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STRUCTURAL CHANGE IN STEEL TRADE AND INTERNATIONAL INDUSTRIAL ADJUSTMENTS

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INTRODUCTION

GLOBAL structure of steel trade has changed markedly in the last couple of decades. The world's total trade in steel expanded from 39 million tons in 1960 to 88 million tons in 1970, and then to an estimated 130 million tons in 1982. Meanwhile, major exporting countries have changed with the increase in traded volume. Japan emerged as a major exporter during the 1960s, and newly industrializing countries (NICs) and Eastern European countries began to gain an edge in the world market, in the 1970s. Steel-exporting countries which numbered thirteen in 1950 nearly tripled to thirty-six by the early 1980s. In the process, former net importers have emerged as net exporters, while some traditional exporters relegated themselves to net importers.

The present paper analyzes the changing global structure of steel production and trade, chiefly by means of a steel flow matrix among major countries or groups of countries, such as Japan, the United States, Western Europe, Asian NICs, ASEAN countries, Brazil, and Australia. The analysis reveals that the industrialized countries have gradually reduced their steel exports, being increasingly caught up by new exporters, and that their ratios of domestic production to domestic demand, or rates of self-sufficiency, have steadily declined in contrast to the NICs where the ratios have risen rapidly. This epitomizes the process of restructuring observed in the interactions between net importers and net exporters in the last two decades or so. The United States has already turned into a net importer, and nine EC countries and Japan are likely to follow suit, judging by the findings of the present analysis. Two basic facts stand out to support this argument; the excess capacity of production in the industrialized countries, and the NICs' plans to expand their capacity through the 1980s. It is highly unlikely, therefore, that the problems of excess capacity in the industrialized

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TABLE
WORLD STEEL

Supply \ Demand		Japan	Taiwan	Korea	Brazil	Singapore	Malaysia	Thai-land	Philip-pines
Japan:									
	1965	22,699	253	149	55	0	135	289	439
	1970	56,483	515	406	191	440	212	459	661
	1975	55,181	886	908	973	967	366	530	431
	1980	70,195	1,771	1,819	203	1,046	719	360	560
	1981	63,792	1,486	1,612	147	1,177	726	770	425
Taiwan:									
	1965	0	93	0	0	0	0	9	2
	1970	0	48	11	1	3	17	10	18
	1975	1	322	1	0	7	5	8	1
	1980	31	2,051	4	0	53	47	27	27
	1981	109	1,438						
Korea:									
	1965	0	0	95	0	0	0	0	2
	1970	0	0	400	0	0	0	0	0
	1975	20	0	1,128	1	1	1	6	0
	1980	881	0	2,478	1	106	115	106	44
	1981	1,197	0	3,598	0	123	102	95	47
Brazil:									
	1965	0	0	0	2,159	0	0	0	0
	1970	0	0	0	3,909	0	0	0	0
	1975	0	0	0	6,774	0	0	0	0
	1980	7	0	1	11,273	0	0	1	0
	1981	19	0	0	9,158	1	3	17	0
Australia:									
	1965	12	2	0	0	0	9	3	8
	1970	11	16	0	0	19	0	6	269
	1975	31	0	2	112	31	16	2	113
	1980	36	0	31	1	68	34	21	128
	1981	0	0	92	0	26	22	69	100
U.S.A.:									
	1965	7	13	6	12	0	10	14	21
	1970	15	36	21	70	13	9	14	78
	1975	4	81	5	155	32	5	53	8
	1980	27	111	33	152	15	6	58	9
	1981	10	68	16	33	11	2	42	20
Canada:									
	1965	0	0	0	5	0	1	1	0
	1970	0	3	0	1	0	0	0	0
	1975	1	10	0	10	0	3	20	0
	1980	49	36	14	2	0	6	78	15
	1981	29	4	29	2	0	5	37	0
Western Europe:									
	1965	6	5	9	52	0	58	33	37
	1970	10	12	3	181	21	26	40	11
	1975	5	40	9	804	25	23	12	10
	1980	103	43	87	294	117	41	55	23
	1981	22	95	96	577	160	116	87	21
Others:									
	1965	19	4	10	11	0	35	4	22
	1970	58	3	35	64	18	25	23	1
	1975	13	388	15	245	1	2	9	1
	1980	45	498	13	40	37	95	553	57
	1981	148	808	120	55	71	110	231	83
Total consumption:									
	1965	22,743	370	269	2,294	0	248	353	531
	1970	56,577	633	876	4,417	514	289	552	1,037
	1975	55,256	1,727	2,068	9,074	1,064	421	640	564
	1980	71,374	4,510	4,476	11,966	1,442	1,063	1,259	819
	1981	65,326	3,899	5,563	9,972	1,569	1,086	1,348	696

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FLOW MATRIX (1,000 tons)

Indo-nesia	Australia	U.S.A.	Canada	Western Europe	Middle East	China	Others	Total Production
94	418	4,122	238	420	254	221	2,659	32,445
223	376	5,580	344	2,287	608	1,580	3,707	74,072
830	277	5,126	318	3,764	4,597	2,830	6,139	84,123
1,192	363	4,883	428	1,160	3,998	3,202	8,001	99,900
1,281	558	5,920	524	486	4,065	2,221	7,057	92,247
0	0	0	0	0	3	0	66	173
12	4	32	0	3	26	0	183	308
33	3	50	0	16	49	0	71	567
52	6	103	5	55	141	0	216	2,818
						0		2,631
0	0	0	0	0	0	0	57	154
0	0	0	0	0	0	0	1	401
21	6	295	20	76	178	0	359	2,112
243	42	959	44	321	688	0	1,104	7,132
200	77	1,578	99	57	616	0	1,172	8,961
0	0	32	0	25	0	0	298	2,514
0	0	23	0	124	0	7	429	4,492
0	0	26	4	24	1	0	94	6,923
4	7	411	40	338	41	53	605	12,781
1	18	722	76	258	109	75	565	11,022
0	4,298	28	11	18	4	2	235	4,630
33	4,660	81	20	160	11	1	471	5,758
35	4,831	66	8	395	58	71	787	6,558
80	4,661	117	9	195	53	295	599	6,328
63	5,229	12	3	32	1	233	481	6,363
3	14	90,391	540	365	47	0	1,223	92,666
9	18	84,375	682	3,053	66	0	2,339	90,798
47	9	77,178	713	204	338	7	1,118	79,957
48	11	80,007	444	497	257	115	2,063	83,853
15	10	84,308	763	153	185	16	1,392	87,044
0	19	570	6,724	69	6	0	163	7.588
0	8	1,052	7,897	195	14	0	163	9,333
7	0	708	9,589	72	33	0	401	10,854
22	2	2,233	9,729	273	72	158	562	13,251
21	2	2,934	8,736	103	42	12	387	12,343
81	174	4,504	1,085	92,883	1,460	265	5,867	106,519
36	71	5,011	341	119,697	1,096	482	6,204	133,242
47	31	3,319	504	103,300	3,487	813	13,813	126,242
107	28	3,912	341	106,189	4,704	773	14,966	131,786
131	45	6,872	1,035	95,983	4,791	252	18,835	129,118
76	1	42	21	1,459	347	234	134,109	136,394
4	1	141	88	4,029	1,234	148	172,664	178,536
17	12	33	24	2,877	620	181	217,393	221,831
104	22	77	3	3,514	1,318	166	260,526	267,068
120	28	136	231	4,941	1,791	74	232,657	241,604
254	4,923	99,692	8,619	95,239	2,121	722	144,677	383,083
317	5,138	96,296	9,372	129,548	3,055	2,218	186,161	497,000
990	5,169	86,800	11,180	110,728	9,361	3,702	240,175	539,167
1,830	5,142	92,702	11,038	112,542	11,275	4,762	288,642	624,917
1,832	5,967	102,482	11,467	102,013	11,600	2,883	262,546	591,333

countries will dissipate in the foreseeable future, or indeed it is more likely that they will become exacerbated. The present paper attempts to analyze the structural change of steel production and trade in quantitative terms and suggest some relevant policy implications.

I. STRUCTURAL CHANGES IN GLOBAL SUPPLY AND DEMAND

The rise of new exporting countries is the key factor to the change in the global patterns of steel trade, and in forcing the industrialized countries, traditional exporters of steel, to adjust their industrial structures. The changing structure of trade is not only observable in the relationship between the traditional and the newly emerged exporters, but also in the markets of the third class of countries which rely on steel imports. This changing structure variously affects the levels of domestic supply and demand in the respective countries concerned. The industrialized countries have been experiencing a decline in export and a rise in import of steel, while an increasing number of other countries have been successful in shifting from import substitution to export promotion of steel. As a result, the excess capacity has emerged as a serious structural imbalance vexing the industrialized countries. In order to analyze such interrelated changes of steel supply and demand in and between the respective countries, the present paper has constructed a world steel flow matrix, which is explained at some length below.

A. *World Steel Flow Matrix*

The world steel flow matrix shown in Table I combines a trade matrix of iron and steel (SITC 6) and supply and demand situations in individual countries or groups of them.[1] In the case of Japan, for example, the row and the column represent, respectively, countries of destination for its export and countries of origin for its import, while the figure in its diagonal cell represents domestic production for domestic use (i.e., production minus export). The column sum is Japan's total demand (domestic demand plus export) and the row sum its total supply (domestic supply plus import).

Total volumes of steel export and import by individual exporting country are available in *Kaigai tekkō tōkei* [Overseas iron and steel statistics] [2], and other similar publications. For individual industrialized countries, the UNECE's *Statistics of World Trade in Steel* [14] gives a breakdown of the total export volume of steel (semifinished and finished steel products) by destination. However, it is hard to obtain similar statistics on new exporting countries such as Korea, Taiwan, and Brazil. Accordingly, the present paper utilizes import volume statistics of the industrialized countries by country of origin (i.e., by new exporter). For the rest of the NICs' exports which could not be collected by this method, the percentage distribution by destination of the total value of steel exports (SITC 67)

[1] For more details on the matrix buildings, see [16].

is obtained from the UN trade statistics for each NIC and used to estimate the export volume by destination.[2]

Balances of steel supply and demand in the respective exporting countries are then added to the trade matrix. Published statistics on production are shown in crude steel for many countries. In order to be consistent with the trade matrix, these statistics are converted to steel by the conversion factor of 1.2. The actual conversion factor changes as a result of some technological innovation, but the margin of error introduced by the application of the uniform rate would not be significantly large for the period under study. Rather, the application of varied rates would create more serious distortions in statistical terms.[3] The said conversion factor of 1.2 is used by the UN statistics for ordinary steel, which normally accounts for over 80 per cent of the total steel output in major producing countries. Domestic demand is apparent consumption, or domestic production minus export plus import.

To facilitate a better grasp of the matrix analysis, the trade matrix and supply and demand balances are integrated into a table similar in form to the input-output table. As explained earlier, this world steel flow matrix shows not only flows of the global trade in steel but the total domestic consumption in a given country and the production for its own domestic market. Furthermore, it is so constructed as to enable the analysis of temporal changes in designated intervals since 1965. Supply and demand coefficients can be calculated from the world steel flow matrix, by dividing a column figure by total supply in a given year of a given country. In other words, this matrix of coefficients is to Table I what the matrix of input coefficients is to the input-output table. The world steel flow matrix in Table I and coefficients calculated therefrom are the basic tools used in the subsequent analysis.

B. *Analysis of Changes in World Supply and Demand*

In 1981, Japan, North America, Western Europe, and other countries which include Eastern Europe accounted for approximately 90 per cent of the world total production, and the shares of the Republic of Korea, Taiwan, and Brazil ranged only from 1 per cent to 2 per cent. It must be noted, however, that the volumes of production remained more or less unchanged in the former countries after 1965, while they rose sharply in the latter countries. Factors of such changes in steel production are analyzed in the following manner. Supposing that $X_{i.}$ stands for total steel production of i country, $X_{.j}$ for total steel consumption of j country, a_{ij} for the percentage share of an import from i country in the total steel consumption of j country, a_{ii} for the percentage share of domestic production in the total steel consumption of i country, and X_{ij} for steel export from i country to j country, it holds that:

$$X_{i.}=\sum_j X_{ij}=\sum_j a_{ij}X_{.j}. \qquad (1)$$

[2] Calculated from data available in the UN trade statistics retrieval system (AIDXT) installed at the Institute of Developing Economies.

[3] See [13].

An increase of steel production in i country is written as:

$$\Delta X_{i\cdot} = \Delta(a_{ii}X_{\cdot i}) + \Delta(\sum_{i \neq j} a_{ij}\, X_{\cdot j}). \qquad (2)$$

The first term on the right side of the equation (2) signifies the effect of a domestic market on the increase in production, and it is broken down to $X_{\cdot i}\Delta a_{ij} + a_{ii}\Delta X_{\cdot i}$. The term $X_{\cdot i}\Delta a_{ii}$ indicates the effect of a change in the relative share of domestic products in total steel consumption, which is affected by the changing levels of imports from other countries. The term $a_{ii}\Delta X_{\cdot i}$ shows the effect of an increase in demand which is determined by changes in total domestic consumption.

The second term signifies the effect of an external market, and it is broken down to $\sum_{i \neq j} X_{\cdot j}\Delta a_{ij} + \sum_{i \neq j} a_{ij}\Delta X_{\cdot j}$. The term $\sum_{i \neq j} X_{\cdot j}\Delta a_{ij}$ indicates the effect of a change in the relative share of i country's export to j country in the latter's total consumption of steel, or to put it differently, a change in i country's competitiveness in the external market. The term $\sum_{i \neq j} a_{ij}\Delta X_{\cdot j}$ indicates the effect of an increase in external demand which is determined by changing levels of total consumption in external market. Table II shows the results of the analysis concerning Japan, the United States, Korea, and Brazil, which showed variously characteristic changes in the matrix.

To begin with the case of Japan, steel production increased sharply during 1965–70, spurred partly by an accelerated expansion in domestic demand during the period of rapid economic growth, and partly by the country's improved international competitiveness which contributed to a sizable expansion of its share in the external market. The oil crisis sharply depressed domestic demand during 1970–75, but the steel output continued to increase because of the rising demand in overseas markets, especially in the Middle East, Southeast Asia, and China. During 1975–80, the rate of self-sufficiency, which had remained more or less close to 100 per cent before then, began to drop because of the increased imports. At the same time, Japan had its share in the external market reduced by new steel exporters and the progress of import substitution in importing countries. In other words, the effects on production of the relative share in both the domestic and the external market turned negative. Nonetheless, production continued to increase, albeit at a slower rate, because the increased demand in both domestic and overseas markets more than offset such setbacks. During 1980–81, however, Japan experienced a substantial drop in steel output, because the effect of the relative share continued to be negative in the domestic market and was practically zero in the external market, on the one hand, and because the effects of both domestic and external demand also turned negative, on the other. The level of steel production in Japan came to rest increasingly on rises, or declines, in domestic and external demand because of its diminishing share in both domestic and external markets. Furthermore, if Japan continues to lose its competitive edge in external markets, its production of steel will be eventually determined by the level of domestic demand, as already observed in the United States for some time.

TABLE II

ANALYSIS OF CHANGES IN PRODUCTION IN SELECTED COUNTRIES

	Domestic Market (1,000 Tons)		External Market (1,000 Tons)		Change in Output (1,000 Tons)	Domestic Market (%)		External Market (%)	
	Share	Demand	Share	Demand		Share	Demand	Share	Demand
Japan:									
1965–70	4.6	33,769.7	5,567.2	2,612.0	41,627	0.0	80.5	13.3	6.2
1970–75	17.0	−1,318.8	263.7	7,089.1	10,051	0.2	−13.1	2.6	110.3
1975–80	−834.4	16,095.4	−5,776.8	6,297.8	15,777	−5.3	102.0	−36.6	39.9
1980–81	−499.6	−5,918.2	40.6	−1,245.8	−7,653	−6.5	−77.7	0.5	−16.3
U.S.A.:									
1965–70	−3,040.6	−3,080.1	2,601.0	1,651.7	−1,868	−162.8	−164.9	139.3	88.4
1970–75	1,242.1	−8,319.5	−4,418.7	655.1	−10,841	11.5	−76.7	−40.8	6.1
1975–80	−2,256.8	5,247.5	523.9	381.4	3,896	−57.9	134.7	13.5	9.7
1980–81	−3,745.2	8,441.1	−967.2	−537.7	3,191	−117.4	264.5	−30.3	−16.8
Korea:									
1965–70	27.8	214.4	−61.2	66.0	247	11.3	86.8	−24.8	26.7
1970–75	77.9	544.3	804.7	284.2	1,711	4.6	31.8	47.0	16.6
1975–80	16.8	1,313.6	2,840.2	849.5	5,020	0.3	26.2	56.6	16.9
1980–81	417.2	601.8	755.5	54.6	1,829	22.8	32.9	41.3	3.0
Brazil:									
1965–70	−128.9	1,998.2	88.7	20.1	1,978	−6.5	101.0	4.5	1.0
1970–75	−467.2	3,149.0	−338.9	89.0	2,431	−19.2	129.5	−13.9	3.6
1975–80	1,205.0	3,826.5	813.1	13.5	5,858	20.6	65.3	13.9	0.6
1980–81	−283.6	−1,878.6	420.8	−17.6	−1,759	−16.1	−106.8	23.9	−1.0

Note: See the text for the method of factor analysis.

The production of steel in the United States declined during 1965–70 and 1970–75 but increased during 1975–80 and 1980–81. This was due to a drop in the former periods, and a rise in the latter, of domestic demand. The effect of external demand on steel production was not very large at any time during the periods under study, a reflection of the country's reduced share in the global trade. A sharp drop in domestic demand was observed in all the industrialized countries during 1970–75, but as already mentioned, Japan more than offset this setback by its increased exports to the Middle East and other developing countries. The effect of increased external demand on the United States' output was equivalent to only 9 per cent of the gain in Japan. The effect of the relative share in domestic market remained negative in the United States throughout the periods under study, and an increase in output was determined by the rise in domestic demand, as most characteristically observed in 1980–81. Therefore, during economic recessions which necessarily dampen domestic demand, the level of steel production in the United States is likely to drop, being adversely affected by combined negative effects of the other factors as well.

While the industrialized countries became more and more subject to changes in their domestic demand, new exporters began to enjoy the combined benefits from the increased demand and their expanding shares in both domestic and external markets. A typical case is Korea. During the periods under study, the country consistently raised its output of steel, due more to its expanding share in the external market than to an increase of its domestic demand. In other words, its continued improvements in competitiveness enabled Korea to gain an edge in the international market at the expense of other steel exporters. As the ratio of domestic products in the country's total consumption rose steadily, the effect of the relative share in domestic market continued to be positive. The effect of an increase in external demand on output was positive but not very large, because Korea's share in international market still remained small compared with major exporters. But it is likely to increase apace with an expected expansion of its relative share in the future.

Brazil also expanded its steel exports in the last two decades. Compared with Korea, however, the country has a much larger domestic market, and a higher ratio of domestic products in total consumption. This means that the effect of increased domestic demand on steel output has been markedly larger in Brazil than in Korea. In contrast to the industrialized countries, however, the effect of the increased share in external market was positive and growing in Brazil.

In sum, it is clear that changes in the structure of supply and demand observed in the last two decades distinctly differ between the industrialized and the newly industrializing countries. More detailed analysis will follow, utilizing the same world flow matrix and supply and demand coefficients.

C. *Different Patterns in DCs and NICs*

Table III shows matrices of steel flow and supply and demand coefficients among three groups of countries: namely, DCs (North America, Western Europe, Japan, and Australia), eight NICs (Korea, Taiwan, Brazil, and five ASEAN

TABLE III

MATRIX OF WORLD SUPPLY AND DEMAND (AGGREGATED)

	Supply and Demand (1,000 Tons)				Supply and Demand Coefficients			
	DCs	NICs	Others	Total	DCs	NICs	Others	Total
DCs:								
1965	229,615	1,827	12,406	243,848	0.9931	0.4230	0.0840	0.6365
1970	292,427	4,034	16,742	313,203	0.9848	0.4671	0.0874	0.6301
1975	265,634	7,608	34,492	307,734	0.9869	0.4422	0.1364	0.5707
1980	285,992	9,308	39,818	335,118	0.9767	0.3307	0.1309	0.5362
1981	277,561	9,584	39,970	327,115	0.9662	0.3566	0.1441	0.5531
NICs:								
1965	57	2,360	424	2,841	0.0002	0.5464	0.0028	0.0074
1970	186	4,429	646	5,261	0.0006	0.5129	0.0033	0.0105
1975	548	8,995	924	10,467	0.0020	0.5229	0.0036	0.0194
1980	3,301	17,717	3,121	24,139	0.0112	0.6296	0.0102	0.0386
1981	4,261	15,871	3,835	23,967	0.0148	0.5906	0.0138	0.0405
Others:								
1965	1,544	132	134,718	136,394	0.0067	0.0305	0.9130	0.3560
1970	4,317	172	174,047	178,536	0.0145	0.0199	0.9091	0.3592
1975	2,951	599	217,416	220,966	0.0109	0.0348	0.8599	0.4098
1980	3,505	1,113	261,042	265,660	0.0185	0.0395	0.8587	0.4251
1981	5,433	1,414	233,404	240,251	0.0189	0.0526	0.8419	0.4062
Total:								
1965	231,216	4,319	147,548	383,083				
1970	296,930	8,635	191,435	497,000				
1975	269,133	17,202	252,832	539,167				
1980	292,798	28,138	303,981	624,917				
1981	287,255	26,869	277,209	591,333				

TABLE IV

ANALYSIS OF CHANGES IN PRODUCTION (AGGREGATED)

(1,000 tons)

	Domestic Market		External Market		Changes in Output
	Share	Demand	Share	Demand	
DCs:					
1965–70	−1,886.5	65,055.0	686.6	5,492.9	69,355
	(−2.7)	(93.8)	(1.0)	(7.9)	
1970–75	414.6	−18,217.2	6,099.0	6,234.1	−5,469
	(7.6)	(−333.1)	(111.5)	(114.0)	
1975–80	−2,524.8	21,918.2	−3,102.6	11,085.0	27,384
	(−9.2)	(80.0)	(−11.3)	(40.5)	
NICs:					
1965–70	−139.2	2,268.3	159.7	130.7	2,420
	(−5.8)	(93.7)	(6.6)	(5.5)	
1970–75	87.5	4,450.6	479.0	187.9	5,206
	(1.7)	(85.5)	(9.2)	(3.6)	
1975–80	2,102.8	6,553.0	4,749.7	265.2	13,672
	(15.4)	(47.9)	(34.7)	(1.9)	

Note: Figures in parentheses show the percentages.

countries), and others. The results of the analysis based on the matrices are shown in Table IV for the periods of 1965–70, 1970–75, and 1975–80. It can be seen that the contribution of increased domestic demand was quite large in both DCs and NICs. The decisive difference lies in the fact that the NICs have continued to expand their share in both domestic and external markets, reflecting their steadily improved competitiveness in import substitution and export promotion. On the contrary, the effects of the relative share in both domestic and external markets turned negative in the DCs during 1975–80; namely, they began to lose their edge to the newly exporting countries in both domestic and external markets. If the DCs continue to reduce their share in external market, they will increasingly relinquish their future benefits due from increased external demand, and have to rely on domestic demand to keep up their production of steel, as already observed in the United States. Indeed, the United States and Western European countries (especially EC countries) often resort to import restrictions as part of their industrial adjustments policy, precisely because their production of steel is largely dependent on the size of domestic demand.

In contrast, the NICs can reasonably presume increases of benefits accruing not only from a continued expansion in domestic demand and in the relative share of domestic products in their total consumption but also from their expanding share in external market, which will amplify the positive effect of increased external demand on their output of steel. All four factors were positive in the NICs, in aggregate more than doubling their output of steel every five years after 1965. The trend appears most likely to continue in the foreseeable future. Confidence in the future is definitely behind their determined efforts to continue expanding their production capacity through the 1980s, and this is inviting defensive attempts on the part of the DCs to protect their respective domestic steel industry, which has been experiencing to a greater or lesser degree a continued slowdown of growth in output.

II. MECHANISM OF NICs' CATCH-UP

A. *"Flying-Geese-Shaped" Development of Steel Industry*

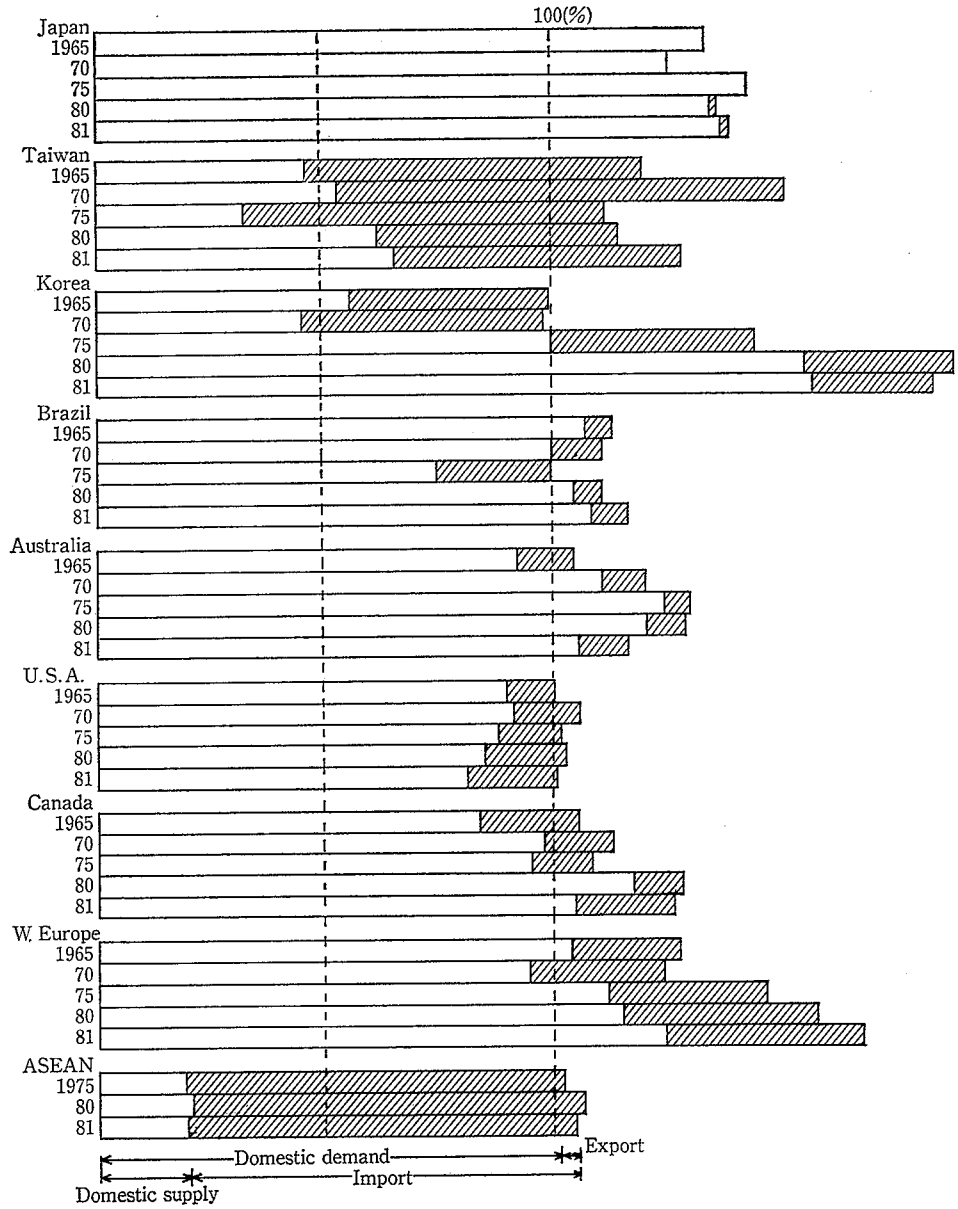
This subsection reviews the long-term trend of production, domestic demand, and trade in the industrialized countries and examines the postwar emergence of newly industrializing countries in order to delineate the mechanism of the latter's catch-up process. Four factors of production (P), domestic demand (D), export (E), and import (M) are not analyzed separately but as they stand in the following equation.

$$P=D+E-M. \tag{3}$$

Dividing by domestic demand (D), the equation is rewritten in percentage terms as:

$$\left(\frac{P}{D}\times 100\right)=100+\left(\frac{E}{D}\times 100\right)-\left(\frac{M}{D}\times 100\right). \tag{4}$$

Fig. 1. Production, Domestic Demand, Export, and Import in Selected Countries



Source: Taken from the trade matrix in Table I.

If $P/D\times 100=S^P$, $E/D\times 100=S^E$, and $M/D\times 100=S^M$, the equation (4) can be shown in a simpler form as:

$$S^P=100+S^E-S^M, \tag{5}$$

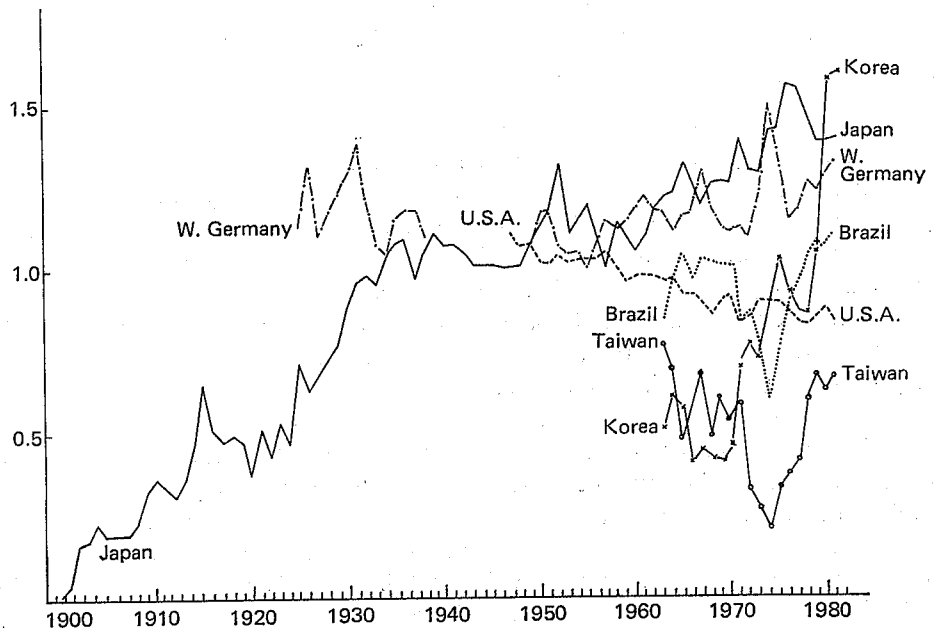
where S^P indicates the rate of self-sufficiency which varies by the size of S^E and S^M. If $S^E-S^M=0$, production equals domestic demand and the self-sufficiency is 100 per cent. If $S^E-S^M>0$, production exceeds domestic demand with an exportable surplus and the self-sufficiency is over 100 per cent. If $S^E-S^M<0$, production falls short of domestic demand and the dependence on steel import lowers the rate of self-sufficiency to less than 100 per cent. Figure 1 illustrates, in the manner similar to a skyline map, changes in S^E, S^M, and S^P in five-year intervals for each country or group of countries under study. By centrally fixing the position of self-sufficiency at 100 per cent, the value of S^E is plotted rightward relative to this position and then the value of S^M is plotted backward relative to the position of S^E. The unshaded area in the figure indicates the rate of self-sufficiency (S^P).

In Japan, Korea, Brazil, Australia, Canada and Western Europe, production exceeds domestic demand with an exportable surplus. Japan and Korea show markedly higher ratios of export, and moreover Japan's dependence on import is extremely low. In contrast, production in lower than domestic demand in the United States, Taiwan, and ASEAN countries. However, there is a definite difference between the United States and Taiwan in that the level of self-sufficiency steadily dropped in the former, while it rose in the latter. ASEAN countries perceptibly increased their self-sufficiency in recent years. The long-term trend of self-sufficiency can be explained by the so-called "flying-geese-shaped" overlapping pattern [6] between the plotted curves showing production, export, and import.

In the beginning, the rate of self-sufficiency is zero with domestic demand being entirely met by imports, but the start of domestic production for import substitution gradually raises the level of self-sufficiency. As illustrated in Figure 1, the pattern changes from one similar to ASEAN countries' to another like Taiwan's. As import substitution nears its full cycle, improved international competitiveness leads to exports; i.e., the transition from a Korean to a Japanese pattern in the same figure. In the final stage, increased imports from newly emerged producers lower the level of self-sufficiency.

Figure 2 was prepared to examine at some length the life cycle of self-sufficiency in steel for a number of selected countries. Production in Japan began to increase in the early 1900s when Yawata Steel Mill started its operation, and the self-sufficiency reached 100 per cent during the later half of the 1930s. After the Second World War, production picked up rapidly, indicating the country's improved export competitiveness. The Federal Republic of Germany zigzagged between 1.0 and 1.5, indicating that its self-sufficiency has hovered near its maximum level for an extended period of time since the 1920s. Self-sufficiency in the United States was reduced to less than 100 per cent during the 1950s, and continued to drop in subsequent years. The cases of Japan, West Germany, and the United States seemingly fit into a temporal continuum in the life cycle of steel industry. Korea, Brazil, and Taiwan show a rising trend in self-sufficiency, albeit with wide short-term fluctuations. Compared with Japan during 1900–1940, it is notable that these NICs made a transition from import

Fig. 2. Long-term Trends in the Ratios of Production to Domestic Demand in Selected Countries



Sources: For Japan, [15]; for West Germany, European Coal and Steel Community, *Iron and Steel Yearbook*, 1974–83 editions; for the United States, American Iron and Steel Institute, *Annual Statistical Report*, various issues; for Brazil, Taiwan, and Korea [2, various issues].

substitution to export expansion in a markedly reduced time span. Among the three countries, Taiwan alone had the self-sufficiency of less than 100 per cent in 1981. But according to the latest report, the completion in 1982 of the second-phase construction works of China Steel raised the rate from about 70 per cent to 103 per cent within the same year, indicating the rapidity of progress among the NICs.

The rapid growth of output over and above the level of domestic demand observed in the NICs accrued, as already mentioned, from the strong positive effects of increased domestic demand, on the one hand, and expanded shares in domestic and external markets due to the improvements in competitiveness, on the other. In the industrialized countries, on the contrary, waning competitiveness curbed their market share, and the domestic demand itself did not grow sizably due to their nearly saturated levels of consumption. Therefore, they began to lose their edge in both domestic and external markets to the rising NICs, with a steady decline in the rate of self-sufficiency as well as in the volume of production. The United States is most advanced in this transition, and Japan and EC

countries face the imminent possibility of following a similar course.[4] This is in evidence in the latter countries' gradually increasing steel imports and deepening stagnation observable in production, export, and consumption. This is supported by the analysis of competitiveness in the following subsection.

B. *Analysis of the Catch-up Mechanism*

In those industries which are briskly turning out technological innovations, a new technology adds to the competitive edge and enables an increase in production and export. Examples abound in the contemporary electronics industry. However, in those industries where production technologies are well standardized, competitiveness is to a greater extent a matter of price, which reflects the levels of wage and productivity, the latter being largely embodied in the age of equipment and machinery. In such a given industry, the lowest level of costs attained in the most modern factory serves as the baseline for competition, and every firm is bound to join in the race.

Japan began to construct the newest models of integrated steel mills in rapid succession in the 1960s to boost its export of steel. The new equipment and the resultant high labor productivity, coupled with its relatively low wage level, enabled the country to gain, and maintain, a superior position in steel trade over competitors. In 1960, the average wage per head in steel industry was U.S.$0.45 an hour in Japan, compared with U.S.$1.03 in West Germany and U.S.$3.58 in the United States, and after ten years it was still lower in Japan at U.S.$1.47 than U.S.$2.32 and U.S.$5.08 respectively in West Germany and the United States.[5] Labor productivity (the output of crude steel per head of labor) in 1970 was 367 tons in Japan, compared with 249 tons in West Germany and 243 tons in the United States.

The difference in age of equipment in operation is glimpsed, for example, from the distribution of LD converters and open-hearth furnaces in use. The LD converter is a postwar innovation which not only reduces the time of refining and raises productivity but costs 30 per cent less than the open-hearth furnace to install [8]. Replacement of open-hearth furnaces with LD converters went on in major producing countries in postwar years. The relative distribution of LD converters and open-hearth furnaces as measured in terms of produced crude steel was 79 per cent to 4 per cent in Japan in 1970, compared with 56 per cent to 26 per cent in West Germany, and 48 per cent to 37 per cent in the United States in the same year. The United States and EC countries kept up investments to compete with Japan, but their investments were chiefly for the expansions and renovations of the existing mills. For instance, new investments in the United States were limited to the mill of U.S. Steel at Fearless in the 1950s and another one of Bethlehem Steel at Burnsharbor in the 1960s. In contrast, capital invest-

[4] The long-term trend of self-sufficiency in the cotton textile industry of Japan shows a clear decline, reflecting the process of catch-up by NICs. The trend curve of self-sufficiency observed in the steel industry indicates a strong possibility that it will take a similar turn in the foreseeable future. For detailed analysis, see [15].

[5] The figures on wage and labor productivity are calculated from data cited in [1].

ments in Japan were mostly for the construction of integrated steel mills, and the resultant improvements in productivity functioned to prevent rises in product price. During 1960–70, for instance, the wholesale price of steel rose only 0.3 per cent per annum in Japan, compared with 3.1 per cent in West Germany and 18.6 per cent in the United States. This attests to Japan's rapid gain in international competitiveness.

The factors which had contributed to Japan's expansion of steel exports during the 1960s were replicated in the NICs after the mid-1970s. Korea and Brazil began to construct the most advanced integrated steel mills by turnkey plant imports, and it was not difficult to absorb the standardized production technology. In Korea, for instance, it took only three and a half months after the firing in 1973 of the newly completed number-one blast furnace to achieve the maximum design level of output at the Pohang Iron and Steel Company (POSCO) [10, Chap. 3], and the number of blast furnaces at POSCO increased to four by 1981. Rapid expansions of plant capacity also went on in Brazil and Taiwan during the same period. Introduction of the most advanced plants brought a large gain in labor productivity in these countries. The speed of Korea's productivity improvements exceeded that of Japan's. The output of crude steel per head of labor in 1982 reached 448 tons in Korea, which was about 80 per cent of Japan's 532 tons, but greatly exceeded 283 tons in West Germany and 284 tons the United States. The average hourly wage in Korea in the same year was only one-third the hourly wage in Japan. If the costs of capital investments are excluded from consideration, this means that Korea could well meet Japan's competition in price, even with only one-third the level of the latter's labor productivity. Korea's actual price advantage is naturally larger than this, as one recent study estimates that Korea's export price per ton is U.S.$100 cheaper than the United States' and U.S.$50 cheaper than Japan's [10, p. 55].

The loss of price competitiveness observed in the industrialized countries after the mid-1970s partly came from the decline in capacity utilization. The annual average rate of operation during 1975–82 was 66.4 per cent in Japan, 76.2 per cent in the United States, and 64.2 per cent in nine EC countries, compared with 85.4 per cent in Korea and 86.7 per cent in Brazil. The share of the constant cost in the total production cost is necessarily high in capital-intensive industries like iron and steel, and the lower the volume of output moves from the plant capacity, the higher rises the cost of production per unit of output.

The emergence of more competitive producers and the loss of price competitiveness from the decline in capacity utilization have led to increased imports of steel in Japan as well as in other industrialized countries. Unless the production technology of steel itself undergoes some fundamental transformation, the mechanism of inter-country competition as discussed above will run its due course. In other words, before long, Japan and EC countries are likely to follow the course already taken by the United States.

III. OVERPRODUCTION AND INDUSTRIAL ADJUSTMENTS

A. *Problems of Excess Capacity*

The world's combined production capacity in 1955 was 285 million tons in crude steel relative to the total production of 273 million tons. In other words, the rate of excess capacity was only 4.2 per cent some thirty years ago. After the mid-1950s, however, the capacity grew at a higher rate than the world total demand. In 1975, it reached 671 million tons relative to the output of 596 million, an excess in capacity of 11.2 per cent. By 1983, the excess rose to 29.3 per cent, with the production of 662 million tons from the capacity of 936 million. The size of excess capacity in the early 1980s is obviously affected by the recession of the world economy, and therefore the figure for 1983 must be treated with caution. Nonetheless, a considerable number of studies agree in foreseeing the continued excess in capacity for the rest of the 1980s. For instance, *Metal Bulletin Monthly* in its March issue of 1983 estimates the world total capacity of 1,002 million tons for the year 1987. If one takes the production of 802 million tons as estimated by the Chase Econometrics for the same year [12, p. 552], the excess would come to some 20 per cent. It must be noted that the Chase Econometrics forecasts are on the optimistic side. The projection based on the more conservatively estimated International Iron and Steel Institute (IISI) consumption figures suggests an excess in capacity of 37 per cent for the year 1990, even assuming that there would be no increase in capacity during 1987–90. And the industrialized countries would account for 81 per cent of this excess.

The excess capacity has grown into a chronic problem chiefly in the industrialized countries. The rate of capacity utilization in these countries markedly dropped after the mid-1970s and has continued to worsen since. In the 1960s, the rates of utilization ranged from 80 per cent to 90 per cent among the industrialized countries, but during 1974–83 they dropped from 78 per cent to 62 per cent in Japan, from 76 per cent to 55 per cent in the United States, and from 87 per cent to 55 per cent in EC countries. On the basis of the aforementioned projection for 1987, the excess in capacity is estimated to be 31 per cent in Japan, 20 per cent in the United States, and 28 per cent in EC countries by the late 1980s. Of the total excess of 201 million tons projected in 1987, 142 million, or 71 per cent would be accounted for by these developed countries.

B. *Supply and Demand Imbalances in DCs and NICs*

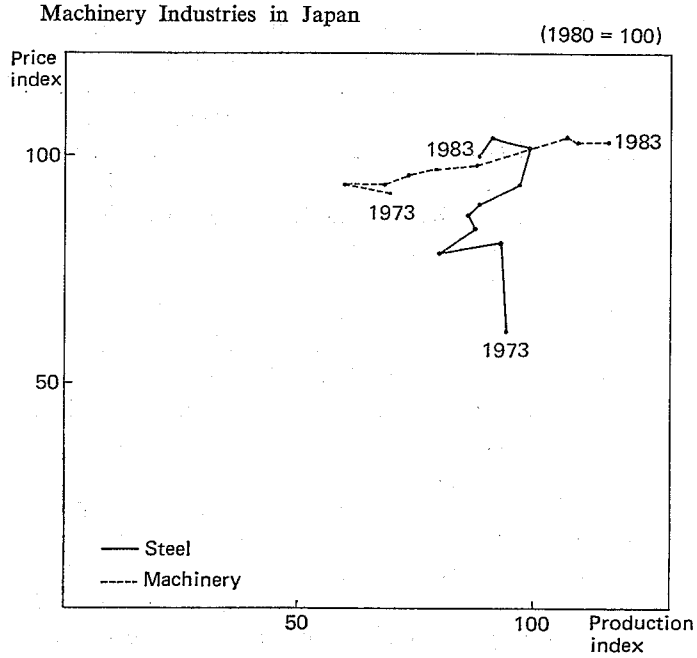
There are a number of factors which one might surmise have contributed to the persistent and growing excess capacity in the industrialized countries, but the most notable factor would be the stagnation of demand. Since the time of the Industrial Revolution, the demand for steel almost consistently increased under the influence of the multiplier effects of technological innovations. The rate of increase in demand always exceeded the growth rate of income. However, the situation is now changed in the industrialized countries. The demand for

steel would evolve in its life cycle from the stage when income elasticity is larger than parity to the stage when it gradually declines below parity, and finally nears the deadend beyond which there would be only a minimal increase, if any, of per capita consumption [11, Chap. 2]. The income elasticity (the ratio of the growth rate in per capita apparent steel consumption to the growth rate in per capita GDP) during 1970–80 is 0.2 in the United States, 0.4 in Japan, 0.5 in West Germany, 0.4 in the United Kingdom, and 0.3 in France, all of which are markedly lower than 2.0 in Korea and 1.3 in Brazil during the same period. The correlation between per capita consumption of crude steel and per capita GNP in 1980 shows that the level of consumption is higher in countries of higher income. But the levels of per capita consumption in the industrialized countries fall in the narrow range between 500 kilograms and 700 kilograms, indicating that they are close to saturation. Changes in per capita consumption during 1972–80 were from 663 to 508 kilograms in the United States, from 643 to 629 kilograms in Japan, and from 495 to 446 kilograms in six EC countries, supporting this finding.

In newly industrializing countries where sustained development efforts are expected to generate rapid economic growth, the consumption of steel will normally expand rapidly because a larger part of steel is used as intermediate inputs in many sectors. In other words, an increase by one unit of final demand for steel will induce, by way of its direct and indirect effects on all the sectors of an economy, an increase by more than one unit of demand for steel. This effect is expressed by the production inducement coefficient. From the international input-output tables prepared for the year 1975, the coefficient is calculated to be 3.0978 in Korea, 3.0550 in Japan, and 2.1932 in the United States [3]. The higher figure reflects the larger proportion of steel used as intermediate inputs, and the coefficient tends to decline in the industrialized countries.

From the series of input-output tables for Japan, for example, it was found that the input of steel increased in almost all the sectors during 1965–70, but that it began to show a decline or stagnation in a considerable number of sectors during 1975–80 [4] [5]. The country's production inducement coefficient accordingly dropped from 2.69 in 1975 to 2.64 in 1980. To refer instead to the coefficient of steel production induced from an increase by one unit of final demand, it steadily dropped in Japan from 0.13 in 1970 to 0.11 in 1975, and 0.10 in 1980. This decline indicates the rise in importance of new industries, most notably electronics, which require less steel as inputs than the conventional industries, on the one hand, and the on-going substitution of steel by a variety of new materials like ceramics and plastics, on the other. After the oil crisis in the early 1970s, the energy-consuming steel industry in Japan found it more and more difficult to maintain the leading position it had enjoyed in the 1960s, because it became increasingly unable to absorb the rises in energy cost in order to supply steel at a price favorable to the users. To compare the industry with the machinery industry, which grew rapidly in Japan during the 1970s, by the price and output correlation during 1973–83, the output declined with rises in

Fig. 3. Correlations of Production and Price in Steel and Machinery Industries in Japan



Source: Bank of Japan, Research and Statistics Department, *Keizai tōkei nenpō, 1983* [Economic statistics annual, 1983] (Tokyo, 1984).

price in the former, while the output increased with more or less stable price in the latter (Figure 3). During the 1960s, the steel industry had shown the correlation similar to the machinery industry of the 1970s. The production of steel had expanded through the mechanism where an expansion of demand would lead to an increase in the scale of production, which would, by lowering the price of steel, lead to another round of demand increase. The correlation during 1973–83 shows however that this mechanism has now gone out of gear, and that other industries have responded to the rises in price by cutting down their consumption of steel.

C. *Industrial Adjustments Policy*

The growth of global demand for steel decelerated from 6.3 per cent per annum during 1951–60 to 5.8 per cent during 1961–70 and 2.0 per cent during 1971–80, and according to the unofficial forecast of the IISI, the rate will go down further to a mere 0.5 per cent in the 1980s. This slowdown of growth will be, as it has been, largely due to the stagnation of demand in the industrialized countries. In the developing countries including NICs, the demand during the 1980s is expected to increase rapidly, at an estimated rate of 4 per cent. If the industrialized countries had had a monopoly over the production of steel, the current problems of excess capacity would not have materialized, for they could

have supplied to the expanding external market. However, the substantially increased number of producing countries, especially of newly exporting countries, precluded them from taking the entire share of the increase in world total demand. On the contrary, they even began to yield part of their own domestic markets to new competition, as already shown in the steel flow matrix.

During the 1960s when Japan managed a rapid expansion of its steel export, the growth of demand in the industrialized countries was still high enough to mask the problems of emerging overcapacity and declining capacity utilization. However, the expansion of NICs' exports after the mid-1970s coincided with the period of declining demand in the industrialized countries, and it was identified as one of the factors that depressed the rate of operation in the latter's steel industries. Furthermore, the demand for steel is projected, as by the IISI, to decrease in the industrialized countries in the 1980s, while the NICs and semi-NICs are energetically planning to expand their respective capacity. It looks as if the problems of excess capacity will persist, or even worsen, in the industrialized countries in the foreseeable future.

The presence of idle capacity pushes up costs of production. Therefore, the industrialized countries have been trying to concentrate as much production as possible in the newer, efficient mills, while shutting down the old, nonviable ones. According to the report by the IISI secretariat, shutdowns planned for the 1980s are estimated to range from 10 million to 16 million in capacity tons in the United States, from 32 million to 42 million tons in nine EC countries, and from 7 million to 12 million tons in Japan. Through such reduction, these countries are planning to raise the level of capacity utilization and lower production costs, in the hope of regaining their competitive edge. The projected decline of excess capacity from some 30 per cent in 1983 to 20 per cent in 1987, as referred to in the beginning of this section, presumably reflects such efforts on the part of the industrialized countries.

Because the rationalization of the existing mills alone is not likely to suffice for the recovery of their competitive edge in domestic and external markets, the governments of the industrialized countries have been trying out various measures to promote new capital investments. The United States government, for instance, introduced the minimum import price by instituting the system of trigger price, and shortened the legal period of depreciation for new fixed assets. The American Iron and Steel Institute once pointed out that capital investment requirements to revamp the country's steel industry would annually amount to U.S.$7 billion during the 1980s. The actual figure was U.S.$3.39 billion in 1980, U.S.$3.37 billion in 1981, and U.S.$4.22 billion in 1982. In order to strengthen competitiveness by abandoning state subsidization[6] and reducing excess capacity, EC countries raised domestic prices in gradual steps, set up the basic import prices, and negotiated bilateral trade agreements over price and volume. These measures

[6] Cumulative totals of state subsidies during 1975–83 were DM47.8 billion in Italy, DM26.0 billion in Belgium, DM27.4 billion in France, and DM48.8 billion in the United Kingdom. Approximately 20 per cent of these subsidies were channelled to the steel industries, the rest going to various non-ferrous metals. For details, see [7, p. 163].

were hoped to boost their steel industries' profits and capital investments, but the actual total investments of seven EC countries amounted to U.S.$3.38 billion in 1980, U.S.$2.75 billion in 1981, and U.S.$2.84 billion in 1982, which were lower than the figures of the United States alone.

The policy measures now pursued in the United States and EC countries are meant to revitalize their respective steel industry by opening up, to a certain extent, their domestic markets to imports, and at the same time by securing some safe percentage of the markets for their domestic enterprises. They are part of the industrial adjustments policy. Industrial adjustments primarily seek to direct productive factors, with the least possible disruption, from industries which have lost comparative advantages to those which possess them, but one of the underlying expectations in the policy is to let the declining industries regain their lost competitiveness in the process. It is desirable in principle to implement the policy without interfering with competition in the market, but industrial adjustments take time, while imports could increase more rapidly than the progress of the policy. The United States and EC countries have been trying to buy enough time for their industrial adjustments by working out restrictive trade agreements with steel-exporting countries. Perhaps their stances cannot be seen as going against the principle of free trade, as long as their ultimate objectives are to carry out the industrial adjustments in the sense described above. However, it is not clearly defined when and how one judges the successful completion of industrial adjustments, or more specifically, what sort of shape their steel industries should be in before trade restrictions are lifted. Considering the projected levels of excess capacity in these countries, trade agreements and other measures which restrict market competition are likely to persist for some time to come.

The government of Japan, so far, has not taken measures similar to those in the United States or EC countries, although the steel makers have tried some steps, such as putting pressures on trading companies which import steel from the NICs and restricting the exports of steel plants to these countries. Because many steel mills in Japan will come to the end of their depreciation periods some time after 1985, it is quite possible that the government will introduce some measures to favorably affect the industry's future capital investments and product prices.

IV. NICs' CATCH-UP AND IMPLICATIONS FOR JAPAN

The problem of industrial adjustments which currently faces the industrialized countries is both similar to and different from what the United States had to cope with when its import of steel from Japan rapidly increased during the 1960s. The dependence on imported steel rose sharply in the United States in postwar years from only 2 per cent of domestic consumption in 1957 to 5 per cent in 1960 and passed 10 per cent in 1965. In recent years, the rate was ranged from 16 to 20 per cent. Japan's dependence on imported steel in recent years was considerably lower than in the United States, but the pace of increase was more rapid. According to the balance of supply and demand with respect to ordinary

steel, the country's import dependence had remained less than 1 per cent until 1978, but rose to nearly 5 per cent by 1983. During eight months from January to August in 1984, Japan imported 280 million tons of steel, with its import dependence rising to 6.7 per cent. The total import is expected to reach some 400 million by the end of the year [17].

The rapid expansion of import is one of the phenomena associated with the process of being caught up by late comers, and is commonly observed in industries other than steel. The rapid rise in Japan's import dependence reflects the so-called "compressed process" of catch-up by newly exporting countries like Korea.[7] Trade frictions between the industrialized and the newly industrializing steel exporters are being observed not only in the former's domestic markets but in the third countries', such as ASEAN countries, markets. What differed in the 1960s compared with the present situation was that the demand for steel was at the time increasing in the industrialized countries as well. Although the demand in the developing countries is expected to increase in the future as well, the demand in the industrialized countries might even decrease in absolute as well as relative terms. This slower pace of expansion anticipated in the global market of steel makes it more difficult to plan and carry out needed industrial adjustments.

The attitudes toward steel imports have changed appreciably in Japan in the last few years. Steel makers including the largest, Nippon Steel Corporation, reportedly tried to press for the boycott of imports among the domestic users of steel during the 1970s. But as seen from the increased import contracts of wide flange beams from Korea by seven major trading companies in 1983, the country's reactions to imports are clearly changing. Japanese steel makers will find it increasingly difficult to counter competition by some extra-market maneuvers in the future.

In a discussion of the adjustments policy appropriate for steel industry, it is important to weigh the future prospects of domestic supply and demand in the newly industrializing countries. Korea, for instance, is likely to experience the first decrease ever in its steel export this year (1984), and considering the accelerating pace of motorization, it is becoming less easy now than before to hold the view that the country's exportable surplus will continue to expand as rapidly as it did in recent years. On the other hand, a rapid growth of domestic demand in the near future will contribute to an expansion in the scale of production, thus inducing an increase in the country's exportable surplus.

Faced with the rapid catch-up by the newly industrializing exporters, Japan is basically left with a choice between two alternatives; namely, the adoption of a controlled trade regime, or the upholding of the free trade principle. It is commonly observed that a lack or a loss in competitiveness leads to the adoption of a protectionistic, controlled trade regime. However, if Japan's steel industry is to survive through market competition in the long run, it would be due to its sustained efforts at technical innovations and its readiness to invest a sizable

[7] The first blast furnace of POSCO in Korea was fired in July 1973, and the country turned a net exporter in 1979.

amount of capital in order to integrate such innovations into some viable system of production. The Japanese steel industry reached the present scale of operation by rapidly increasing its share in the external market, notably in the United States. It is hardly justifiable for Japan to take a protectionist stance now, simply because it is now in the position of being caught up instead of catching up.

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