countries are Australia, Jamaica, and Surinam. The increase of Australian export is particularly remarkable with 1980 export being 100 times larger than that of 1965. The rapid increase in Australian export is mainly attributable to increased Japanese and U.S. imports. Jamaican exports roughly tripled between 1965 and 1975, but between 1975 and 1980 the growth slowed down markedly to about 10%. This may reflect weakening of Jamaican competitiveness.

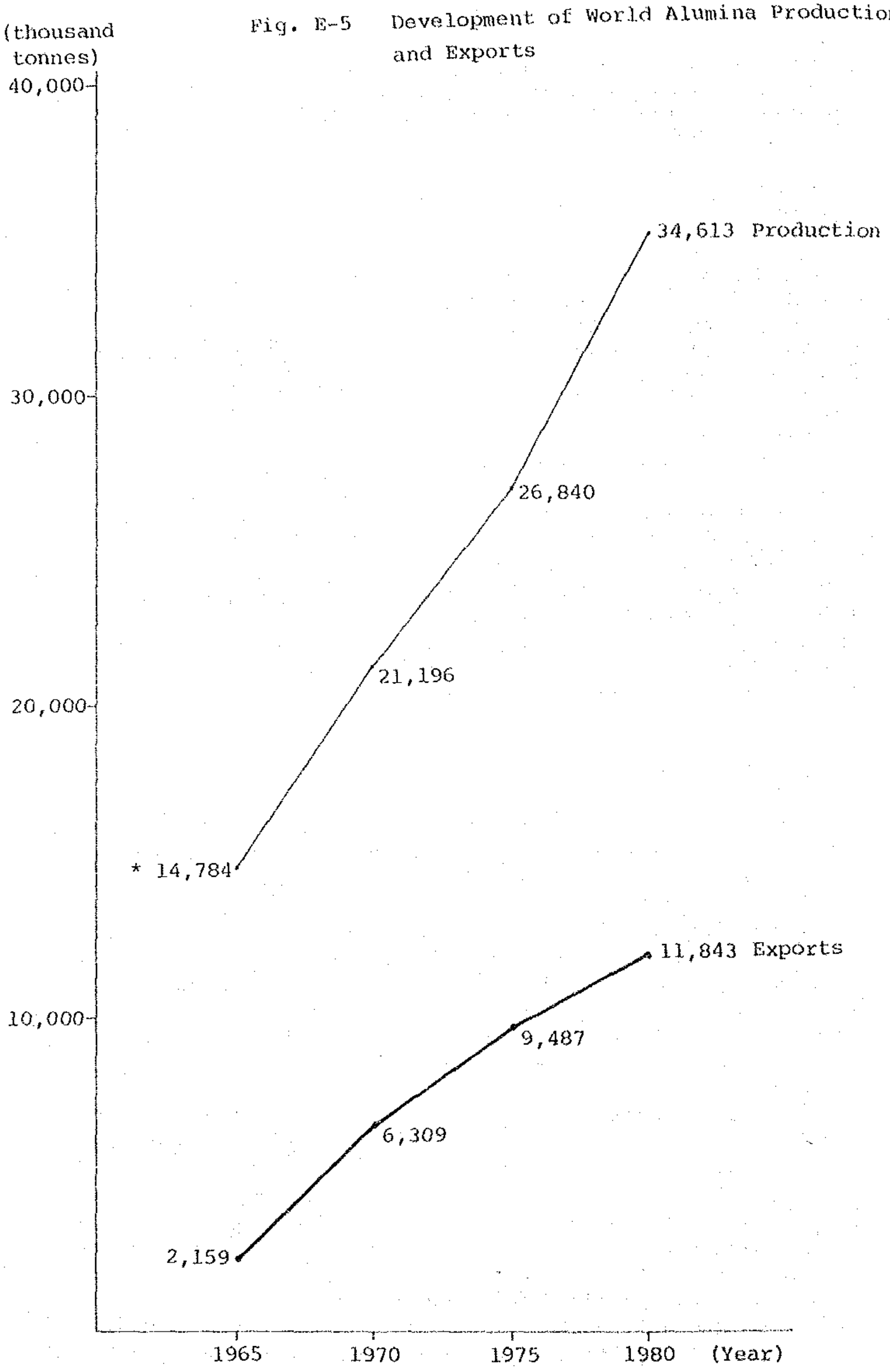
2.2 Alumina Importing Countries

The major alumina importing countries are the United States, Norway, Canada, the United Kingdom, Japan, and the Federal Republic of Germany. As shown in Fig. E-7, the import amount of the United States increased by about 19 times from a mere 230 thousand tonnes in 1965 to 4.35 million tonnes in 1980. Incidentally, 40% of metallurgical type alumina used for aluminum production in 1980 was imported. On the other hand, in the Federal Republic of Germany alumina is so produced as to meet aluminum production usually and, except for temporary import in case of shortage, the integrated production system is maintained from bauxite to aluminum.

The development of the sources of the United States alumina import as shown in Fig. E-8 indicates Jamaica's decrease and Australia's increase in the share.

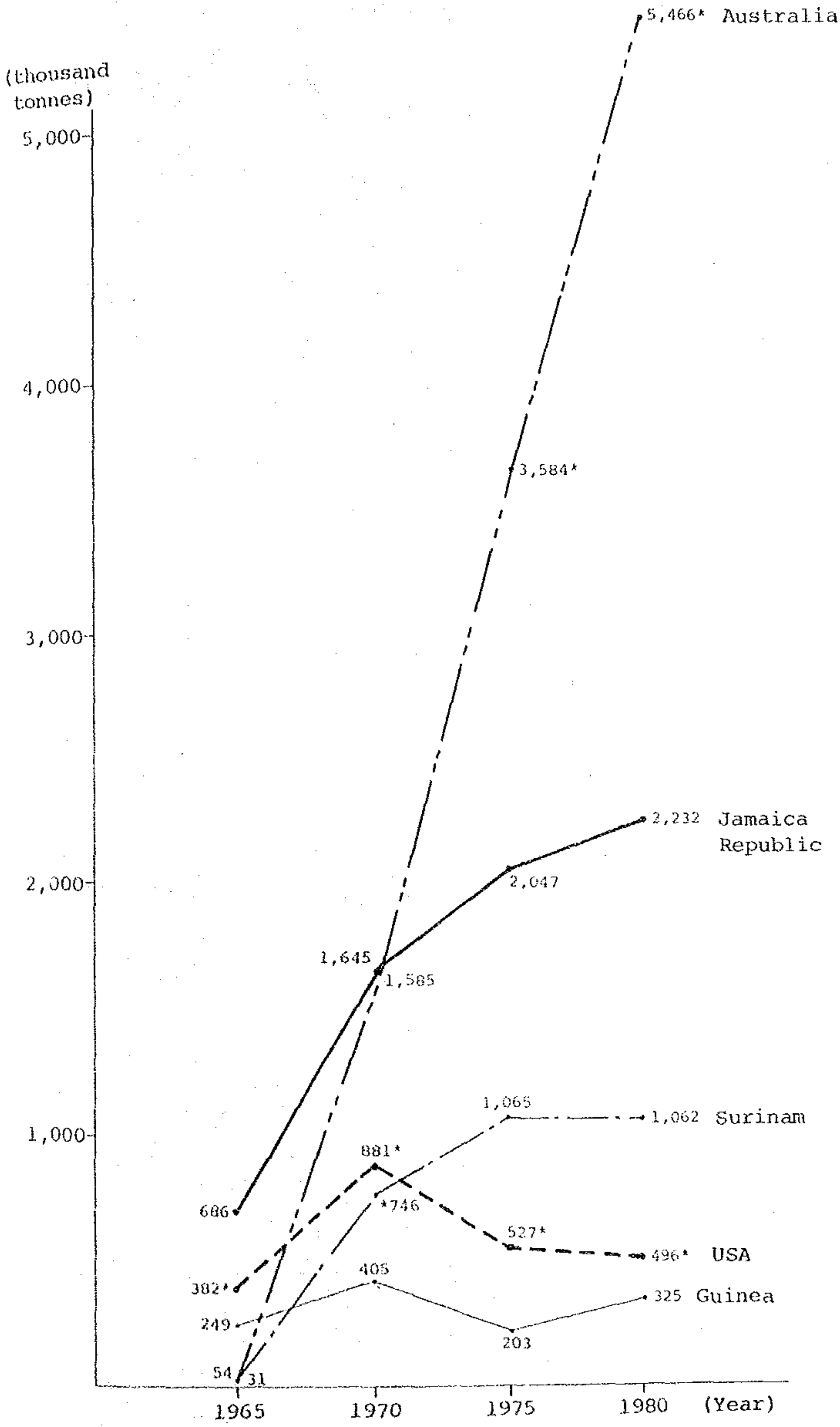
The flow of alumina imports and exports is mostly fixed like that of bauxite. For example, the largest exporting country, Australia, concentrates almost all its exports on the United States and Japan, while Jamaica concentrates almost all its exports on the United States, Norway, and the United Kingdom. In the background for this trade pattern may lie the integration in the aluminum industry.

Fig. E-5 Development of World Alumina Production and Exports



* 1966
Source: MS

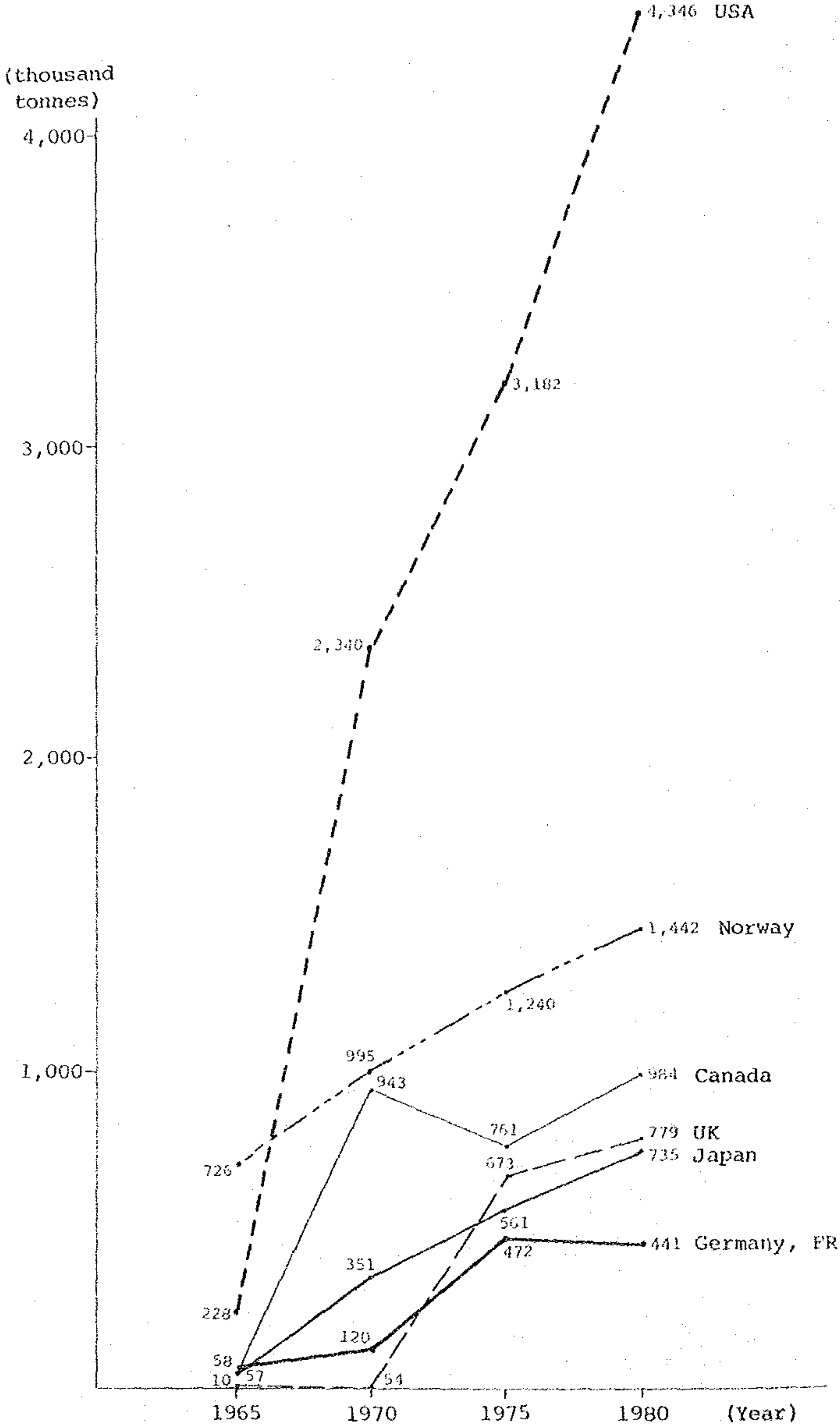
Fig. E-6 Development of Exports of Alumina by the Major Exporting Countries



* Estimated

Source: MS

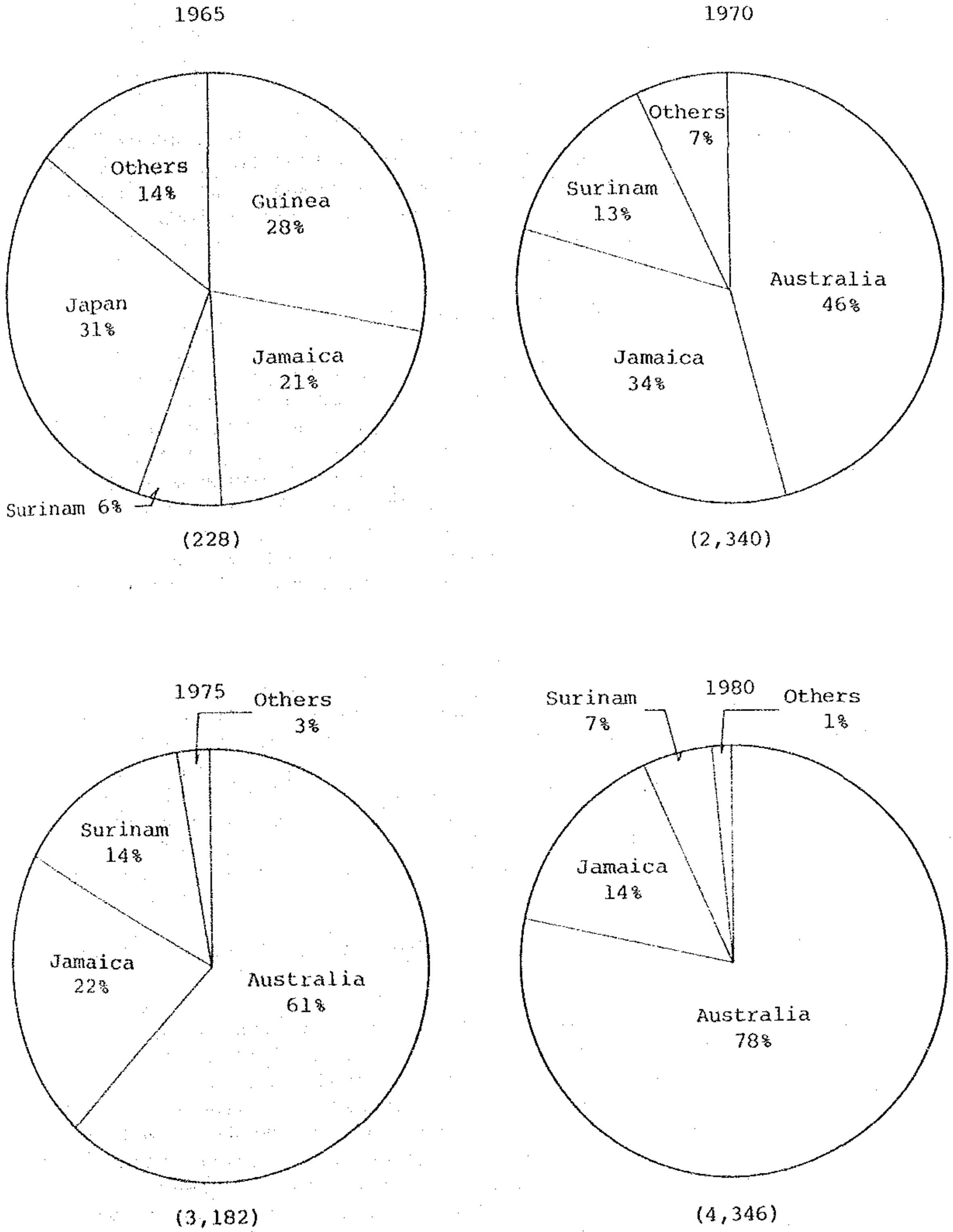
Fig. E-7 Development of Imports of Alumina by the Major Importing Countries



Source: MS

Fig. E-8 Development of the Sources for USA Alumina Import

(1,000 tonnes, %)



Source: MS

Reference Fig. E-2 shows the flow of world trade in aluminum in 1980.

3. Aluminum

World aluminum production as shown in Fig. E-9 increased by about 2.4 times from 6.6 million tonnes in 1965 to 16 million tonnes in 1980. World exports, just like the increase in aluminum production, increased by about 2.3 times from 1.7 million tonnes in 1965 to 3.9 million tonnes in 1980.

3.1 Aluminum Exporting Countries

Presently, the major exporting countries are Canada, the United States, and Norway. However, as shown in Fig. E-10, the ups and downs of Canadian and American exports are quite large. Since 1975 some export oriented countries, like Norway and Canada, in the developing countries have joined the world aluminum producers. They include Ghana, Venezuela, Bahrain, the United Arab Emirates, etc. The volume of exports from each country is small but when combined these countries are estimated to have exported over 500,000 tonnes in 1980. And it is believed to increase rapidly in the future.

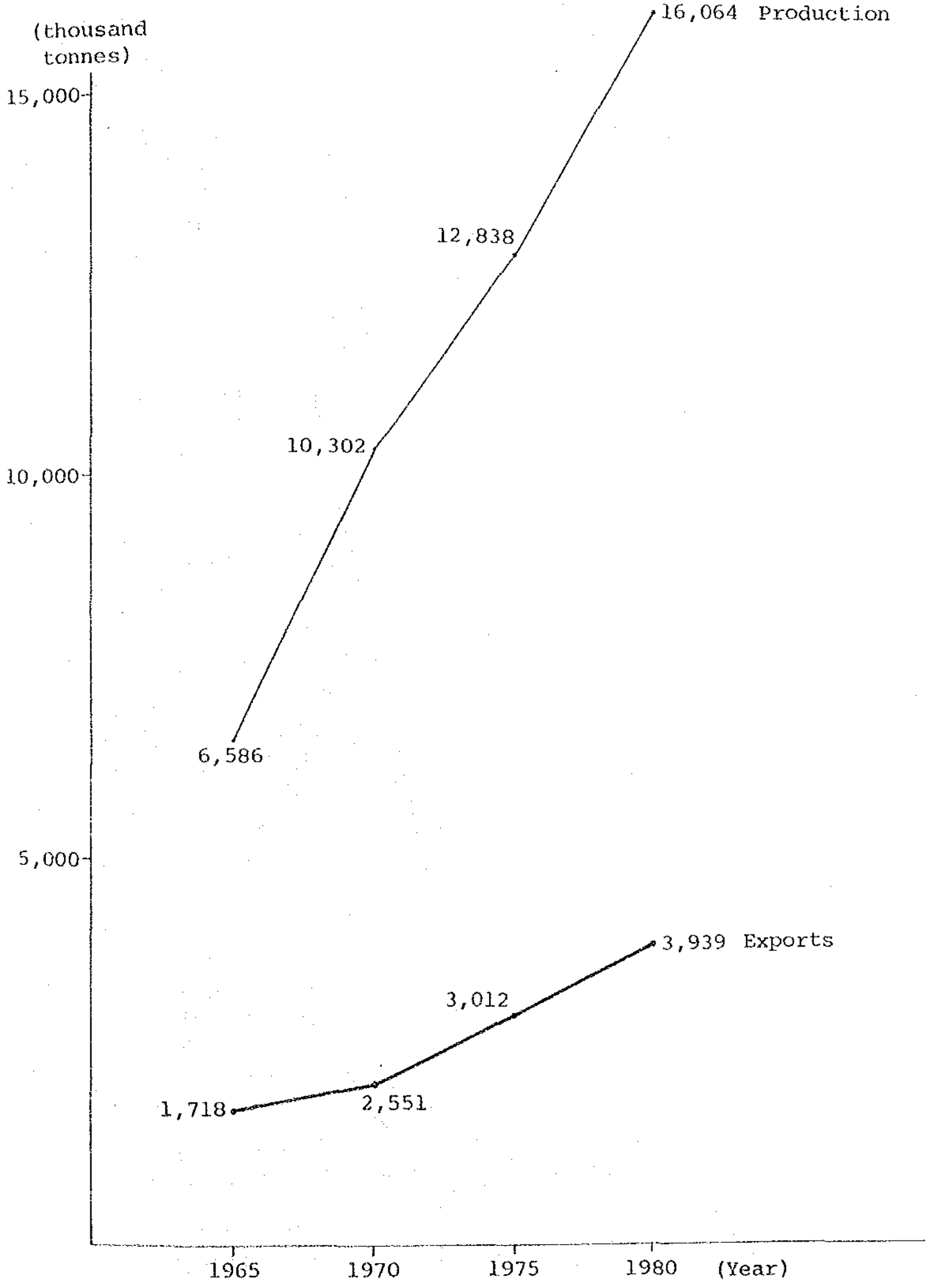
3.2 Aluminum Importing Countries

The major aluminum importing countries are Japan and the EC countries. As shown in Fig. E-11, between 1965 and 1980, the rapid increase of Japanese imports is conspicuous. The development of import sources in terms of the share for Japan, the biggest importer, as shown Fig. E-12 shows a notable diversification among the sources since 1970. In particular, the increase of imports from the developing countries discussed in the above subsection has been obvious.

Reference Fig. E-3 shows the flow of world aluminum trade in 1980.

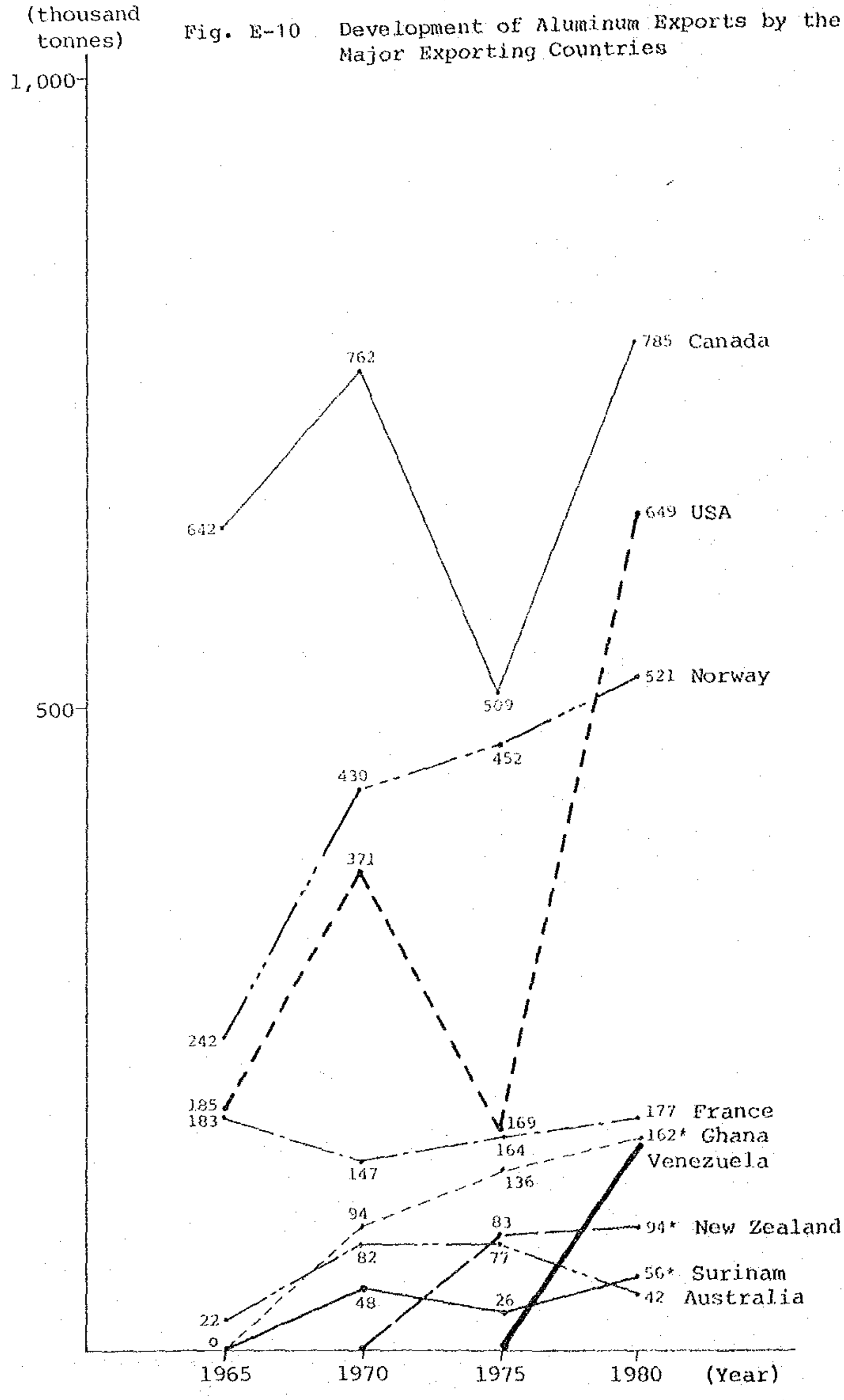
In summary, the flow of aluminum is quite free. A free market is formed for aluminum trade, flowing from the non-consuming countries and producing countries with small consumption to the consuming countries. But trades of bauxite and alumina are mostly carried out among specific countries, being integrated within framework of the Major Producers and evidently their trades do not form markets for the transaction of commodities. However, included in such flows is the fact that an integration is based on the long term competitiveness as shown in development of the U.S. import sources.

Fig. E-9 Development of World Aluminum Production and Exports



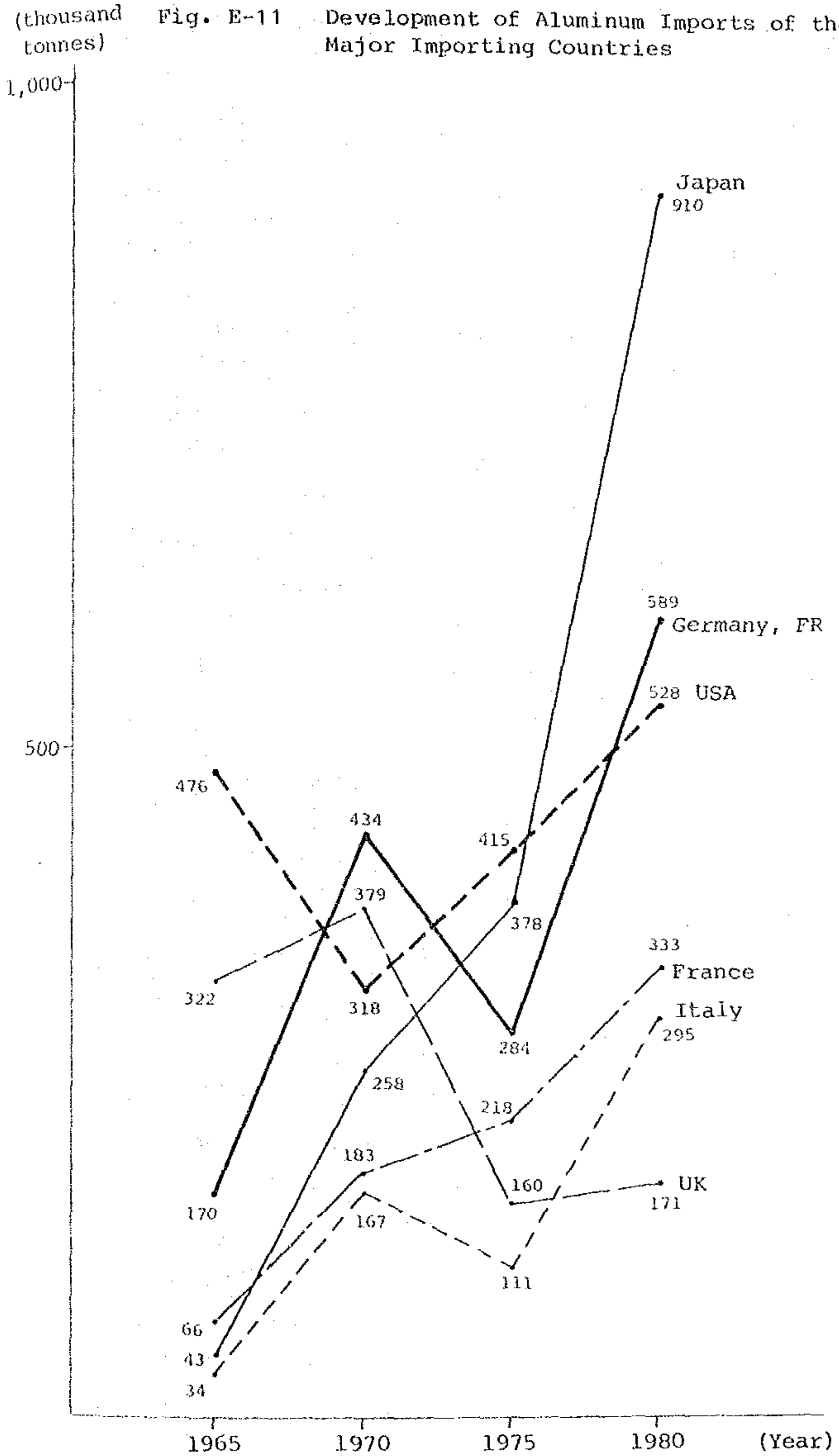
Source: MS

Fig. E-10 Development of Aluminum Exports by the Major Exporting Countries



Source: MS

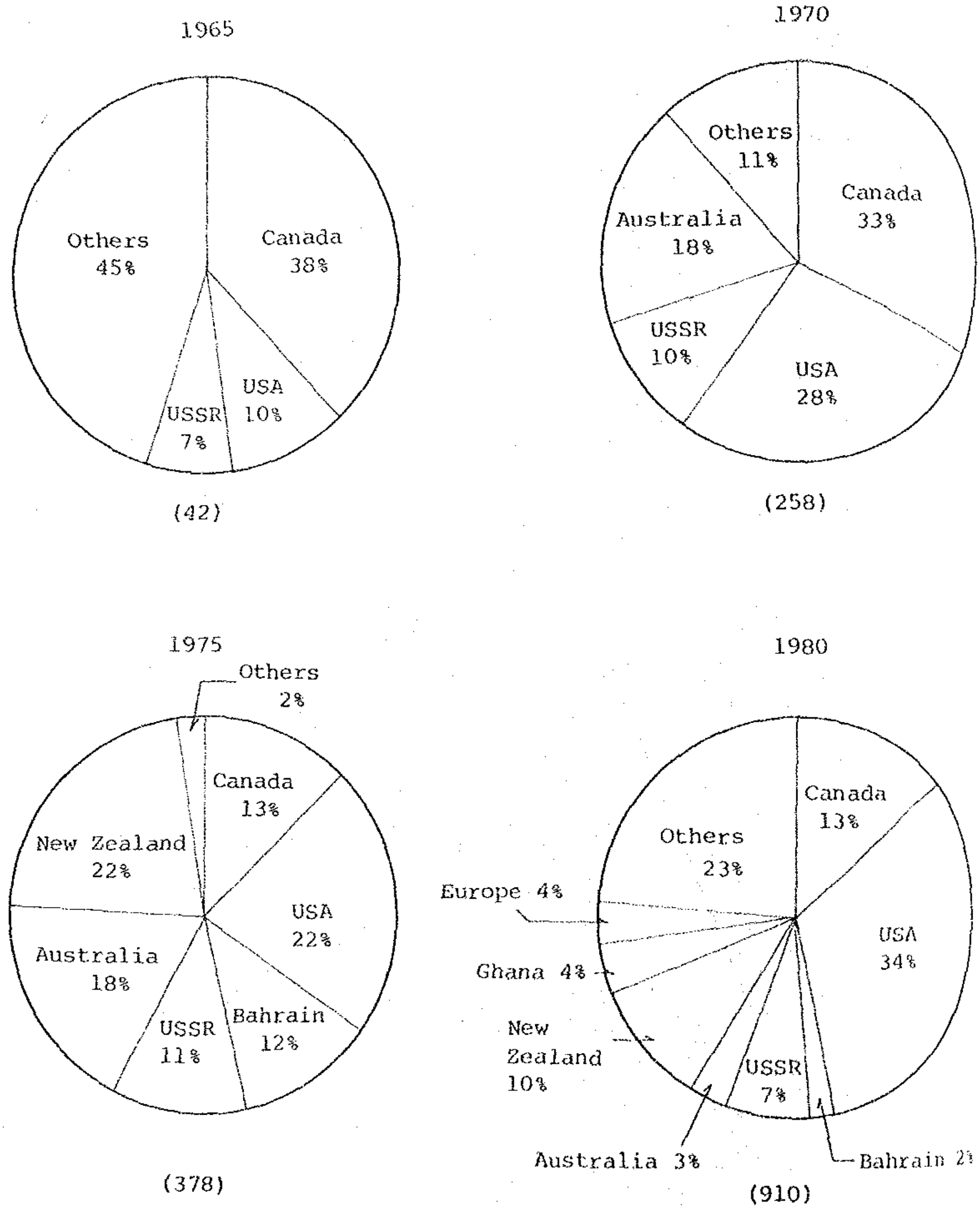
Fig. E-11 Development of Aluminum Imports of the Major Importing Countries



Source: MS

Fig. E-12 Development of the Sources for Japanese Aluminum Imports

(1,000 tonnes, %)



Source: MS

II. Actual Conditions of International Transactions

1. The Forms of International Transactions

International trades as explained in the previous chapter may roughly be classified into the following three systems in terms of transaction form.

The first is the development contract (import-export), in which the right to purchase the product is obtained either by equity participation (share holding or fund contributions) in or by provision of technical assistance and others to the partner country's project. All of the Major Producers integration is based on this method. Under this system the sale price is usually cost-based.

The second is the long-term contract. The long-term contract, without development assistance to the partner country as above, is purchase and sales contracts for products covering long-term period of, say, 3 to 10 years. There is no fixed formula for the price determination.

The reason, as already explained, bauxite and alumina do not form markets as normal trading commodities is that the two contract systems as mentioned above account for most of these trades. According to IBA estimation, 85-90% of the bauxite and 80-85% of the alumina are consumed by the producers, consortia or their affiliated companies under the said two types of contracts.

The third is spot transactions. The primary and secondary aluminum is often traded this way. Since the price and volume vary according to market conditions, actual conditions are difficult to fully understand but this type of spot transaction seems to have been gradually increasing recently.

One unique role of international trade is played by Japanese trading companies. Although they are not producers, they participate in projects and assume the function of regulating many types of transactions.

2. Prices

Aluminum prices were already discussed and the actual level of bauxite and alumina prices will be roughly examined.

2.1 Bauxite

Before the 1970s, the majority of bauxite was under the control of the Major Producers and traded under long-term supply contracts with a set formula. However, to meet the rise of costs prices seem to have been reviewed about every two to five years.

However, since early the 1970s the countries possessing resorces have become more aware of their own resources and this has brought about changes in bauxite prices as well. These changes were mainly brought about by the International Bauxite Association (IBA), which recommended to link bauxite price to aluminum price. The price the IBA is recommending now is the CIF price, referring to the primary aluminum price as appears in the American Metal Market (AMM) and according to their December 1980 recommendation the 1981 minimum reference price for metallurgical grade bauxite is 2% of the price for the primary aluminum. 1)

Thus, if the countries possessing resources come to have higher and higher interest in the matter in the future and act jointly, bauxite prices may tend to increase as a whole.

Within the IBA, however, there is still room for further discussion on such a uniform price system. At present, the uniform price is not necessarily implemented. The key for pricing is competitiveness among the sources after all and the present method employed for determining prices is typically based on the long-term formula which incorporates costs and quality, reflecting its characteristic as a base material for aluminum. Table E-1 shows the recent level of bauxite prices.

2.2 Alumina

The IBA recommends a price for alumina just as it does for bauxite. The recommended level of the price is 16-19% of the primary aluminum price on a CIF basis.2)

However, the alumina on which the IBA has influence is limited in volume. Actual alumina prices seem to be determined mostly between buyers and sellers on an individual basis. Methods for determining the price are believed to be based either on the price sliding formula linked to the primary aluminum price or on the cost-linked formula with an escalation clause (for energy

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1) The U.S. domestic list price for the primary aluminum is quoted in the American Metal Market. The list pirce as at October 1982 is 76 ¢/LB ($1,675/T) and 2% of this is $33.50/T.

2) If $1,675/T for a primary aluminum price as in the above footnote (1) is used, this would be $268 to $318.

Table E-1 Average Bauxite Trade Values, 1970-1980 a)

(US$ per tonne)

Exporter	Importer	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
CIF Values at Importer:												
Jamaica	USA b)	10.74	10.63	11.23	11.06	11.23	21.44	19.72	25.25	22.58	32.92	32.29
Surinam	USA	10.55	11.19	12.25	11.95	12.03	21.46	22.67	23.44	32.28	34.94	41.46
Guinea	USA	4.71	5.22	-	8.40	9.16	12.83	18.60	19.95	29.05	28.09	33.06
Guinea	France	-	-	-	13.26	14.69	18.29	26.03	26.24	28.29	37.72	38.53
Guinea	Germany, FR	-	-	-	11.34	17.01	18.81	24.12	28.45	29.14	34.11	40.22
Australia	Japan	9.66	9.66	9.97	10.63	13.41	14.03	15.73	16.32	18.66	19.72	23.54
Australia	Italy	-	-	10.75	11.30	10.86	12.78	16.19	22.18	29.99	28.58	37.25
FOB Values at Exporter:												
Greece	average	7.69	7.76	8.01	8.43	9.58	12.79	15.70	15.95	16.83	17.83	21.07
Yugoslavia	average	9.30	16.10	11.28	14.38	17.10	25.66	31.82	33.51	36.90	n.a.	n.a.
Brazil b)	average											
All sources, average c)		10.74	10.82	11.49	11.20	11.60	20.34	23.77	25.32	27.30	26.35	n.a.

a) Incomplete data for other countries from Min. J., Jan. 5, 1979; Guyana -- average value of exports to USA (including significant quantities of calcined bauxite -- about US$70/tonne in 1978; Dominican Republic -- value of imports in USA US$33.44/tonne in Oct. 1978; Ghana -- average CIF value of bauxite imported into the UK was US$28.50 in 1978; Sierra Leone -- CIF value of exports to USA in Oct. 1978 was US$21.66/tonne.

b) Exports from the Trombetas bauxite project, which began in 1979, were reported to be "competitive" at that time at US$22.34 per tonne FOB Trombetas (MW OCT. 2, 1978). According to a Brazilian newspaper "Relatorio Reservado" (2-8 Nov. 1981) the price of bauxite sold was about US$30/tonne in mid 1981 (MB June 19, 1981).

c) Data from U.S. Bureau of the Census, U.S. Statistical Abstract.

Source: AME

cost, caustic soda cost, price index, wage index, etc.), but actual methods are not very clear. However, even if the price is to follow the pirmary aluminum price, the actual records show that they are not as high as the IBA recommends.

With alumina the spot deal is occasionally observed. Because alumina is difficult to store, it is very readily put on spot market for sale in case of relative oversupply due to the reduced consumption. At the same time, it seems that some producers are counting on the spot market. The price level of such spot transactions fluctuates depending on market conditions. Recently, barter deals of alumina for the primary aluminum have been increasing. Table E-2 shows the level of recent alumina transaction prices.

3. Seaborne Trade

Bauxite and alumina are one of the five major dry bulk commodities in world seaborne trade. In 1980 the volume of trade was 48 million tonnes, accounting for 6% of the volume of the said commodities.[1] Table E-3 shows the volume of bauxite marine transport classified by loading and unloading regions. The volume shipped from the Americas to North America was 14 million tonnes, by far the largest in the Table, reflecting the bauxite trade flow previously explained. Second largest was from Australia to North America, Europe and Japan with 4 million tonnes each.

In terms of the size of ship, transport by ships under 40,000 DWT accounted for 61% of the total volume of marine transport, 40,000-60,000 DWT ships 21% and 60,000-80,000 DWT ships 18%. Though the marine transport cost per unit as has already been seen is more advantageous with the large-sized ships, yet large ships serve only small proportion of transport notably. While Panamax type bulk carriers [2] (55,000-65,000 DWT) are assigned for transport from ports

1) Development of marine transport of the five major dry bulk commodities

	1970	1975	1980
Iron ore	247	292	314
Coal	101	127	188
Grains	89	137	198
Bauxite and Alumina	34	41	48
Phosphorus ore	33	38	48
Total	504	635	796
Share accounted for by bauxite and alumina	6.7%	6.5%	6.0%

Source: World Bulk Trade 1980

2) General carriers that can handle grains, coal, etc.

Table E-2 Average CIF Values of Alumina Imports, 1973-1981

(US$ per tonne)

Importer and Exporter	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Imports by USA:									
From - Jamaica	70.46	84.59	136.63	141.88	170.07	187.73	185.19	185.28	232.65
- Australia	66.33	77.27	103.26	113.99	123.06	140.08	157.31	188.10	202.08
Imports by Germany, FR:									
From - Guinea	78.57	103.17	109.73	126.48	137.42	-	154.86	228.22	236.13
- Jamaica	-	82.50	-	117.87	-	143.00	-	-	-
- Australia	82.87	115.82	136.52	136.95	161.62	178.59	194.89	219.04	215.74
Imports by Norway:									
From - Guinea	92.03	111.86	139.43	104.76	-	-	-	-	-
- Jamaica	78.02	96.67	131.05	127.53	157.22	169.43	194.89	221.75	245.40
- Australia	-	107.88	128.17	113.65	131.63	142.10	173.64	234.55	235.57
Imports by Japan:									
From - Australia	65.29	80.78	95.99	117.29	122.62	143.32	160.29	219.26	n.a.

* Annual rate based on the figures for the first 6 months.

Source: AME

Table E-3 Volume of Bauxite and Alumina Marine Transport (1980)

(1,000 MT)

Loading Regions	Unloading Regions: Europe	North America	Japan	Others	Total
Mediterranean Sea	2,490 (-)	5 (-)	11 (-)	19 (-)	2,525 (-)
Africa	6,321 (2,110)	4,453 (1,540)	- (-)	600 (410)	11,374 (4,060)
The Americas	2,713 (610)	14,442 (6,870)	67 (-)	825 (40)	18,047 (7,520)
Asia	358 (-)	288 (-)	1,918 (-)	384 (-)	2,948 (-)
Australia	4,305 (4,150)	3,957 (834)	4,417 (2,390)	500 (50)	13,179 (7,420)
Others	129 (-)	41 (-)	27 (-)	- (-)	197 (-)
Total	16,316 (6,870)	23,186 (9,240)	6,440 (2,390)	2,328 (500)	48,270 (19,000)

The figures in bracket are the volumes of marine transport by ships over 40,000 DWT out of relevant volumes.

Source: World Bulk Trade, 1980

of large bauxite mines of Australia and Guinea, handy-sized ships of 25,000 to 35,000 DWT are used for almost all transport of Caribbean bauxite and world alumina transport, resulting in the proportions as seen above. The ships assigned for transport of Brazil's Trombetas bauxite bound for the U.S. Gulf Coast are comparatively small with 25,000 to 35,000 DWT class.

Marine transport contracts are usually based on the time-charter system of bulk carriers under contracts of affreightment (COA). Since alumina and bauxite have a large storage factor, low transport cost can be enjoyed with ships of minimal hull structure. In Japan for example, in the 1970s ships over 400,000 tonnes of carriers were specially assigned for bauxite transport.[1] The said

1) The stowage factor is a factor of the volume needed to hold one weight tonne. Some presentative standard factors for dry bulk commodities are as follows:
Iron ore - 15; Coal - 42; Bauxite - 32; Alumina - 38; Grains - 50; and Aluminum ingots - 20.

type of contracts, COA, may worth examining when large-volume of transport is constantly assured.

The same type of economic investigation is possible for aluminum ingots. It is easier to reduce transport rate with trampers under COA contracts than with normal liner boats (general cargo ships or container ships) under freight conference contracts of relevant countries. Gantry type ships and roll-on roll-off type ships are more advantageous for efficient loading and unloading operation of aluminum ingots and these special types of ships have alreary been put in service for transport of aluminum ingots bound for Japan.[1] However, when using these types of special ships, overall evaluation of the economics of the new system is necessary including preparation cost of the matching equipment to the system at the relevant ports.

The charter of the UN Convention on a Code of Conduct For Liner Conference published in 1974 sets the target ratio of loading amount among exporting countries, importing countries and third party countries at 4:4:2 respectively. For seaborne transport the realization of international cooperation which will support stable as well as internationally competitive transport is highly desirable.

III. International Organizations and Their Roles

In the aluminum industry there are various groups as international organizations. The representative ones are as follows.

USA	The Aluminum Association (AA)
Europe	Organization of European Aluminium Smelters (OEA)
Japan	Japan Aluminium Federation (JAF)
World Smelter's Organization	
	International Primary Aluminium Institute (IPAI)

The materials published by these groups such as statistical information and annual reports are regarded highly reliable and are used all over the world. However, all of these groups' main purpose is to exchange information, to collect statistical information, etc. and they are not engaged in any activities like cartel.

To the contrary the International Bauxite Association (IBA) established in March 1974 is an international resource cartel orga-

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1) A gantry type ship is a ship equipped with cranes that can load and unload unitized cargo. A roll-on roll-off type ship is the one trailers and trucks can directly move into the hold for loading and unloading.

nized by bauxite producing countries, led by the developing countries with their growing resource nationalism, after OPEC and CIPEC. The original members on establishment were seven countries, Jamaica, Sierra Leone, Surinam, Guyana, Guinea, Yugoslavia and Australia (as an observer). Afterwards, four countries, Haiti, the Dominican Republic, Ghana and Indonesia, have joined the association, bringing the total number of members to eleven. According to the IBA statistics as shown in Table E-4, production by all the member countries in 1980 accounted for over 70% of the world total production and over 80% of the free world total production, a production scale whose influence cannot be ignored.

Needless to say, the basic purpose of the IBA is the realization of economic nationalism under the guiding principle of revising the existing terms of trade in its favor.

Thus, its ultimate purpose is to dominate prices completely by realizing a uniform price for bauxite shortly after its establishment the IBA has actively turned offensive led by Jamaica. Examples of this activity are the success in establishing a minimum sale price for the North American market, the introduction of a production levy, etc.[1]

The development of the minimum reference price for metallurgical grade bauxite quoted by the IBA is as follows.

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1) The nationalist movements of the major bauxite producers around the time of the IBA establishment were as follows.

Ghana : The only Ghanian bauxite mining operation in the Awasco region was wholly owned by British Aluminium up to 1974. Then the Ghanian Government has acquired 55% of the share and the company is now called the Ghana Bauxite Co.

Guinea : Fria-Kimbo bauxite is of low quality and is exported in the form of alumina. The deposit was developed by Pechiney under the former colonial government, but in 1973 the Guinea Government purchased 49% of the shares and the deposit is now managed on a consortium basis. The Guinean Government holds 49% of the equity in the consortium that developed the world-foremost Boke deposit by participating in the project from the planning stage. The Kindia deposit developed with a Russian aid is 100% owned by the government.

Jamaica: In 1974 the Jamaican Government imposed a heavy tax on all bauxite and alumina companies in operation and worked out plans to acquire 51% of the shares of each company. Presently the Jamaican Government owns 51% of the shares in the bauxite business of Kaiser and Reynolds, 7% of ALCAN's and 6% of ALCOA's bauxite and alumina businesses.

Table E-4 World Bauxite Production, 1975-1980

(1,000 MT)

	1975	1976	1977	1978	1979	1980	Share in world total in 1980 (%)
IBA member countries							
Australia	21,003	24,085	26,086	24,293	27,583	27,178	29.5
Dominican Rep.	785	516	722	757	521	510	0.6
Ghana	325	268	235	340	251	197	0.2
Guinea	8,406	11,316	10,871	11,648	12,199	13,311	14.5
Guyana	3,828	3,108	3,344	3,479	3,354	3,052	3.3
Haiti	522	660	588	565	560	461	0.5
Indonesia	993	940	1,301	1,008	1,093	1,249	1.4
Jamaica	11,380	10,296	11,433	11,736	11,505	11,991	13.0
Sierra Leone	716	660	745	716	680	746	0.8
Surinam	4,751	4,588	4,951	5,113	4,741	4,864	5.3
Yugoslavia	2,306	2,033	2,044	2,566	3,012	3,138	3.4
Total IBA	55,015	58,470	61,720	62,221	65,499	66,697	72.5
IBA's Share in World Total (%)	71	73	73	74	75	72	
Other countries							
Brazil	969	998	1,040	1,131	1,642	4,152	4.5
France	2,563	2,330	2,059	1,978	1,970	1,892	2.0
Greece	3,006	2,551	2,882	2,630	2,915	3,286	3.6
Hungary	2,890	2,918	2,948	2,899	2,976	2,900E	3.1
India	1,274	1,449	1,508	1,282	1,934	1,740	1.9
Malaysia	704	660	616	615	387	920	1.0
USA	1,800	1,989	2,013	1,669	1,752	1,617	1.8
USSR	6,600	6,700	6,700	6,700	6,500	6,500E	7.1
Others	2,282	2,395	2,509	2,395	2,242	2,300E	2.5
Total Other Countries	22,088	21,990	22,587	21,393	22,318	25,307	27.5
World Total	77,103	80,460	84,307	83,520	87,817	92,004	100.0

Source: IBA Quarterly Report

Year	Terms	Price
1976	FOB	$15-20/T
1977-78	CIF	$24/T (for North America)
1979-	CIF	2% of the aluminum price listed in AMM

However, the said moves of the hardliners led by Jamaica have brought about a loss of competitiveness and the customer's aversion, having slowed down their exports to the North America and helped to increase the export rapidly from moderate countries led by Australia. Recently, Jamaica has been forced to take such measures as reducing its levy and so on and the previous hardline policy is gradually giving way.

Though the IBA is a resource cartel, the situation of each member country is quite different. And additionally in view of the fact bauxite is a resource of rather over supply, it may not be certain whether the IBA will be able to realize the objective through its activities in the future.

IV. The Policy of the Major Countries

1. Import Policy in the Major Consuming Countries

The main bauxite, alumina and aluminum consuming countries are all developed countries. In order to assist the expansion of those exports from the developing countries, the General System of Preferences (GSP) 1) has been implemented, while exempted from the provisions of the GATT. In particular, effective from the Tokyo Round of the multilateral trade negotiation in 1979, the developed countries can at its own decision extend the GSP system without limit.

At present the major bauxite consuming countries including the United States, the EC countries, Japan, and Canada levy no import tariff on bauxite. The United States, Japan, and Canada also levy no tariff on alumina, while the EC countries employ the tax rate of the most-favored nation treatment agreed at the Tokyo Round. Canada levies no tariff on aluminum ingots (except alloys), while the

1) The most-favored nations treatment provision of Clause 1 of the General Agreement on Tariffs and Trade (GATT) stipulates that trade must be conducted without discrimination. The specially-favored tariff system is a violation of this aim.

United States, the EC countries and Japan employ the tax rate of the most-favored nation treatment. And the United States levies no tariff on aluminum from specially-favored nations. In addition, these countries have no non-tariff barriers such as import quota. Reference Table E-1 gives the details of these major countries' GSP systems.

Thus, presently the advanced countries give most-favored nation or specially-favored nation treatments to bauxite, alumina and aluminum imports so there are no special barriers for entry of the developing countries into the market.[1)]

This may reflect the fact that there is no need to create intentional trade barriers, since the huge amount of investment and difficult development work required will naturally consitute the barriers for the developing countries to enter into the aluminum industry.

2. Enticement Policy for the Aluminum Industry

Those countries that intend to develop their aluminum industry have prepared various incentives for investment in their countries. These policies vary in their forms of enticement, but basically all of these favors are aimed at attracting foreign investment to their countries and at the development of their domestic industry. In Australia such incentives are included in the ordinary laws, while in Indonesia the incentives are given under the specially prepared agreement based on a new enactment for the aluminum development project.

Among the incentives of various countries the tax incentives are by far substantial, followed by governmental assistance to infrastructure, reduction or exemption of import duties on the project equipments and many other incentives. Table E-5 lists up actual examples of various projects Japan has so far participated. The main points are as follows.

2.1 Australia

Australia is the biggest producer of bauxite and aluminum in the world but its primary aluminum production is still small. Because of this, the Australian Government, which is eager to see a higher level of processing (primary aluminum production) and the

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1) The UNCTAD report states: "The available evidence suggests that tariffs and non-tariff barriers are not a major constraint for the expansion of developing country exports of processed aluminum products". (Extracted from p.30 of the UNCTAD Report)

Table E-5 Incentives in Major Countries

	Australia Boyne Smelters Ltd.	New Zealand New Zealand Aluminium Smelters Ltd.	Indonesia PT Indonesia Asahan Aluminium (INALUM)	Venezuela Industria Venezolana de Aluminio C.A. (VENALUM)
Tax System	1) Corporate tax a. Investment allowance (20%) b. Accelerated depreciation	1) Corporate tax a. Specially-favored tax rates lower than those normally applied to foreign corporations are applied, for 25 years from the commencement of operation, to operations income arising from foreign corporate's participation in "Special Development Projects". b. The net tax at the home country's tax rate is levied on interest income of non-resident investors, arising from loan to the project. c. Accelerated depreciation	1) Corporate tax a. A reduced 37.5% tax rate is applied for 30 years after commencement of operations (normal rate; 45%) b. Losses for 3 years after commencement of operation may be carried over unlimitedly. Losses afterwards may be brought forward for 4 years. 2) Withholding tax Interest on loans from Japanese governmental financial organizations and the Indonesian Government is exempt from withholding taxation. And tax rates on interest, dividents and royalties are reduced to half of the normal rates applicable. 3) Personal income tax Foreigners employed under the development plan or providing services for it are entitled to	1) Corporate tax Based on the export encouragement legislation, those part of the FOB export amount which is attributable to the value added in Venezuela is proportionately credited against the corporate tax.

Table E-5 (cont'd.)

		2) Withholding Tax In place of withholding taxation the tax as explained in 1)-b above will be applied to interest received from the development project by non-resident investors.	a 50% tax reduction for 10 years after commencement of operation. 4) Sales tax The tax on sales connected to construction contracts is reduced to 1/10 of its normal rate (5%). 5) Local taxes and other taxes Complete exemption from regional taxes and other taxes (except ship transfer taxes and stamp duties). 6) Others For 4 years after making investment 5% of the invested amount will be shielded by tax as expenses.	
Tariffs	1) The tariff on imports of equipments that do not compete with domestic products is reduced from 15% to 2%.	1) Tariffs on imports of equipment and raw materials are reduced or exempted.	1) Except passenger vehicles, trucks, office equipments and raw materials other than alumina for production of domestically sold aluminum no tariffs will be levied. However, items that compete with domestic products are to be negotiated.	1) Tariffs are reduced or exempted on equipments and raw material imports.

Table E-5 (cont'd.)

	Australia Boyne Smelters Ltd.	New Zealand New Zealand Aluminium Smelters Ltd.	Indonesia PT Indonesia Asahan Aluminium (INALUM)	Venezuela Industria Venezolana de Aluminio C.A. (VENALUM)
			2) Raw materials other than alumina are exempt from taxation for 2 years after commencement of operation. Afterwards, such portion of the said materials as will be used for production of domestically sold aluminum will be subject to taxation. 3) Foreign employees may import daily necessities worth $50/month/person or $100/month/family duty-free.	
Infra-structure	1) Some of the housing for employees are built by the state government. 2) The state government provided services such as roads, water supply, and sewage preparations.	1) Government asistance: .Construction of employee housing .Warf preparation .Road preparation .Establishment of communications and water supply facilities	1) The government purchased the land, executed regional policy and constructed roads.	1) A regional development corporation established by the government constructed roads and cities and provided services in the area around the plant.

Table E-5 (cont'd.)

Others	1) Confirmation by the government authority to assure foreign exchange relationg to the project.	1) Comprehensive import permits for equipments and raw materials. 2) Confirmation by the government authority to assure foreign exchange control on overseas procurement and investment of construction fund and working capital (equity, loan).	1) The accounting is permitted to be expressed in U.S. dollars. 2) A development coordination authority has been established under direct presidential control to coordinate and facilitate overall project development.

development of the fabrication field domestically, has prepared various incentives including an enticement policy under the ordinary laws, tax favor, infrastructural development assistance and other.

2.2 New Zealand

The New Zealand Government concluded agreements with the investors for the development of aluminum smelting plants and has offered favorable tax treatment inclusive of one under the ordinary law and infrastructure provision in anticipation of obtaining the foreign currency and creating stable employment opportunity.

2.3 Indonesia

The Asahan project in which the Indonesian Government holds 25% of the equity is a large-scaled national project that includes construction of power station, roads, harbors, and towns. And various detailed measures are arranged reflecting such a scheme. The Asahan project is carried out in a country in which investment climates are not necessarily favorable. And it is a good example of the fact that powerful government assistance is necessary in the said circumstances.

2.4 Venezuela

The Venezuelan Government, along with its policy of nationalizing and Venezuelanizing basic industries, holds 80% of the shares of Venalum and manages it. Few privileges are granted solely to Venalum but it is entitled to the incentives under the industrial and export encouragement policies.

That these incentives may naturally differ among countries depending on each country's political and economic conditions and on the level of its expectation for and evaluation of the project. For example, a government that definitely desires to entice the aluminum industry may have to prepare quite substantial incentives in order to change the minds of reluctant investors.

For investors, however, the most important matter is the long-term stablility of those policies. The Australia's strong competitiveness are based not only on energy and resources but also on the stability of its policy.

Reference Table E-1 The General System of Preferences in the Major Countries for Bauxite, Alumina and Aluminum

The following are the tariff rates and special tariff rates in the major consuming countries, USA, the EC, Japan and Canada.

(1) USA

Table 1 Tariff rates before and after the Tokyo Round

Tariff code	Description	1976 imports (thousands of US$)		Tariff rate (%)		
		Total trade	Developing country share (%)	Pre-Tokyo	Post-Tokyo	GSP rate
260152117	Bauxite, calcined	25 398	95.9	0.0	0.0	..
260160106	Crude bauxite	304 238	100.0	0.0	0.0	..
760161801	Unwrought aluminum	50	0.0	3.2	2.6	..
760161802	Unwrought aluminum, Mes	207 034	22.6	2.7	0.0	..

Table 2 Details of the aluminum tariff rates

GSP	Item	Stat. Suf-fix	Article	Units of quantity	Rates of duty 1	Rates of duty LDDC	Rates of duty 2
			Unwrought aluminum:				
	618.01	00	Of uniform cross-section throughout its length, the least cross-sectional dimension of which is not greater than 0.375 inch, in coils..	lb...	3% ad val.	2.6% ad val.	18.5% ad val.
			Other:				
A	618.02	00	Aluminum other than alloys of aluminum	lb...	0.6¢ per lb	Free	11% ad val.
			Alloys of aluminum:				
	618.04	00	Aluminum silicon .	lb...	2.4% ad val.	2.1% ad val.	25% ad val.
A	618.06		Other	.....	0.6¢ per lb	Free	10.5% ad val.
		10	Beryllium aluminum master alloy ..	lb			

Reference Table E-1 (cont'd.)

GSP	Item	Stat. Suf-fix	Articles	Units of quantity	Rates of duty 1	LDDC	2
A	618.06	30	Other .... Of uniform circular cross-section throughout its length, not in coils	lb			
		50	Other	lb			
A	618.10	00	Aluminum waste and scarp	lb...	2% ad val.		16% ad val.

USA gives no-tariff favors to specially-favored countries or beneficiary developing countries. The items which are entitled to this treatment are those marked "A" in the GSP column of the Table 2 above.

The criteria for recognizing the place of origin is whether the added value exceeds 35%. Furthermore, the least-developed developing countries are specified and these countries are entitled to the rates shown in the LDDC column in Table 2.

To the planned eonomy countries the rates shown in column 2 of Table 2 are applied, while to the other countries the rates in column 1.

(2) The European Community Countries

Table 3 Tariff rates for bauxite, alumina and aluminu before and after the Tokyo Round

Tariff code	Description	1976 imports (thousand of US$) Total trade	Developing country share (%)	Tariff rate (%) Pre-Tokyo	Post-Tokyo	GSP rate
26019300	Ores, other than iron and uranium	1 730 472	42.0	0.0	0.0	..
28201000	Aluminum hydroxide	165 980	54.5	8.8	5.7	..
76011000	Unwrought aluminum	704 801	12.4	7.0	6.0	..

Reference Table E-1 (cont'd.)

Table 4 Details of the aluminum tariff rates

Heading number	Description	Rate of duty Autonomous (%)	Conventional (%)
1	2	3	4
76.01	Unwrought aluminum; aluminum waste and scrap:		
	A. Unwrought	10	6.6
	B. Waste and scrap:		
	1. Waste		
	a) Turnings, shavings, chips, milling waste, sawdust and filings; waste of colored, coated or bonded sheers and foil, of a thickness (excluding any backing) of 0.20 mm or less ...	Free	2.4
	b) Other (including factory rejects)	5	3.7
	2. Scrap	Free	Free

To imports from GATT member countries and those countries that have concluded treaties with the EC, the "conventional" rates shown in column 4 are applied, but in case the "autonomous" rates in column 3 are lower, they are applied. However, the special autonomous customs duties or the preferential customs duties will prevail over them, when applicable.

(3) Japan

Table 5 Tariff rates for bauxite, alumina and aluminum before and after the Tokyo Round

Tariff code	Description	1976 imports (thousands of US$) Total trade	Developing country share (%)	Tariff rate (%) Pre-Tokyo	Post-Tokyo	GSP rate
2601300	Bauxite & concentrates	74 000	40.1	0.0	0.0	..
2820110	Aluminum oxide	72 524	0.0	7.5	7.5	..
7601112	Pure unwrought aluminum	284 653	31.9	9.0	9.0	0.0

Reference Table E-1 (cont'd.)

Table 6 Details of the aluminum tariff rates

No.	Stat. Code No.	For NAC-CS	Description	Rate of duty: General	Rate of duty: GATT 12/31 '81	Rate of duty: GATT 3/31 '82	Rate of duty: Preferential	Rate of duty: Temporary	Unit
76.01			Unwrought aluminum; aluminum waste and scrap:						
			1. Unwrought aluminum:						
			1) Unalloyed	10%	9%	9%	4.5% free		
	111	0	- Containing not less than 99.9% by weight of aluminum						MT
	112	1	- Containing not less than 99.0% but less than 99.9% by weight of aluminum						MT
	113	2	- Containing less than 99.0% by weight of aluminum						MT
	120	2	2) Alloyed	10%	9%	9%	free		MT
			2. Waste and scrap	(5%)	(1.9%)	(1.6%)		free	

The tariff rates for aluminum oxide or alumina shown in Table 5 are not applied to metallurgical type of alumina, since the domestic law requiring no tax on it is applicable.

The specially-favored tariff rates for aluminum ingots in Tables 5 and 6 are free to the least-developed developing countries and 4.5% to other specially favored nations. There are limits of volume on imports on a specially-favored basis.

Reference Table E-1 (cont'd.)

(4) Canada

Table 7 Tariff rates for bauxite, alumina and aluminum before and after the Tokyo Round

Tariff code	Description	1976 imports (thousands of US$) Total trade	Developing country share (%)	Tariff rate (%) Pre-Tokyo	Post-Tokyo	GSP rate
260132910	Bauxite ore	24 037	75.8	0.0	0.0	..
260192820	Alumina	123 522	6.4	7.5	0.0	0.0
760135301	Aluminum ingots	18 030	2.6	2.2	0.0	0.0

Table 8 Details of the aluminum tariff rates

Description of commodity and foreign tariff item No.	Present rate of duty*	Negotiated rate of duty**
Aluminum and alloys thereof:		
Pigs, ingots, blocks, notch bars, slabs, billets, blooms, and wrie bars (35301-1)	0.8¢ per pound	Free

* Rates currently applicable to imports from the United States.
** Final rates negotiated under the Multilateral Trade Negotiations.

Note : The tariff rates in these tables are shown at the tariff line. Thus, the post-Tokyo Round rates may not match the detailed tariff rates as listed above.

Sources:

Tables 1, 3, 5 and 7 --
UNCTAD, Processing and marketing of bauxite/alumina/aluminium: Areas for international cooperation, Aug. 18, 1981 (TD/B/C.1/PSC/19)

Table 2 -- Tariff Schedules of the United States Annotated, 1982

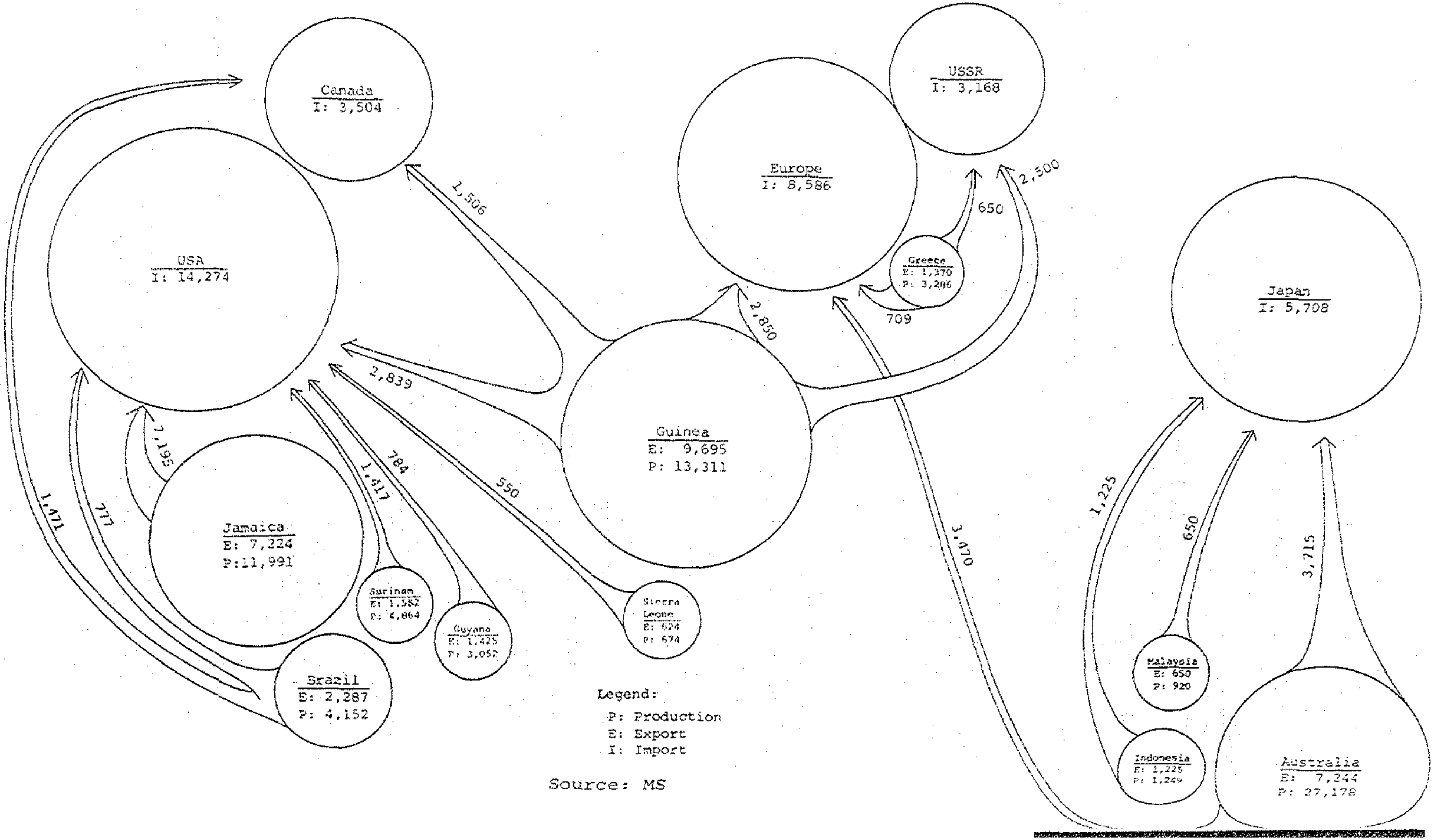
Table 4 -- Official Journal of the European Communities - L335, Nov. 23, 1981

Table 6 -- Japan Tariff Association, Customs Tariff Schedule of Japan, 1981

Table 8 -- United States International Trade Commission, Summary of Trade and Tariff Information - Aluminium, April 1982

Reference Fig. E-1 World Trade Flow of Bauxite in 1980

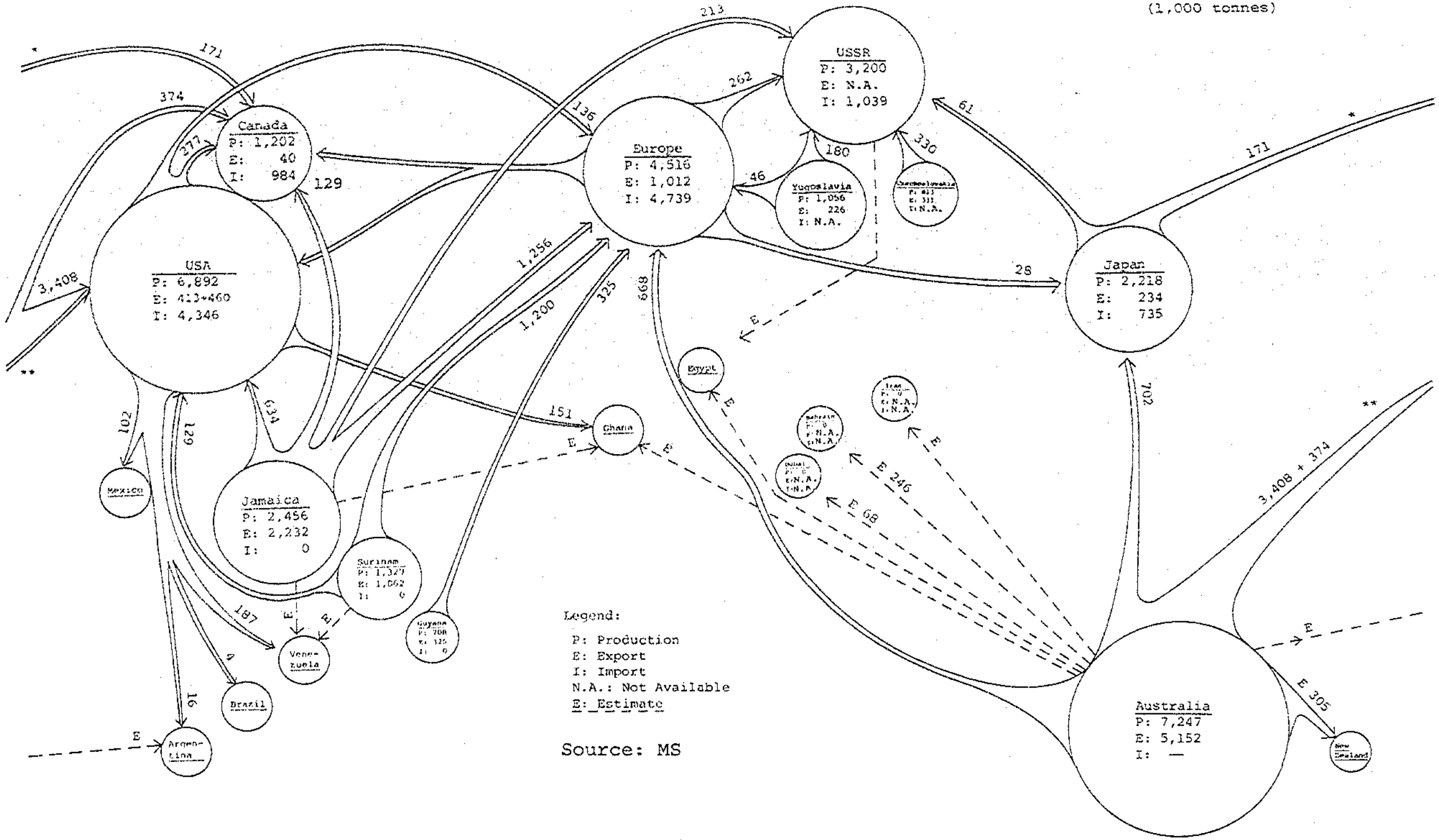
(1,000 tonnes)



Source: MS

Reference Fig. E-2 World Trade Flow of Alumina in 1980

(1,000 tonnes)

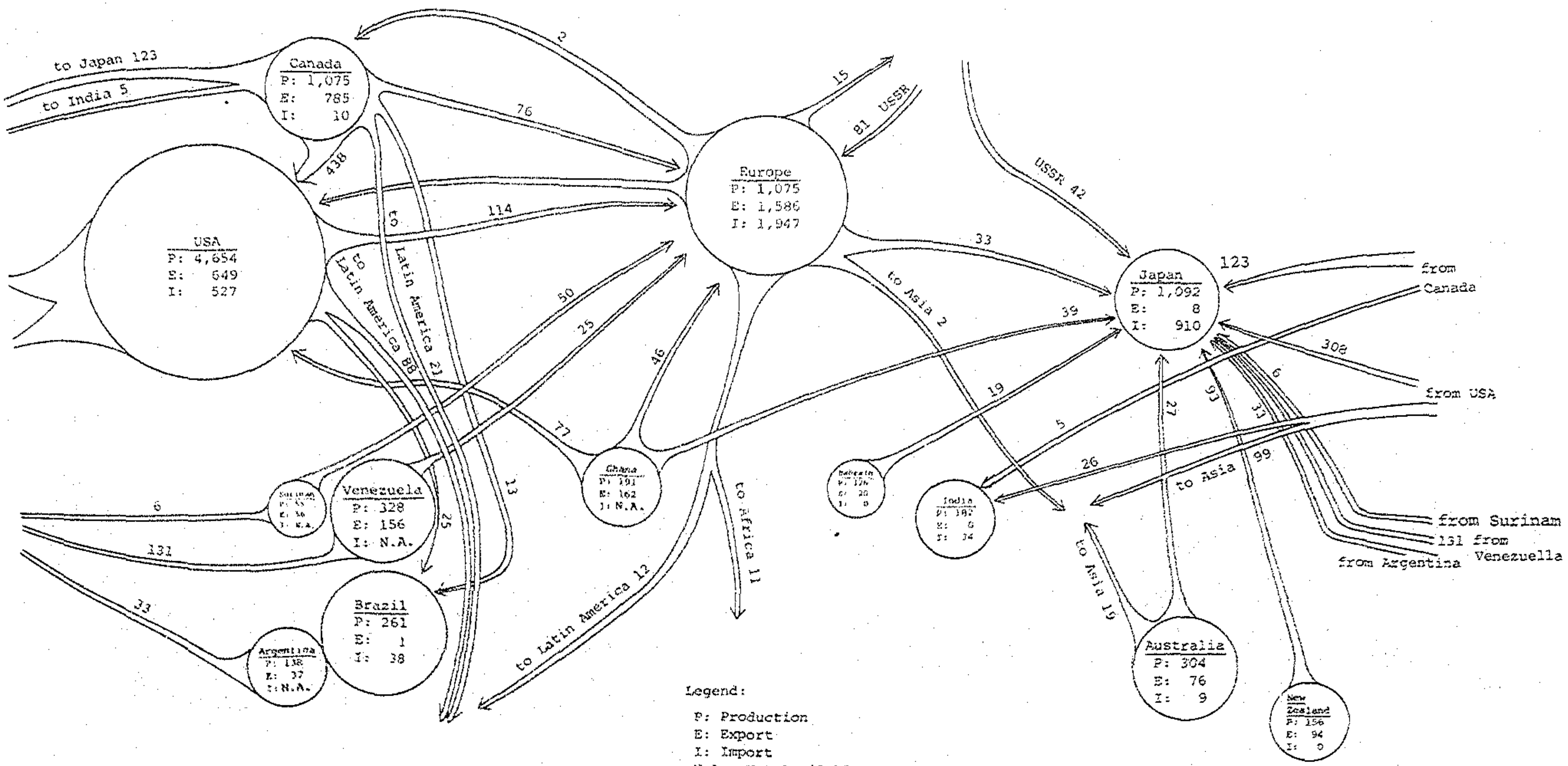


Legend:
P: Production
E: Export
I: Import
N.A.: Not Available
E: Estimate

Source: MS

Reference Fig. E-3 World Trade Flow of Aluminum in 1980

(1,000 tonnes)



Legend:

P: Production
E: Export
I: Import
N.A.: Not Available

Source: MS

F. SUPPLY AND DEMAND PROJECTION

I. Development Plans in the World

1. Outline of Development Plans

As for the development plans for aluminum, alumina and bauxite, trends in the development plans for aluminum smelteres to a large extent dominate the possibility of realizing development plans for bauxite and alumina, because bauxite is the raw material and alumina is the intermediate material for aluminum.

1.1 Situations in Development Plans

Table F-1 gives details on aluminum development plans. Adding up all the plans announced up to the end of 1980 gives a total of about 2.9 million tonnes per year. Based on current smelting capacity, 14 million tonnes per year at the end of 1982,[1)] this is equivalent to the increase in capacity for next 5 to 7 years at an annual rate of 3 to 4%.

1.2 Development Plans and Location

Many developments are planned to locate in the developing countries and Australia. This reflects the aluminum industry's need for long-term, stable and cheap supply of electricity and stable supply of aluminum's basic raw materials, bauxite and alumina.

1.3 The Organization of Projects

Almost all projects for new plant or expansion are organized by consortia (including those with government investment) with some cases of 100% government ownership. This is because enormous funds are required for realizing the projects due to the annual increase of capital cost as well as the fact that, in the developing countries, infrastructure arrangement and electric power development sometimes form integral part of aluminum smelter projects. This also reflects the need for risk hedge etc.

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1) IPAI statistics

2. Development Plans in Each Region

This section discusses the development plans in each region. Details are shown in Tables F-1, F-2, and F-3.

2.1 Latin America

2.1.1 Brazil

(1) Aluminum

Based on rich hydro power sources as well as abundant and high quality bauxite resources in Amazon area, Brazil has as many aluminum projects as Australia. The new Albras and Alumar projects are connected with the plan for the Tucurui power station now in progress in Amazon area and expect to receive the supply of cheap electricity.

(2) Alumina, Bauxite

There are two new alumina projects, Alunorte and Alumar, which are developed in connection with aluminum projects. The possibility of realization and timing of start up for these projects depend on the progress of aluminum projects.

Bauxite development is planned by Mineracao Rio de Norte.

2.1.2 Venezuela

(1) Aluminum

ALCASA and VENALUM have possibility of expanding their smelters subject to the expansion plan of Guri hydropower station, their power supply source.

(2) Alumina, Bauxite

The state company, BAUXIVEN, plans to develop bauxite resources with the initial capacity of 3 million tonnes per year and to supply bauxite to the refinery of Interalumina.

Interalumina will start its operation in 1983 with the initial capacity of 1 million tonnes per year to supply alumina to ALCASA and VENALUM.

Table F-1 Development Plans —— Aluminum

(1,000 MT/Y)

Company (Country)	Expansion/ New project	Company ownership	Capacity	Capital Cost	Start-up Date/ Progress	Remarks
North America						
Canadian Reynolds Metals Co., Ltd. (Canada)	Expansion	100% Reynolds	113		Production start-up scheduled for 1985-86	Present capacity: 159,000 tonnes/year
Howmet Aluminum Corp. (Canada)	New project	100% Pechiney	200		F/S to be completed by the end of 1982. Start up in 1986 (if plan goes ahead)	Final capacity 300,000 tonnes/ year
ARCO Metals (USA)	Expansion	100% Atlantic Richfield (ARCO)	54		1986 start-up scheduled	Supplement for the expansion of own aluminum sheet mill.
Latin America						
Aluar Aluminio Argentino (Argentina)	Expansion	51% Fate 49% Private interests	140		Expansion to 140,000 tonnes/ year completed in 1979. capacity under consideration (1986 start-up)	Present capacity 140,000 tonnes/year; Alumina imported from ALCOA of Australia
Consortio-Alumar (Brazil)	New project	60% ALCOA Aluminio SA (68% Alcoa; 32% Hanna Mining) 40% Shell Brasil SA	300	$1.2 billion* (1980 est.)	Construction started 1980. 1984 start-up of 100,000 tonnes/year capacity; To be expanded 300,000 tonnes/year until 1990.	* Cost of a smelter with initial capacity of 100,000 tonnes/year and an alumina refinery with 500,000 tonnes/year which started constructuion in 1980. Alumina to be supplied from the new refinery at Sao Luis
Cia. Brasileira de Aluminio (CBA) (Brazil)	Expansion	80% Votorantim 20% Govt	50	$600-650 mill.* (1980 est.)	Completion of expansion to 120,000 tonnes/year scheduled by 1982. Further expansion to 170,000 tonnes/year planned.	Planned capacity for 1982: 120,000 tonnes/year. * Corresponding bauxite and alumina capacity expansion costs included; Alumina to be supplied from the company's own refinery
Aluminio do Brasil Nordeste SA (Brazil)	Expansion	100% ALCAN	30	$100 mill. (1980 est.)	Under construction: start-up scheduled for the end of 1982.	Final capacity 148,000 tonnes/ year; Present capacity 28,000 tonnes/year; Alumina from the company's own refinery

Table F-1 (cont'd.)

(1,000 MT/Y)

Company (Country)	Expansion/ New project	Company ownership	Capacity	Capital Cost	Start-up Date/ Progress	Remarks
Valesul Aluminio SA (Brazil)	New project	49% CVRD (Govt.) 35% Shell Brasil 5% Reynolds 11% Consortium of Brasilian companies	86	$418 mill. (1980 est.)	Started-up May 1982; Full operation expected by the end of 1983	Final capacity 180,000 tonnes/year. Alumina to be imported until the Alunorte refinery can supply alumina.
Albras (Brazil)	New project	51% CVRD (Govt.) 49% Nippon Amazon Aluminium	320	$1.857 bill.* (1981 est.)	Presently under construction; 1985 start up scheduled	* Including the cost of Alunorte refinery; 80,000 tonnes/year capacity in 1985-86 then to be expanded by several stages (80,000 tonnes/year/stage). Alumina to be supplied from Alunorte.
Europe						
Gränges Aluminium AB (Sweden)	Expansion	100% Gränges	65		Expansion scheduled in 1986/87	Final capacity 152,000 tonnes/year
Asia						
Bharat Aluminium Co. Ltd. (India)	Expansion	100% Govt.	110		Expansion start up planned for 1987; but uncertain	Present capacity 100,000 tonnes/year
Etibank (Turkey)	Expansion	100% Govt.	60		1986/87: 60,000 tonnes/year Expansion schedule; but uncertain	Final capacity 120,000 tonnes/year
National Aluminium Co. of India - (India)	New project	100% Govt.	218	$424 mill. (1980 est.)	Initial: construction began in 1981; full operation scheduled in 1986	Cost of mine, refinery, smelter, power plant and infrastructure was estimated in 1980 at $2.1 billion. Alumina from an associated refinery
Indonesia Asahan Aluminium (Indonesia)	New project	75% Nippon Asahan Aluminium 25% Govt.	225	$1.0 bill.* (1980 est.)	Operation started in Feb. 1982; 1st, 2nd stages construction continuing; Capacity scheduled to reach 225,000 tonnes/year in 1984	* Total cost of the smelter/hydroelectric power project 2.0 billion (1981 est.) Alumina to be initially imported from Japan. Upon completion of planned refinery, alumina to be supplied from there.

Table F-1 (cont'd.)

(1,000 MT/Y)

Company (Country)	Expansion/ New project	Company ownership	Capacity	Capital Cost	Start-up Date/ Progress	Remarks
Africa						
Aluminium Co. of Egypt (Egypt)	Expansion	100% Govt.	33	$690 mill. (1980 est.)	Expansion to 166,000 tonnes/year scheduled by 1983	Present capacity 133,000 tonnes/year
Libya	New project	Libya Govt./ Yugoslav Govt.	120	$1.9 bill. (1980 est.)	Completion scheduled in 1986; details unclear	Alumina source: Yugoslavia
Alusaf (Pty) Ltd. (South Africa)	Expansion	66% Industrial Development Corp. (Govt.) 22% ALUSUISSE 12% Others	87	$265 mill.*	87,000 tonnes/year facility bought from Nippon Light Metal in 1980. Expansion in progress	* Including shipment and reconstruction Planned capacity 169,000 tonnes/year in 1982
Oceania						
ALCOA of Australia Ltd. (Australia)	New project	51% ALCOA 20% Western Mining 13.1% Broken Hill South 15.9% North Broken Hill and others	132	$403 mill. (1980 est.)	Delay of plans for 2 years announced in July, 1982 (Now start-up expected in 1985)	Alumina from the company's own Wagerup refinery.
ALCAN Australia Ltd. (Australia)	Expansion	70% ALCAN 30% Australian institutions	45	$130 mill.	Construction in progress	
Tomago Aluminium Ltd. (Australia)	New project	35% Aluminium Pechiney Australia 35% Gove Aluminium Finance 15% TOA Pty Ltd. 15% VAW Australia and others	220	$680 mill. (1980 est.)	Construction started in the first half of 1981 and is in progress. Start-up scheduled in 1983.	1st stage: 110,000 tonnes/year start up in 1983 2nd stage: 110,000 tonnes/year start up in 1985
Boyne Smelters Ltd. (Australia)	New project	30% Comalco 20% Kaiser 17% Sumitomo Light Metal 33% Other Japanese interests	206	$680 mill. (1980 est.)	Operation started in Feb. 1982; 2nd potline under construction; Full operation scheduled in 1984.	Alumina from QAL
New Zealand Aluminium Smelters Ltd. (New Zealand)	Expansion	58.72% Comalco 20.64% Showa Aluminum 20.64% Sumitomo Aluminium	87	$NZ 230 mill. (1980 est.)	Operation started in Aug. 1982 and are scheduled to reach 244,000 tonnes/year in 1983.	Existing capacity 167,000 tonnes/year in 1982

Table F-2 Development Plans —— Alumina

(1,000 MT/Y)

Company (Country)	Expansion/ New project	Company ownership	Capacity	Capital Cost	Start-up Date/ Progress	Remarks
North America						
Martin Marietta Aluminum Inc. (USA)	Expansion	87% Martin Marietta 13% Other private interests	135	$45 mill. (1980 est.)	Expansion to 635,000 tonnes/ year scheduled by the end of 1983	Alumina to be supplied to the company's own smelters or to Norway.
Latin America						
Interamericana de Alumina SA (Interalumina) (Venezuela)	New project	88.75% Govt. 11.25% ALUSUISSE	1,500	$720 mill. (mid 1980)	Under construction since 1979; Start-up scheduled in 1983	Initial capacity 1 million tonnes/year (0.5 million tonnes/year at the end of 1982); Expansion (1985 or later) to 1.5 million tonnes/year dependent on Bauxiven project. 850,000 tonnes output out of initial capacity to go to Alcasa and Venalum
Alunorte SA (Brazil)	New project	60.8% CVRD (Govt.) 39.2% Nippon Amazon Aluminium	800	$715 mill. (1981 est.)	Start-up scheduled in 1985/86 dependent on the progress of the Albras project; Under construction	Refinery and smelter Total cost of $1.235 billion (1980 est.) for refinery and smelter; To be supplied to Albras and Valesul.
Alumar Project (Brazil)	New project	60% ALCOA Aluminio SA (68% ALCOA, 32% Hanna Mining) 40% Shell Brasil SA	3,000	$1.2 billion* (1980 est.)	Construction started in 1980. Start-up scheduled in 1985 (Initial capacity 500,000 tonnes/year)	Total cost for the joint smelter-refinery project. To be supplied to Sao Luis smelter
Europe						
Aughinish Alumina Ltd. (Ireland)	New project	40% ALCAN 35% Billiton 25% Arco Metals	2,400	$1 bill. (1981 est.)	Under construction since 1978; Start-up scheduled in 1983	Initial capacity 800,000 tonnes/ year; Expansion to 2.4 million tonnes/year uncertain; Alumina to be exported to the participants.
Eurallumina SpA (Italy)	Expansion	41.7% ALSAR (Italian Govt-owned) 20.8% Alumetal (") 20.0% Comalco (Aust.) 17.5% Metallgesellshaft	1,000		F/S of expansion from 0.6 million to 1.6 million tonnes/ year completed in 1980 (Start-up scheduled in 1983/84) *Expansion plans delayed in 1981.*	Alumina to be supplied according to shares Bauxite from Weipa in Australia

Table F-2 (cont'd.)

(1,000 MT/Y)

Company (Country)	Expansion/ New project	Company ownership	Capacity	Capital Cost	Start-up Date/ Progress	Remarks
South Asia						
National Aluminium Co. of India (India)	New project	100% Govt.	800	$492 mill. (1980 est.)	Construction started in April 1981; Start-up scheduled in 1986	Total cost of mine, refinery, smelter and power plant: 2.1 billion (1980 est.) Alumina mostly to be exported, some to be supplied to a planned smelter.
Oceania						
ALCOA of Australia Ltd. (Australia)	New project	51% ALCOA 20% Western Mining 13.1% Broken Hill South 15.9% North Broken Hill and others	500	$390 mill.* (1980 est.)	Completed in June 1982, but start-up delayed until 1983	Alumina to be supplied to the company's own smelter or exported. Expansion to 2.0 million tonnes/ year already approved. * Including bauxite mine cost.
Worsley Alumina Pty Ltd. (Australia)	New project	40% Reynolds Australia Alumina 30% Shell Co. of Australia 20% BHP Co. Ltd. 10% Kobe Alumina Associates	1,000	$1 bill. (1980 est.)	Under construction; Start-up scheduled in 1984	Final capacity 2 million tonnes/ year Alumina to be supplied to Australian smelters or exported
Queensland Alumina Ltd. (QAL) (Australia)	Expansion	30.3% COMALCO of Japan 28.3% Kaiser 21.4% ALCAN 20.0% Pechiney	300	$230 mill. (1980 est.)	Expansion scheduled in 1983	Existing capacity 2.438 million tonnes/year

Table F-3 Development Plans —— Bauxite

(1,000 MT/Y)

Company (Country)	Expansion/ New project	Company ownership	Capacity	Capital Cost	Start-up Date/ Progress	Remarks
Mineracao Rio do Norte SA (Trombetas, Brazil)	Expansion	51% Cia. Vale do Rio Doce (CVRD - Govt owned) 10% Cia. Brasileira de Aluminio (CBA) 19% ALCAN 5% each - Reynolds, Billiton, Norsk Hydro Alumina Español	8,000	$150-$200 mill.	Expansion to 8 million tonnes/ year scheduled to start in 1983 and complete in 1984/85	To be exported to the partici- pants; To be supplied in future to Alunorte/Alumar project Exsiting capacity 3.35 million tonnes/year.
CVG Bauxite Venezolana (BAUXIVEN) (Venezuela)	New project	Corp. Venezolana de Guayana (CVG - Govt owned) Fondo do Inversiones de Venezuela (FIV - Govt owned)	3,000	$395 mill.	Start-up scheduled in 1985	Expansion to 6 million tonnes/ near envisioned at the end of the 1980s; To be supplied to Interalumina
National Aluminium Co. of India (Orissa, India)	New project	100% Govt	2,400	2.1 billion* (1980 est.)	Construction started in 1981. Start-up scheduled in 1985	* Mine/refinery/smelter complex total cost To be supplied to associated alumina refinery.
Alcoa of Australia Ltd. (Willowdale, Australia)	New Project	51% ALCOA 20% Western Mining Corp. 13.1% Broken Hill South 15.9% North Broken Hill and others	2,810 (1985)	$350 mill.	Start-up scheduled in 1982/83. (Expansion dependent on Wagerup refinery)	To be supplied to Wagerup refinery scheduled to star-up in 1983 Expansion to 3.75 - 7.5 million tonnes/year from 1985 onwards
Worsley Alumina Co. (Mt. Saddleback, Australia)	New project	40% Reynolds 30% Shell Co. of Australia 20% BHP Co. Ltd. 10% Kobe Alumina Associates of Japan	3,170 (1985)	$1 billion (1980 est.)	Under construction, start-up scheduled at the end of 1983	* Cost for initial stage of mine and refinery Dependent on demand, capacity to be doubled to 6.34 million tonnes/year from 1985 onwards

Sources (Table F-1, F-2 and F-3):
1. Spector Report, 1982-87 Capacity Survey, Aug. 20, 1982
2. Australian Minerla Economics, Vol. I, II
   Existing and planned Bauxite, Alumina and Primary aluminium capacity, pp. 191-218
   Apendix: World Bauxite, Alumina and Primary Aluminium capacity estimates, pp. 295-386
3. Metals Week
4. Metal Bulletin

2.1.3 Others

Argentina and Guyana have new or expansion plans for aluminum smelters; Jamaica, Surinam, and Guyana have new or expansion plans for bauxite and alumina development.

2.2 Oceania

2.2.1 Australia

(1) Aluminum

With the background of abundant coal and bauxite as well as political and economic stability, many plans have been announced for new or expansion of aluminum smelters based on coal fired thermal power. The plants for Tomago Aluminium, ALCOA of Australia, Boyne Smelters etc. are under construction or have already started operations.

At one time, Australia had as many as seven new projects, but a variety of restrictions on development, such as the stagnation of world aluminum market since 1981, the impact on natural environment, the difficulties in negotiations with the state governments about electricity, and the government restrictions on overseas capital participation, forced either suspension or delay of all the projects. It appears difficult to realize some projects at the preliminary stage unless market conditions improve greatly.

(2) Alumina, Bauxite

It is highly likely that both bauxite/alumina developments by ALCOA of Australia and Worsley Alumina are realized.

Many development plans have been progressing in Australia based on abundant coal and bauxite resources. However, long term prospect in the future indicates that Australia will have to face severe competition due to the entry into the market by countries such as Indonesia and the South American countries which have basic advantage of abundant hydropower and bauxite resources.

2.2.2 New Zealand

In addition to the expansion plan of NZAS, the Fletcher Holdings Consortium has a new project for aluminum smelter.

2.3 Europe

(1) Aluminum

In addition to the expansion plan of Granges Aluminum (Sweden), France, the Federal Republic of Germany, and the United Kingdom have plans for small-scale expansion plans in order to improve energy efficiency and productivity. Norway, Iceland and Yugoslavia have plans based on new hydropower developments.

(2) Alumina

In addition to projects of Aughinish Alumina (Ireland) and Eurallumina (Italy), Spain and Greece have projects which have already started up or at the planning stage.

2.4 Asia

2.4.1 India

There are two smelter projects based on abundant bauxite in the states of Orissa and Andhra Pradesh. National Aluminum Co. of India (Orissa) is scheduled to start operation in its integrated project (bauxite, alumina and aluminum) in 1985.

Bharat Aluminium (Andhra Pradesh) plans to start with only bauxite and alumina production, and to progress to an aluminum smelter in the second half of the 1980s.

In addition, a third plan for new alumina plant in Gujarat is being investgated.

2.4.2 Other regions

(1) Aluminum

In addition to Asahan Aluminium's plant in Indonesia which started operation in 1982, there are aluminum smelting plans in the Philippines and Malaysia.

Plans for new or expansion aluminum plants in the Persian Gulf based on inexpensive natural gas are being investigated, but they are at very preliminary stage.

2.5 Africa

(1) Aluminum

There is a new project owned by the Libyan Government. Aluminum Co. of Egypt and ALUSAF are planning the expansion of their plants. In addition, there is a project to be started up in Algeria in 1984 and one in Zaire, although details are unclear.

(2) Alumina, Bauxite

In Guinea, only one alumina producing country in Africa, there are three plans being investigated, an alumina project in line with the development of Aye Koye bauxite at Boké area, an expansion project by Friguia Consortium at Kimbo area and a bauxite/alumina project at Dabola/Tougue area.

Besides Guinea, Ghana, Cameroon, and Sierra Leone have new or expansion projects.

2.6 North America

2.6.1 Canada

In addition to Canadian Reynolds' and Howmet Aluminum's new or expansion projects, ALCAN has a new aluminum project in Manitoba and Reynolds has a new aluminum project in Churchill Falls. Except for Howmet, all these new projects depend on the development of electricity.

2.6.2 The United States

Besides Arco Metal's expansion project, Alumax is investigating a new smelter in Oregon. There is no other new project in the United States due to the increase in energy cost.

The status of aluminum, alumina and bauxite development projects are outlined above. But, recently, the world-wide stagnation of aluminum market caused the suspension of projects in the world one after another. Even Australia, being considered as the most competitive country, has now come to the stage where all the projects have to be suspended.

Therefore, it is extremely difficult to estimate clearly the future supply of aluminum in terms of quantity.

II. Aluminum Supply and Demand Projection

Many organizations, research companies, industry analysts have issued various aluminum supply and demand projections for short, medium or long term. In this Chapter a long term supply and demand projection is made based on analysis and comparison of some of these recent projections.

1. Published Supply and Demand Projections

(1) OECD's projection of medium-term supply and demand for primary aluminum (June 1980).

(2) UNIDO's projection of medium and long-term final demand for aluminum (July 1980).

(3) IPAI's survey of medium-term primary aluminum production capacity (June 1982).

(4) IBA's August, 1981 projection of medium and long-term bauxite, alumina, and aluminum consumption (August 1981).

(5) Chase Econometrics Associates Inc.'s medium and long-term projection of demand for primary aluminum (February 1982).

(6) Mr. Stewart R. Spector's projection of short and medium-term supply and demand for primary aluminum (August-September 1982).

(7) Kaiser Aluminum, Mr. James A. Vais's projection of medium and long-term aluminum supply and demand (September 1982).

(8) Other projections.

1.1 OECD's Projection of Supply and Demand for Aluminum Industry

OECD published a report on the aluminum industry in June 1980.1)

As shown in Table F-4, this report assumed the annual growth rate of world GNP to be 3.8% from 1978 to 1985, which was lower than the 4.1% rate from 1970 to 1978. Although this growth rate seems conservative, it reflected the possibility of significant slow down of growth rate expected in 1980 and 1981.

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1) Present Situation, Prospects and Problems of the Aluminum Industry - The Aluminum Industry Entering the 1980's

Table F-4 OECD Projection - Average Annual Growth Rates of GNP (1978 - 1985)

World total	3.8%
USA	2.3%
Germany, FR	3.0%
France	2.8%
Japan	4.7%
Italy	2.8%
UK	1.5%

Meanwhile, GNP elasticity of aluminum consumption was 1.96 from 1960 to 1965, and 1.38 between 1970 and 1978. Considering this decrease in the elasticity, 1.2 was estimated as an appropriate GNP elasticity of total aluminum consumption until 1985.

Based on this elasticity of 1.2 and GNP growth rate of 3.8%, an increase rate for total aluminum consumption from 1978 to 1985 was estimated at 4.5%. At this rate, total aluminum consumption was expected to expand to about 26.5 million tonnes in 1985 from 19.465 million tonnes in 1978.

On the other hand, a trend of increase in aluminum recovery from beverage cans, etc., was expected to increase the share of secondary metal in total aluminum supply from 20% in 1970 to 22% in 1980 and 24% in 1985. It was therefore estimated that, in 1985, secondary aluminum supply would reach to 6.4 million tonnes and hence demand for primary aluminum would be 20.1 million tonnes, equal to 26.5 million tonnes minus 6.4 million tonnes.

As for inventory, it was assumed that the inventory equivalent to 15% of the additional shipment was required because the level of inventory increased along the increase in the shipment to to consumers.

Based on these concepts, required primary aluminum production for each year up to 1985 was estimated by calculating the demand for aluminum for each year as just explained and taking into account changes in inventory. The production capacity for primary aluminum each year was also estimated by taking into consideration the expansion plans of existing plants and the plans for new plants with high possibility of realization. Then operation rate for each year was calculated by dividing primary aluminum requirements by production capacity. Table F-5 summarizes these estimates.

Table F-5 OECD Supply and Demand Projection Summary Table

	Demand for primary aluminum	Required primary aluminum production	Production capacity	Operation rate
	(1,000 tonnes)	(1,000 tonnes)	(1,000 tonnes)	(%)
1978	15,200	-	-	-
1979	15,700	-	-	-
1980	15,600	15,600	17,500	89.1
1981	16,400	16,500	18,000	91.7
1982	17,200	17,300	18,800	92.0
1983	18,500	18,700	19,800	94.4
1984	19,400	19,500	20,700	94.2
1985	20,100	20,200	21,800	92.7

This report also made a projection of final consumption of aluminum in 1985 by 5 consumption sectors in total of 6 countries, i.e., the United States, Japan, the Federal Republic of Germany, France, Italy and the United Kingdom as shown in Table F-6 below.

Table F-6 OECD Projection - Average Annual Growth Rate for Total Aluminum Consumption (1978 - 1985)

6 country total*	3.6%
Transportation	5.5%
Electrical and machinery	2.5%
Building and construction	3.1%
Packaging	3.4%
Others	3.1%

* USA, Japan, Germany, Fed. Rep., France, Italy, UK

Based on supply and demand projections above, OECD commented as follows: Considering the factors such as the scrap down of some Japanese plants due to high energy costs and the trouble of production experienced in the United States due to water shortage, it appeared certain that the situation of supply and demand up to 1985 would be tight. As experienced in 1974-1975 recession when some expansion plans were delayed or cancelled because excess production capacity caused troubles in the past, the same situation would come again in 1980 if it was a recession year.

In conclusion, OECD report expected that the seller's market continued in aluminum industry for next five years.

1.2 UNIDO's Aluminum Demand Projection

In July 1980, UNIDO [1] published its report, titled "the Development of Aluminum Sales up to 1990".

The data UNIDO used for its projection of total aluminum demand were based on the OECD data on the final demand for aluminum by demand sectors, which were transportation, construction, packaging, machinery and electrical industry. Country-by-country projections were made for 10 countries, which included the developed industrial countries (the EC countries, Spain, the United States, Japan) and the developing countries (Brazil, etc.), although emphasis was placed on the developed industrial countries.

The projections were based on data up to 1978 and forecasted for 1980, 1985, and 1990. For projections, such unique methods were employed as analyses of aluminum consuming industries and aluminum usage situations and interview surveys. These are summarized in Table F-7.

The total aluminum demand for 10 countries were estimated by UNIDO at 11.25 million tonnes in 1980, 16.23 million tonnes in 1985, and 21.87 million tonnes in 1990. The average annual growth rates for the 5-year periods were 7.6% for 1980-1985 and 6.1% for 1985-1990, which showed rather higher growth rates than those in other projections.

As for annual growth rate for each demand sector, the transportation sector had the highest growth rate of 8.2% from 1980 to 1985, followed by electrical, packaging, construction and machinery. For 1985-1990, electrical had the highest of 8.3% followed by packaging, machinery, transportation and construction. For this period, it was characteristic that the growth rates had a wide variation from 8.3% to 4.4% for each sector and, except electrical and machinery, the growth rates for all other sectors fell below those for the previous period.

Analysis by country showed those with high growth rates over 10% were Brazil, with the highest of 13%, Spain and Japan. The countries within 5-10% growth rates were Belgium/Luxemburg, Italy, and Netherlands. Other main European countries and the United States were at around 5% level or below. Comparing the two periods, 1980-1985 and 1985-1900, Great Britain showed relatively

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1) United Nations Industrial Development Organization

Table F-7 UNIDO Aluminum Demand Projections for Main Countries

		Trans-portation	Machin-ery	Elec-trical	Construc-tion	Packaging	5 sector total	Growth rate (%)	Share of 10 country total (%)	GDP growth rate (%)
Germany, FR	1980	300.1	92.0	81.9	176.8	112.0	762.8	-	6.8	
	1985	375.8	126.0	92.2	245.4	144.3	983.7	5.2	6.1	2.7
	1990	470.5	183.4	101.8	331.6	181.6	1,268.9	5.2	5.8	2.5
France	1980	221.7	32.9	100.6	65.8	68.3	489.3	-	4.3	
	1985	306.7	41.9	135.9	92.7	75.9	653.1	5.9	4.0	3.3
	1990	422.2	56.9	184.4	130.7	98.7	892.9	6.5	4.1	3.1
UK	1980	122.2	25.7	69.6	64.7	54.1	336.3	-	3.0	
	1985	134.2	33.0	79.7	88.6	70.1	405.6	3.8	2.5	2.0
	1990	147.5	42.5	114.4	121.4	91.2	517.0	5.0	2.4	2.0
Italy	1980	210.7	42.0	37.7	140.0	66.4	496.8	-	4.4	
	1985	324.2	58.9	57.7	190.9	89.3	721.0	7.7	4.4	2.7
	1990	496.5	81.0	89.7	249.5	118.4	1,035.1	7.5	4.7	2.6
Netherlands	1980	11.4	8.7	11.3	29.9	40.1	101.4	-	0.9	
	1985	15.2	10.7	15.1	36.2	60.9	138.1	6.4	0.9	2.9
	1990	20.0	13.2	20.1	43.6	92.3	189.2	6.5	0.9	2.8
Belgium and Luxemburg	1980	2.8	1.8	6.2	13.5	8.0	32.3	-	0.3	
	1985	4.0	2.9	8.9	19.4	13.6	48.8	8.6	0.3	2.9
	1990	5.9	4.2	12.3	27.9	23.0	73.3	8.5	0.3	2.8
Spain	1980	82.3	13.4	41.9	85.6	33.2	256.4	-	2.3	
	1985	143.0	18.6	84.6	125.8	70.0	442.0	11.5	2.7	4.0
	1990	247.6	26.1	172.5	176.5	148.9	771.6	11.8	3.5	3.8

Table F-7 (cont'd.)

		Trans-portation	Machin-ery	Elec-trical	Construc-tion	Packaging	5 sector total	Growth rate (%)	Share of 10 country total (%)	GDP growth rate (%)
USA	1980	2,019.7	393.8	688.0	1,738.1	1,613.4	6,453.0	-	57.4	
	1985	2,953.9	524.5	894.9	2,207.8	2,316.2	8,897.3	6.6	54.8	4.2
	1990	3,525.3	705.2	1,169.6	2,071.8	3,143.7	10,615.6	3.6	48.5	1.6
Japan	1980	563.5	106.0	277.0	879.4	143.6	1,969.5	-	17.5	
	1985	958.1	160.1	473.0	1,461.9	234.5	3,287.6	10.8	20.3	6.8
	1990	1,585.7	235.2	779.3	2,259.6	449.5	5,309.3	10.1	24.3	6.3
Brazil	1980	83.2	12.9	142.7	85.9	28.3	353.0	-	3.1	
	1985	154.7	25.7	266.4	161.7	43.6	652.1	13.1	4.0	7.3
	1990	270.2	50.2	490.8	318.3	67.3	1,196.8	12.9	5.5	7.3
10 country total	1980	3,617.6	729.2	1,456.9	3,279.7	2,167.4	11,250.8	-	100	
	1985	5,369.8	1,002.3	2,108.4	4,630.4	3,118.4	16,229.3	7.6	100	
	1990	7,191.4	1,397.9	3,134.9	5,730.9	4,414.6	21,869.7	6.1	100	
Growth rate (%)	1985/1980	8.2	6.6	7.7	7.1	7.5	7.6	7.6		
	1990/1985	6.0	6.9	8.3	4.4	7.2	6.1	6.1		
Share	1980	32.2	6.5	12.9	29.1	19.3	100			
	1985	33.1	6.2	13.0	28.5	19.2	100			
	1990	32.9	6.4	14.3	26.2	20.2	100			