

# CHANGES IN JAPAN'S INDUSTRIAL STRUCTURE SINCE THE OIL CRISIS

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## INTRODUCTION

**T**HE purpose of this paper is to analyze the industrial adjustment process of manufacturing industries in Japan since the first oil crisis.

In the first section of this paper, we give a descriptive analysis of the macroscopic outlook of the Japanese economy and of change in the Japanese industrial structure, with the focus mainly on manufacturing industries.

The second section studies the factors that have made possible such adjustment of the industrial structure, using the "degree of dependency of production of each sector on each item of final demand" on the basis of the Leontief model.

In the third and final sections, the industrial adjustment that has occurred since the first oil crisis is put into relief through analysis of the factors of change in the industrial structure, using a model formulated on the basis of the Leontief model.

### I. THE FIRST OIL CRISIS AND CHANGE IN THE INDUSTRIAL STRUCTURE

In 1980 was held the sixth summit conference of the world's developed capitalist countries in a series initiated by French President Giscard d'Estaing for the purpose of rebuilding the world economy after the first oil crisis. Still fresh in our memories are the expectations given rise to by the "locomotive theory," set forth at the London summit in 1977, which held that the U.S., Japanese, and West German economies should have the role of pulling the other national economies along, and by the idea espoused at the Bonn summit in 1978 that each country should do its part toward correcting the imbalances in international payments. Then at the Tokyo summit in 1979, energy problems were the main subject on the agenda, all of the participating countries being well aware of the need for industrial adjustment with a view to reducing energy consumption.

At the present time, all of the developed capitalist countries with the exception of Japan are looking more and more like they are in a recession. Japan, on the other hand, although having experienced growth stagnation immediately after the first oil crisis, with negative growth of 0.5 per cent in GNP in 1974 and positive growth of only 1.4 per cent in 1975, subsequently experienced a pickup in economic conditions mainly due to private demand supported by plant and equipment investment and exports and has since then registered steady GNP

TABLE I  
GNP GROWTH RATE (REAL)

Sector	Year						
	1973	1974	1975	1976	1977	1978	1979
Gross national expenditure	10.0	-0.5	1.4	6.4	5.2	5.7	6.1
Private final consumption expenditure	9.5	0.8	4.2	4.4	3.8	6.2	5.0
Governmental final consumption expenditure	5.5	3.4	6.2	3.7	4.3	5.6	3.4
Private housing investment	16.4	-12.7	2.4	9.5	1.3	2.7	-1.6
Private investment in plant and equipment	18.6	-6.1	-6.9	0.6	1.1	11.1	13.0
Public fixed capital formation	8.3	-13.8	5.2	3.7	10.4	15.9	-1.4
Private inventory investment	26.7	25.4	-95.2	477.0	29.9	165.9	88.0
Increase in public inventories	—	—	474.5	-21.5	17.1	-7.6	-95.2
Exports	8.6	22.4	3.9	20.0	11.3	-1.4	14.1
Imports	25.3	10.4	-9.1	8.0	-3.5	13.8	12.8

Note: Figures calculated on the basis of information given in Economic Planning Agency, *Kokumin keizai keisan nempō* [National economic statistical yearbook] (1980).

growth: 6.4 per cent in 1976, 5.2 per cent in 1977, 5.8 per cent in 1978, and 6.1 per cent in 1979. This has been due to a marked increase in exports in 1976, exports and government investment in 1977, private investment in plant and equipment and exports in 1979, as indicated in Table I, and to the appropriate industrial adjustment undertaken in relation to such increases.

There are three factors behind the fact that private investment in plant and equipment has shown the high rate of increase in past several years. First of all, there is the fact that replacement investment became very active because of the obsolescence of production facilities that resulted from the couple of years during which businesses held back their investment in plant and equipment, contributing to the economic recession. Secondly, there has been a great deal of investment for the purpose of reducing energy consumption in view of the high price thereof, and thirdly, automobile, electrical machinery, and other manufacturers that have been doing well in exports as a result of greater international competitiveness have been investing to expand their production capacities.

In the course of these developments, the Japanese industrial structure has undergone pronounced change. Table II and Figure 1 show such change over the eighteen years between 1960 and 1978 in terms of production figures for different industries.

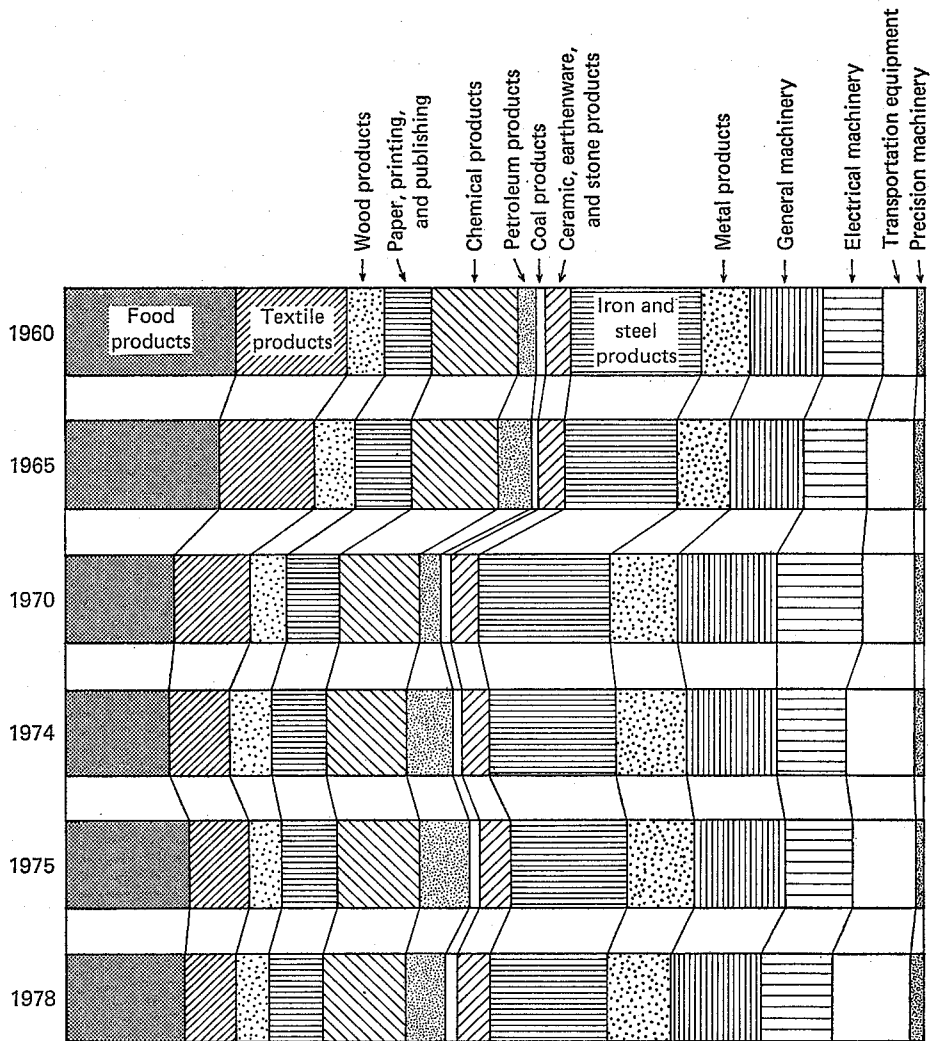
The repercussions of the oil crisis that occurred at the end of 1973 caused a 0.5 per cent decline in GNP, a 12.7 per cent decline in private housing investment, a 6.1 per cent decline in private investment in plant and equipment, and a 13.5 per cent decline in government investment in 1974 in comparison to the year before, and under these recession conditions, there was a pronounced slump in industrial activity in 1975, total production of manufacturing industries declining by about 1,900 billion yen from about 140,000 billion yen in 1974

TABLE II  
VALUE OF PRODUCTION BY INDUSTRIES

Industry	1960		1965		1970		1974		1975		1978	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
Food products	3,622	18.85	5,739	16.91	9,621	12.34	16,894	12.02	19,008	13.72	23,798	13.25
Textile products	2,350	12.23	3,592	10.59	6,135	7.87	9,214	6.56	9,419	6.80	11,061	6.16
Wood products	790	4.11	1,563	4.61	3,399	4.36	6,093	4.34	5,403	3.90	6,371	3.55
Paper, printing, and publishing	1,055	5.49	2,096	6.18	4,473	5.74	8,733	6.21	8,507	6.14	10,632	5.92
Chemical products	1,856	9.66	3,519	10.37	7,040	9.03	12,666	9.01	12,444	9.00	16,490	9.18
Petroleum products	481	2.50	1,031	3.04	2,373	3.04	7,044	5.01	7,788	5.62	8,581	4.78
Coal products	153	0.80	249	0.73	646	0.83	1,200	0.85	1,851	1.34	2,062	1.15
Ceramic, earthenware, and stone products	523	2.72	1,024	3.02	2,670	3.42	5,050	3.59	4,875	3.52	7,010	3.90
Iron and steel products	2,779	14.46	4,186	12.34	11,285	14.48	20,251	14.41	19,169	13.83	23,060	12.84
Metal products	1,012	5.27	2,134	6.29	5,633	7.23	10,491	7.46	9,349	6.75	12,486	6.95
General machinery	1,564	8.14	2,758	8.13	8,324	10.68	13,781	9.81	13,561	9.79	17,971	10.01
Electrical machinery	1,396	7.27	2,378	7.01	7,632	9.79	11,278	8.03	10,584	7.64	15,905	8.86
Transportation equipment	1,420	7.39	3,161	9.32	7,624	9.78	16,021	11.40	14,979	10.81	21,533	11.99
Precision machinery	215	1.12	499	1.47	1,103	1.41	1,802	1.28	1,639	1.18	2,611	1.45
Total	19,216	100.00	33,929	100.00	77,958	100.00	140,518	100.00	138,576	100.00	179,571	100.00

Sources: The figures for 1960, 1965, 1970, and 1975 are based on the input-output tables compiled for those years by the Administrative Management Agency and other government agencies, and those for 1974 and 1978 are based on extended input-output tables compiled by the Ministry of International Trade and Industry.

Fig. 1. Change in the Industrial Structure



Sources: See Table II.

to about 138,600 billion yen in 1975. Particularly serious production slumps occurred in the electrical machinery, iron and steel, metal products, and transportation equipment industries.

However, being supported by self-help corporate efforts and industrial adjustment through the market mechanism, in 1976 and 1977 business conditions recovered chiefly owing to private demand, and industrial activity regained its vitality, and in 1978 the level of total production reached 179,600 billion yen, for a high average annual growth rate of 13.68 per cent from 1965.

Let us now take a brief look at the change in the Japanese industrial structure over those years.

First of all, one is struck by the sharp decline during that period in the share of total production represented by light industry, and particularly textile manufacturing industry, which was suffered from growing power of international competition in newly industrialized countries and from a decline in exports due to the high exchange rate of the yen to the dollar. In 1978, textile products represented only 6.16 per cent of the total production of Japanese manufacturing industries, whereas they accounted for a full 12.23 per cent in 1960. Likewise, food products experienced a decline from 18.85 per cent to 13.25 per cent over the same period.

On the other hand, Japan's heavy and chemical industrialization, with emphasis on the chemical industry, was largely completed during this period, and particularly between 1965 and 1970, the government promoting this heavy and chemical industrialization through concrete policies for (1) concentration of capital, funds, raw materials, etc. in strategic industries; (2) protection and fostering of such industries with import restrictions, protective tariffs, low-interest financing, and tax breaks; and (3) concentration of public investment in the fields of industrial infrastructure. In addition, there were such advantages in terms of international competitiveness as a very low exchange rate of 360 yen to the dollar, available of large quantities of petroleum at low prices, and the nonexistence of strong competitors among other Asian countries. Under these background, the Japanese government formulated a Medium-term Economic Plan (*Chūki keizai keikaku*) in January 1965 and a Socioeconomic Development Plan (*Keizai shakai hatten keikaku*) in March 1967, both under cabinets headed by Prime Minister Satō, which set the target rate of growth of GNP as 8.1 per cent and 8.3 per cent, respectively. The actual growth rates, however, were a much higher 10.8 per cent and 10.9 per cent, being supported by private investment in plant and equipment and government investment. Looking at individual industries, we see that there were marked increases in the percentages share of total production of iron and steel, metal products, machinery, and other heavy industries between 1965 and 1970: iron and steel from 12.34 per cent to 14.48 per cent, metal products from 6.29 per cent to 7.23 per cent, and machinery from 25.93 per cent to 31.66 per cent, with particularly great increases in the cases of general machinery and electrical machinery, from 8.13 per cent to 10.68 per cent and 7.01 per cent to 9.79 per cent, respectively.

As we have already seen in Table I, the sudden oil crisis of 1973-74 brought about a sharp decline in corporate enthusiasm for investment in plant and equipment. Under such business conditions, such industries as iron and steel, electrical machinery, and general machinery could do nothing to prevent their shares of total Japanese industrial production from declining again, to 13.83 per cent in 1975 in the case of the iron and steel industry, versus 14.48 per cent in 1970, 7.64 per cent versus 9.79 per cent in the case of the electrical machinery industry, and 9.79 per cent versus 10.88 per cent in the case of the general machinery industry.

TABLE III  
 PERCENTAGE OF ALL JAPANESE INDUSTRY CONSTITUTED  
 BY HEAVY AND CHEMICAL INDUSTRY

Year \ Sector	Light Industry	Heavy Industry
1960	40.68	59.32
1965	38.29	61.71
1970	30.31	69.69
1974	29.13	70.87
1975	30.56	69.46
1978	28.88	71.12

Source: Calculated from Table II.

Of these three industries, the electrical machinery and general machinery industries recovered its activities around 1976 mainly depending upon private investment in plant and equipment at home and upon exports, and their production shares returned to 8.80 per cent and 10.01 per cent, respectively, by 1978.

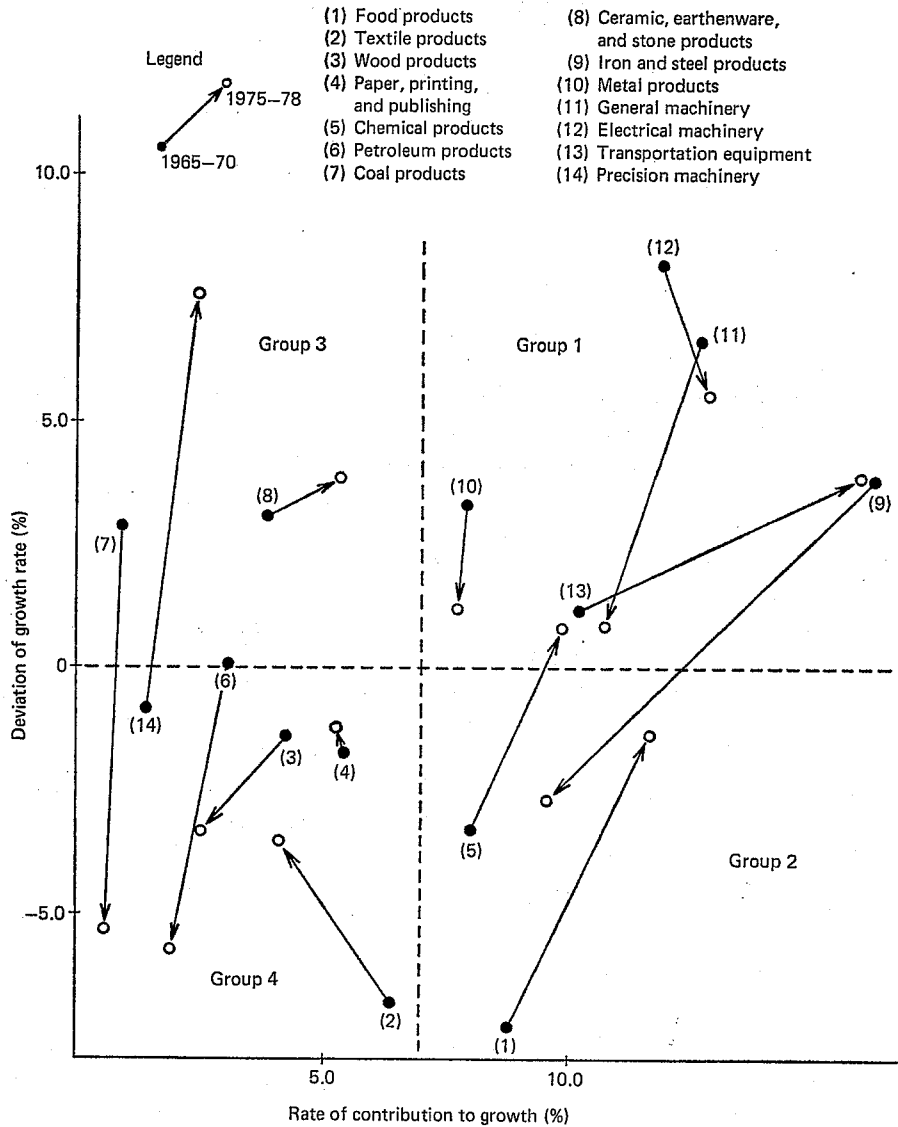
Prior to about 1973, the exchange rate of yen to the dollar had been highly valued for quite some time, but for a time after the oil crisis it did not do so well. In 1976, however, the exchange rate rose again owing to steadily increasing exports, reaching a peak in 1978. In addition, around 1978 the problem of the so-called structural recession industries such as electric open-hearth furnace steel manufacture, aluminum refining, synthetic fiber, shipbuilding, and spinning were coming to a head under circumstances of, among other things, higher and higher oil prices and the mounting challenge posed by the newly industrialized countries. Around the middle of 1978, however, the government began to provide policy guidance in the direction of adjustment of the industrial structure on the basis of newly enacted laws such as the Temporary Measures Law for Stabilization of Particular Recession Industries (*tokutei fukyō sangyō antei rinji sochi hō*) and the Temporary Measures Law for Relief of Smaller Businesses in Particular Recession Areas (*tokutei fukyō chiiki chūshō-kigyō taisaku rinji sochi hō*) in order to cope with such structural recession.

Although the shipbuilding industry had to be reorganized because of the seriousness of its structural recession, the transportation equipment industry as a whole has increased its share of total production under such conditions, largely owing to the good showing of the motor vehicle industry, from 9.78 per cent in 1970 to 11.40 per cent in 1974 and 11.99 per cent in 1978, with only a dip in 1975 to 10.81 per cent as a consequence of the shipbuilding recession.

Thus, in spite of a setback in 1975 right after the first oil crisis, Japanese heavy and chemical industrialization continued to make steady headway in the 1970s, as shown in Table III.

Using the figures in Table II, let us define the rate of contribution to industrial growth of each industry as being its increase in production,  $\Delta X_i$ , divided by the total increase in production for all industries,  $\sum \Delta X_i$ . This is, in other words, the degree to which the growth of a particular industry contributes to the growth

Fig. 2. Rate of Contribution to Industrial Growth and Deviation of Growth Rate by Industries



of all industry. Furthermore, let us define the difference between the rate of growth of a particular industry,  $\Delta X_i/X_i$ , and the rate of growth of all industry,  $\sum \Delta X_i / \sum X_i$ , as the deviation of growth rate of that industry. Figure 2, in which the deviations of growth rate of particular industries are plotted with respect to the vertical axis and their rates of contribution to growth with respect to the horizontal axis, compares how each industry stood in terms of these values during the five-year period, 1965-70, during which Japanese heavy and chemical

industrialization was completed, as indicated in Table II, to how it stood in the three-year period 1975–78, during which the industrial adjustment after the first oil crisis was completed.

From Figure 2 it is possible to make a list of the leading industries, i.e., those that are both large in scale and high in growth rates. These are the industries belonging to Group 1, i.e., all of the machinery industries, as one can see in the figure. From the fact that the transportation equipment industry in particular has a shift in coordinate position between the two periods in the direction of the upper right-hand corner, it is clear that it played a leading role in the superb recovery of the Japanese economy from the first oil crisis. Furthermore, of the industries belonging to Group 1 during the period 1965–70, the iron and steel industry fell to Group 2 in the period 1975–78, the group of large-scale industries that are stagnating, which shows that the iron and steel industry is in a structural recession.

Although the chemical industry belonged to Group 2 in the period 1965–70, it jumped up to Group 1 in the period 1975–78 to become one of the leading industries in the Japanese economy.

Group 3 and Group 4 can be characterized as growing small-scale industries and stagnating small-scale industries, respectively. Although the coal products industry belonged to Group 3 in 1965–70, it was relegated to Group 4 in 1975–78, and the precision machinery industry made the reverse advancement between the two periods.

As we have seen, the first oil crisis was the occasion for a fairly drastic industrial adjustment within the Japanese economy, which had already just about completed its heavy and chemical industrialization, and depending upon that industrial adjustment the Japanese economy was able to make an admirable comeback.

## II. THE CHANGE IN THE INDUSTRIAL STRUCTURE AND THE STRUCTURE OF FINAL DEMAND

In the preceding section, we gave a brief summary of the Japanese industrial structure by taking a look at the statistical breakdown of production by industry. In this section, we are going to analyze the factors comprising that industrial structure with the help of Leontief's input-output model [2].

In a national economy, relations of mutual interdependence are established among different industries with different technological structures through the input of raw materials. In the motor vehicle industry, for example, production would be impossible without the supply of chassis, glass, rubber, and so on, and iron and steel is necessary for the production of chassis while limestone, soda ash, and bleaching powder are necessary in the production of glass, and caustic soda, magnesium carbonate, and benzol are necessary in the production of rubber. The motor vehicle industry therefore has indirect relations of interdependence with the production of benzol, for example.

Leontief model, of course, is a system for determining the total amounts



of different products needed directly and indirectly by different industries in accordance with their technological structures in order to meet the final demand such as consumption, investment, and exports.

By multiplying the inverse matrix coefficients in the Leontief model by column vectors of the final demand (consumption, investment, exports, etc.), one obtains the amount of production induced in each industry by each item of final demand. This amount for each item of final demand divided by the total amount of production of a particular industry gives us a coefficient indicating the degree to which the production of that industry is dependent on each item of final demand. The mathematical definition of such coefficients is as follows [1, pp. 88–89]:

- (a) The degree of dependency of the production of sector  $i$  on consumption

$$= \sum_{j=1}^n b_{ij} C_j / X_i;$$

- (b) The degree of dependency of the production of sector  $i$  on investment

$$= \sum_{j=1}^n b_{ij} I_j / X_i;$$

- (c) The degree of dependency of the production of sector  $i$  on exports

$$= \sum_{j=1}^n b_{ij} E_j / X_i;$$

where  $b_{ij}$  is the row  $i$ , column  $j$  element of the Leontief inverse matrix, and  $C_j$ ,  $I_j$ , and  $E_j$  are the amounts of product  $j$  going to consumption, investment, and exports, respectively.

Table IV gives the coefficients of the degree of dependency of the production of major industrial sectors on household consumption, gross domestic fixed capital formation, and exports for 1970, 1974, 1975, and 1978 for comparison before and after the oil crisis as calculated on the basis of input-output tables published by the government (1970 and 1975) and the Ministry of International Trade and Industry (1974 and 1978).

As can be seen in Table IVA, only the production of consumer-goods sectors such as food products, textile products, and printing and publishing is highly dependent on household consumption among major manufacturing industries. Looking at the change in these coefficients over time, the degree of dependency of the production of food product sectors on household consumption has been rising, as has that of such sectors as spinning and clothing, except for a decline in 1975. Leather products and petroleum products have also shown a steady rise in such degree of dependency between 1970 and 1978 in spite of the oil crisis, with rather high coefficients of 0.728 and 0.516, respectively, in 1978.

Such degree of dependency of iron and steel, general machinery, electrical machinery, transportation equipment, and other heavy industry sectors has also been rising, that of the transportation equipment industry in particular, with the motor vehicle industry figuring most prominently, rising from 0.168 in 1970 to 0.239 in 1974 and 0.258 in 1978 after a slight decline in 1975 to 0.236 as a result of the oil crisis.

TABLE IV  
A. DEGREE OF DEPENDENCY OF THE PRODUCTION OF DIFFERENT  
SECTORS ON HOUSEHOLD CONSUMPTION

Sector	Year			
	1970	1974	1975	1978
Butcheries, meat, and dairy products	0.912	0.903	0.936	0.928
Fishery products	0.822	0.834	0.880	0.880
Refined grains and meals	0.946	0.915	0.962	0.937
Personal effects	0.734	0.832	0.871	0.881
Natural fiber spinning	0.592	0.636	0.637	0.623
Chemical fiber spinning	0.562	0.584	0.558	0.595
Woven goods and other textile products	0.636	0.679	0.645	0.670
Pulp and paper	0.442	0.400	0.525	0.519
Printing and publishing	0.578	0.543	0.599	0.604
Leather and leather products	0.651	0.682	0.724	0.728
Petroleum products	0.449	0.431	0.478	0.516
Coal products	0.113	0.057	0.095	0.119
Ceramic, earthenware, and stone products	0.154	0.148	0.149	0.147
Pig iron and crude steel	0.111	0.091	0.102	0.129
Primary steel products	0.116	0.104	0.104	0.125
Primary nonferrous products	0.183	0.165	0.177	0.178
Metal products	0.210	0.193	0.219	0.217
General machinery	0.074	0.096	0.085	0.089
Electrical machinery	0.170	0.155	0.204	0.171
Transportation equipment	0.168	0.239	0.236	0.258
Precision machinery	0.344	0.342	0.334	0.304

B. DEGREE OF DEPENDENCY OF THE PRODUCTION OF DIFFERENT SECTORS  
ON GROSS DOMESTIC FIXED CAPITAL FORMATION

Sector	Year			
	1970	1974	1975	1978
Butcheries, meat, and dairy products	0.012	0.013	0.013	0.014
Fishery products	0.008	0.010	0.009	0.010
Refined grains and meals	0.010	0.015	0.009	0.011
Natural fiber spinning	0.087	0.086	0.098	0.101
Chemical fiber spinning	0.086	0.082	0.089	0.099
Woven goods and other textile products	0.087	0.086	0.100	0.109
Petroleum products	0.295	0.266	0.223	0.247
Coal products	0.533	0.384	0.460	0.551
Ceramic, earthenware, and stone products	0.681	0.665	0.694	0.716
Pig iron and crude steel	0.499	0.334	0.390	0.492
Primary steel products	0.520	0.377	0.418	0.492
Primary nonferrous metal products	0.444	0.320	0.455	0.471
Metal products	0.560	0.540	0.594	0.694
General machinery	0.709	0.612	0.628	0.604
Electrical machinery	0.528	0.517	0.515	0.496
Transportation equipment	0.528	0.371	0.321	0.324
Precision machinery	0.253	0.193	0.266	0.264

TABLE IV (Continued)  
 C. DEGREE OF DEPENDENCY OF THE PRODUCTION OF DIFFERENT  
 SECTORS ON EXPORTS

Sector	Year			
	1970	1974	1975	1978
Butcheries, meat, and dairy products	0.014	0.012	0.014	0.016
Fishery products	0.106	0.081	0.074	0.063
Refined grains and meals	0.016	0.009	0.007	0.006
Natural fiber spinning	0.234	0.213	0.199	0.167
Chemical fiber spinning	0.269	0.250	0.280	0.222
Woven goods and other textile products	0.196	0.181	0.185	0.151
Petroleum products	0.135	0.164	0.217	0.167
Coal products	0.258	0.404	0.434	0.338
Ceramic, earthenware, and stone products	0.091	0.092	0.115	0.101
Pig iron and crude steel	0.303	0.450	0.469	0.393
Primary steel products	0.291	0.435	0.455	0.372
Primary nonferrous metal products	0.255	0.347	0.321	0.336
Metal products	0.107	0.122	0.146	0.141
General machinery	0.147	0.213	0.265	0.282
Electrical machinery	0.189	0.241	0.279	0.302
Transportation equipment	0.238	0.322	0.418	0.384
Precision machinery	0.289	0.352	0.390	0.401

Thus, the Japanese economy has been able to overcome the oil crisis largely owing to industrial adjustment in the direction of raising the dependence of the production of not just consumer-goods industries but also heavy industry sectors on household consumption. In other words, the various industries concerned have been able to undergo industrial adjustment successfully in the direction of conforming to changing household needs in the course of rise of the level of income.

As can be seen in Table IVB, it is mainly the production of heavy industry products that has been highly dependent on gross domestic fixed capital formation among manufacturing industries. Nevertheless, that of transportation equipment, electrical machinery, and others has been declining since 1970. Such degree of dependency of ceramic, earthenware, and stone products; primary iron and steel products; precision machinery; and others, on the other hand, has been steadily rising after a decline in 1974.

The fact that the degree of dependency of the production of such leading industries in the Japanese economy as the transportation equipment industry, the electrical machinery industry, the general machinery industry, and other heavy industries on gross domestic fixed capital formation has been declining means that the dependency of the production of such industries on other categories of final demand has been rising.<sup>1</sup> This in turn is an indication that after the oil

<sup>1</sup> For the period prior to the oil crisis, see Yukio Kaneko, "Sengo Nihon keizai no kōzō ni kansuru sangyō renkan bunseki" [Input-output analysis on the structural change of Japanese economy in the postwar period], *Waseda seiji-keizaigaku zasshi* [The Waseda journal of political science and economics], No. 259-60 (November 1979).

crisis the Japanese economy recovered, depending upon a background of change in its particular demand structure, by adjusting its industrial structure to such change in its demand structure. There were a rapid departure from an industrial structure in which the industrial activities of heavy and chemical industry depended mainly upon gross domestic fixed capital formation and a corresponding shift of dependency upon other demand, and as a result of such industrial adjustment the Japanese economy was able to stage a recovery in business conditions after the oil crisis. As we will mention below, this "other demand" has been exports.

As can be seen in Table IVC, there has been a sharp rise, particularly since 1974, in the dependency of the production of heavy and chemical industries other than iron and steel on exports. In the case of transportation equipment, there was a decline in this respect in 1978, but this was due to the special circumstance of exacerbation of U.S.-Japan trade conflicts at that time, with a resultant shift in the demand structure of the motor vehicle industry and a corresponding rise in the dependency of transportation equipment industry production on gross domestic fixed capital formation.

As for the iron and steel industry, the dependency of its production on exports rose from 1970 to 1974 to 1975, but it declined in 1978 as a result of the abnormally high exchange rate of the yen to the dollar and U.S.-Japan trade conflicts. As it so happened, in September of that year a supplementary budget amounting to 2,500 billion yen for public investment for the purpose of relieving recession industries was approved, and this resulted in a shift in the demand structure of iron and steel in the direction of domestic capital formation, raising the dependency of its production on that category of final demand and lowering it with respect to exports.

In the 1970s, the system of flexible exchange rates was adopted, and under this system the exports of products of heavy industries, which rose the dependency of their production on exports, widened the surplus in Japan's balance of payments and brought about an unusually high exchange rate of the yen to the dollar. As a result of this, there was a corresponding decline after 1974 in the dependency of the production of such industries as fishery products; spinning; woven goods; petroleum products; coal products; ceramic, earthenware, and stone products; and metal products on exports. Of these industries, spinning, woven goods, petroleum products, and coal products were able to maintain their production levels by raising their dependency on household consumption, and ceramic earthenware, and stone products and metal products were able to do the same by raising their dependency on gross domestic fixed capital formation.

Thus, as we have seen in spite of soaring crude oil prices, as a result of the oil crisis and the high exchange rate of the yen to the dollar the Japanese economy has successfully adapted to such change on the basis of industrial adjustment for an appropriate combination of shifts between the three types of demand structure: that of primary dependency on exports, as in the case of such industries as transportation equipment and electrical machinery; that of primary dependency on gross domestic fixed capital formation, as in the case of iron and steel and

ceramic, earthenware, and stone products; and that of primary dependency on household consumption, as in the case of food products, woven goods, petroleum products, and coal products. This high capacity for adjustment of its industrial structure can be considered to be the main factor underlying the stable growth of the Japanese economy.

### III. ANALYSIS OF THE FACTORS UNDERLYING CHANGE IN THE INDUSTRIAL STRUCTURE

According to the Leontief model, the change in the amount of production of any industry consists of two factors, i.e., variation in input-coefficients and the shift in final demand. The latter can in turn be classified into the shift due to change in the total amount of demand, to change in the relative percentages of the different categories of final demand (consumption, investment, exports, etc.), and to change in the percentage breakdown of each of the categories of final demand by product item. Let  $X_i$  be the amount of production of sector  $i$ ,  $b_{ij}$  be the row  $i$ , column  $j$  element of the Leontief inverse matrix, and  $C_j$ ,  $I_j$ , and  $E_j$  be the amounts of consumption, investment, and export, of product item  $j$ , respectively. The following relationship holds,

$$\begin{aligned} \Delta X_i = & \sum_{j=1}^n b_{ij}^0 (\Delta C_j + \Delta I_j + \Delta E_j) + \sum_{j=1}^n \Delta b_{ij} (C_j^0 + I_j^0 + E_j^0) \\ & + \sum_{j=1}^n \Delta b_{ij} (\Delta C_j + \Delta I_j + \Delta E_j), \end{aligned} \quad (1)$$

where the symbol  $\Delta$  means the increment, and the superscript 0 indicates that the quantity concerned is for a base year prior to the change in question. Denoting the relative percentages of total consumption, total investment, and total exports in the total amount of final demand as  $\alpha$ ,  $\beta$ , and  $\gamma$ , respectively, and the percentage breakdown by product item of consumption, investment, and exports as  $f_i$ ,  $g_i$ , and  $h_i$ , respectively, we get the following relationship:

$$\begin{aligned} \Delta C_i = & (f_i^0 + \Delta f_i) (\alpha^0 + \Delta \alpha) \left( \sum_{j=1}^n F_j^0 + \sum_{j=1}^n \Delta F_j \right) - f_i^0 \alpha^0 \left( \sum_{j=1}^n F_j^0 \right) \\ = & f_i^0 \alpha^0 \left( \sum_{j=1}^n \Delta F_j \right) + \Delta f_i \alpha^0 \left( \sum_{j=1}^n F_j^0 \right) + f_i^0 \Delta \alpha \left( \sum_{j=1}^n F_j^0 \right) \\ & + \Delta f_i \Delta \alpha \left( \sum_{j=1}^n F_j^0 \right) + f_i^0 \Delta \alpha \left( \sum_{j=1}^n \Delta F_j \right) + \Delta f_i \alpha^0 \left( \sum_{j=1}^n \Delta F_j \right) \\ & + \Delta f_i \Delta \alpha \left( \sum_{j=1}^n \Delta F_j \right). \end{aligned} \quad (2)$$

Here  $F_j$  stands for the total final demand ( $= C_j + I_j + E_j$ ) for product  $j$ . Similarly, we obtain the following equations for  $\Delta I_i$  and  $\Delta E_i$  by substituting  $g_i$  and  $h_i$  for  $f_i$ , and  $\beta$  and  $\gamma$  for  $\alpha$ :

$$\begin{aligned} \Delta I_i = & g_i^0 \beta^0 \left( \sum_{j=1}^n \Delta F_j \right) + \Delta g_i \beta^0 \left( \sum_{j=1}^n F_j^0 \right) + g_i^0 \Delta \beta \left( \sum_{j=1}^n F_j^0 \right) + \Delta g_i \Delta \beta \left( \sum_{j=1}^n F_j^0 \right) \\ & + g_i^0 \Delta \beta \left( \sum_{j=1}^n \Delta F_j \right) + \Delta g_i \beta^0 \left( \sum_{j=1}^n \Delta F_j \right) + \Delta g_i \Delta \beta \left( \sum_{j=1}^n \Delta F_j \right), \end{aligned} \quad (3)$$

$$\begin{aligned} \Delta E_i = & h_i^0 \gamma^0 \left( \sum_{j=1}^n \Delta F_j \right) + \Delta h_i \gamma^0 \left( \sum_{j=1}^n F_j^0 \right) + h_i^0 \Delta \gamma \left( \sum_{j=1}^n F_j^0 \right) \\ & + \Delta h_i \Delta \gamma \left( \sum_{j=1}^n F_j^0 \right) + h_i^0 \Delta \gamma \left( \sum_{j=1}^n \Delta F_j \right) + \Delta h_i \gamma^0 \left( \sum_{j=1}^n \Delta F_j \right) \\ & + \Delta h_i \Delta \gamma \left( \sum_{j=1}^n \Delta F_j \right). \end{aligned} \quad (4)$$

Next, substituting expressions (2), (3), and (4) in equation (1), we obtain the following equation:

$$\begin{aligned} \Delta X_i = & \sum_{j=1}^n b_{ij}^0 f_i^0 \alpha^0 \left( \sum_{j=1}^n \Delta F_j \right) + \sum_{j=1}^n \Delta b_{ij} f_i^0 \alpha^0 \left( \sum_{j=1}^n F_j^0 \right) \\ & + \sum_{j=1}^n b_{ij}^0 \Delta f_i \alpha^0 \left( \sum_{j=1}^n \Delta F_j \right) + \sum_{j=1}^n b_{ij}^0 f_i^0 \Delta \alpha \left( \sum_{j=1}^n F_j^0 \right) \\ & + \sum_{j=1}^n b_{ij}^0 g_i^0 \beta^0 \left( \sum_{j=1}^n \Delta F_j \right) + \sum_{j=1}^n \Delta b_{ij} g_i^0 \beta^0 \left( \sum_{j=1}^n F_j^0 \right) \\ & + \sum_{j=1}^n b_{ij}^0 \Delta g_i \beta^0 \left( \sum_{j=1}^n F_j^0 \right) + \sum_{j=1}^n b_{ij}^0 g_i^0 \Delta \beta \left( \sum_{j=1}^n F_j^0 \right) \\ & + \sum_{j=1}^n b_{ij}^0 h_i^0 \gamma^0 \left( \sum_{j=1}^n \Delta F_j \right) + \sum_{j=1}^n \Delta b_{ij} h_i^0 \gamma^0 \left( \sum_{j=1}^n F_j^0 \right) \\ & + \sum_{j=1}^n b_{ij}^0 \Delta h_i \gamma^0 \left( \sum_{j=1}^n F_j^0 \right) + \sum_{j=1}^n b_{ij}^0 h_i^0 \Delta \gamma \left( \sum_{j=1}^n F_j^0 \right) + \varepsilon_i. \end{aligned} \quad (5)$$

Here  $\varepsilon_i$  represents the cross term of the elements of the increment as indicated in the following equation:

$$\begin{aligned} \varepsilon_i = & \sum_{j=1}^n b_{ij}^0 \left\{ \Delta f_i \Delta \alpha \left( \sum_{j=1}^n F_j^0 \right) + f_i^0 \Delta \alpha \left( \sum_{j=1}^n \Delta F_j \right) + \Delta f_i \alpha^0 \left( \sum_{j=1}^n \Delta F_j \right) \right. \\ & + \Delta f_i \Delta \alpha \left( \sum_{j=1}^n \Delta F_j \right) + \Delta g_i \Delta \beta \left( \sum_{j=1}^n F_j^0 \right) + g_i^0 \Delta \beta \left( \sum_{j=1}^n \Delta F_j \right) \\ & + \Delta g_i \beta^0 \left( \sum_{j=1}^n \Delta F_j \right) + \Delta g_i \Delta \beta \left( \sum_{j=1}^n \Delta F_j^0 \right) + \Delta h_i \Delta \gamma \left( \sum_{j=1}^n F_j^0 \right) \\ & + h_i^0 \Delta \gamma \left( \sum_{j=1}^n \Delta F_j \right) + \Delta h_i \gamma^0 \left( \sum_{j=1}^n \Delta F_j \right) + \Delta h_i \Delta \gamma \left( \sum_{j=1}^n \Delta F_j \right) \left. \right\} \\ & + \sum_{j=1}^n \Delta b_{ij} (\Delta C_j + \Delta I_j + \Delta E_j). \end{aligned} \quad (6)$$

As is evident if one reads expression (5), the change in the amount of production in each industry can be resolved into the following thirteen items:

- (1) Change in the amount of production inducement by consumption, due to change in the total amount of final demand,  $\sum_{j=1}^n \Delta F_j$ ;
- (2) Change in the amount of production inducement by consumption, due to change in the input coefficient,  $\Delta b_{ij}$ ;
- (3) Change in the amount of production inducement by consumption, due to change in the percentage breakdown of consumption by item,  $\Delta f_i$ ;

TABLE  
A. FACTOR BREAKDOWN OF CHANGE IN

Sector	Production-inducing Factor	Household Consumption				Total	$\sum_{j=1}^n \Delta F_j$ (5)
	Factor of Change	$\sum_{j=1}^n \Delta F_j$ (1)	$\Delta b_{ij}$ (2)	$\Delta f_i$ (3)	$\Delta \alpha$ (4)		
Fishery products		68.5	12.4	43.3	-2.1	122.1	0.9
Woven goods and other textile products		108.4	0.8	-16.6	-3.3	89.3	17.5
Basic chemical pharmaceuticals		61.7	17.9	-13.3	-1.9	64.4	22.4
Petroleum products		73.2	-5.4	4.2	-2.2	69.8	34.9
Coal products		16.4	-8.4	-4.7	-0.5	2.8	49.1
Ceramic, earthenware, and stone products		14.8	8.3	-4.8	-0.5	17.8	61.8
Pig iron and crude steel		31.4	-3.3	-9.1	-1.0	18.0	103.4
Primary steel products		12.6	6.1	-1.4	-0.4	16.9	45.6
Primary nonferrous metal products		17.1	12.4	-3.3	-0.5	25.7	44.4
Metal products		19.7	1.2	-3.3	-0.6	17.0	48.9
General machinery		11.6	0.8	-0.7	-0.4	11.3	70.8
Electrical machinery		14.6	0.9	-5.9	-0.5	9.1	34.9
Transportation equipment		18.3	4.2	1.0	-0.6	22.9	24.5
Precision machinery		24.4	3.0	-6.7	-0.8	19.9	19.5

B. FACTOR BREAKDOWN OF CHANGE IN

Sector	Production-inducing Factor	Household Consumption				Total	$\sum_{j=1}^n \Delta F_j$ (5)
	Factor of Change	$\sum_{j=1}^n \Delta F_j$ (1)	$\Delta b_{ij}$ (2)	$\Delta f_i$ (3)	$\Delta \alpha$ (4)		
Fishery products		91.1	1.5	24.6	2.2	119.4	1.1
Woven goods and other textile products		125.6	2.4	-28.9	3.0	102.1	20.3
Basic chemical pharmaceuticals		87.4	-1.2	-13.8	2.1	74.5	31.7
Petroleum products		202.0	-95.5	6.9	4.9	118.3	96.2
Coal products		47.5	-23.6	-8.3	1.1	16.7	142.7
Ceramic, earthenware, and stone products		12.9	3.4	2.4	0.3	19.0	53.9
Pig iron and crude steel		49.8	-2.7	-6.1	1.2	42.2	164.2
Primary steel products		14.5	4.7	-0.1	0.4	19.5	52.5
Primary nonferrous metal products		24.1	7.1	-1.8	0.6	30.0	62.4
Metal products		24.7	-2.8	-0.8	0.6	21.7	61.3
General machinery		11.3	-0.9	-0.3	0.3	10.4	69.2
Electrical machinery		15.6	-0.4	-3.9	0.4	11.7	37.2
Transportation equipment		20.4	6.2	2.5	0.5	29.6	27.4
Precision machinery		23.4	2.1	0.9	0.6	27.0	18.7

- (4) Change in the amount of production inducement by consumption, due to change in the percentage of consumption to final demand,  $\Delta \alpha$ ;
- (5) Change in the amount of production inducement by investment, due to change in the total amount of final demand,  $\sum_{j=1}^n \Delta F_j$ ;

V

THE AMOUNT OF PRODUCTION, 1975-77

(Rate of contribution, %)

Gross Domestic Fixed Capital Formation				Exports				Total	Cross Term and Other Final Demand
$\Delta b_{ij}$	$\Delta g_i$	$\Delta \beta$	Total	$\sum_{j=1}^n \Delta F_j$	$\Delta b_{ij}$	$\Delta h_i$	$\Delta \gamma$		
(6)	(7)	(8)		(9)	(10)	(11)	(12)		
1.4	-0.1	-0.1	2.1	5.2	0.6	-0.6	1.0	6.2	-30.3
-3.1	-0.2	-2.9	11.3	29.1	-0.9	-12.0	5.6	21.8	-22.5
9.4	-3.0	-3.7	25.1	40.2	6.1	-27.4	7.8	26.7	-16.4
4.4	-0.9	-5.7	32.7	30.7	0.1	-18.9	6.0	17.9	-20.2
25.6	-10.2	-8.0	56.5	41.7	11.1	-27.5	8.1	33.4	7.3
6.5	3.8	-10.1	62.1	10.4	0.1	1.6	2.0	14.1	6.1
10.4	-31.4	-16.9	65.5	109.5	-14.3	-72.2	21.2	44.2	-27.9
26.1	-5.2	-7.4	59.1	47.6	7.6	-29.2	9.2	35.2	-11.2
32.6	-23.4	-7.2	46.4	25.9	16.3	14.3	5.0	61.5	-33.5
24.0	-5.7	-8.0	59.2	12.3	-0.3	3.2	2.4	17.6	6.2
4.9	-19.6	-11.6	44.5	29.0	0.5	7.4	5.6	42.5	1.7
3.5	0.1	-5.7	32.8	18.1	1.4	18.9	3.5	42.3	16.0
3.7	-11.3	-4.0	12.9	28.1	3.0	18.6	5.5	55.2	8.9
1.7	7.3	-3.2	25.3	24.1	1.9	22.3	4.7	53.0	1.8

THE AMOUNT OF PRODUCTION, 1975-78

(Rate of contribution, %)

Gross Domestic Fixed Capital Formation				Exports				Total	Cross Term and Other Final Demand
$\Delta b_{ij}$	$\Delta g_i$	$\Delta \beta$	Total	$\sum_{j=1}^n \Delta F_j$	$\Delta b_{ij}$	$\Delta h_i$	$\Delta \gamma$		
(6)	(7)	(8)		(9)	(10)	(11)	(12)		
0.5	-0.1	-0.0	1.5	6.9	0.0	-1.0	-1.9	4.0	-24.9
-1.4	-0.7	-0.4	17.8	33.7	-0.9	-18.7	-9.3	4.8	-24.6
0.9	-1.8	-0.6	30.2	56.9	-2.1	-32.0	-15.7	7.1	-11.7
-36.8	0.0	-1.7	57.7	84.8	-35.4	-46.5	-23.4	-20.5	-55.3
14.7	-14.8	-2.5	140.1	121.2	-12.6	-62.4	-33.5	12.7	-69.7
15.7	2.2	-1.0	70.8	9.0	0.2	1.0	-2.5	7.7	7.1
19.2	-25.2	-2.9	155.3	173.9	-2.9	-92.8	-48.0	30.2	-127.7
19.0	-2.1	-0.9	68.5	54.9	6.9	-27.1	-15.2	19.5	-7.5
19.7	-13.3	-1.1	67.7	36.4	10.1	17.8	-10.0	54.3	-52.0
-1.2	-0.2	-1.1	58.8	15.4	-1.8	3.7	-4.3	13.0	6.4
-0.1	-13.6	-1.2	54.3	18.3	-1.2	14.6	-7.8	23.9	1.4
-0.8	8.0	-0.7	43.7	19.3	-0.2	19.1	-5.3	32.9	11.7
5.2	-5.6	-0.5	26.5	31.4	4.1	11.8	-8.7	38.6	5.3
-0.1	7.9	-0.3	26.2	23.1	0.7	22.5	-6.4	39.9	6.9

- (6) Change in the amount of production inducement by investment, due to change in the input coefficient,  $\Delta b_{ij}$ ;
- (7) Change in the amount of production inducement by investment, due to change in the percentage breakdown of investment by item,  $\Delta g_i$ ;
- (8) Change in the amount of production inducement by investment, due to



- change in the percentage of investment to final demand,  $\Delta\beta$ ;
- (9) Change in the amount of production inducement by exports, due to change in the total amount of final demand,  $\sum_{j=1}^n \Delta F_j$ ;
- (10) Change in the amount of production inducement by exports, due to change in the input coefficient,  $\Delta b_{ij}$ ;
- (11) Change in the amount of production inducement by exports, due to change in the percentage breakdown of exports by item,  $\Delta h_i$ ;
- (12) Change in the amount of production inducement by exports, due to change in the percentage of exports to final demand,  $\Delta\gamma$ ; and
- (13) The cross term of these incremental change.

In this section, we analyze empirically the change in production in each production sector by the factors involved, by using above formulation and the input-output tables of Japan for 1975, 1977, and 1978.<sup>2</sup> This kind of factor analysis makes it possible to determine from a standpoint of functional analysis the extent to which each factor has contributed to the steady adjustment of the Japanese industrial structure that has been taking place since the first oil crisis.

In Table V, the factors of change in the amount of production of different major manufacturing sectors (this change being equivalent to adjustment of the industrial structure) are shown by using equation (5).

As one can see in these tables, a considerable portion of the change in the amount of production of food, textile products, and other light industries both between 1975 and 1977 and between 1975 and 1978 was due to the household consumption category of final demand, the major factor being change in the breakdown by item of household consumption in the case of food products and change in the scale of final demand in the case of textile products. Moreover, this tendency was more pronounced between 1975 and 1978 than between 1975 and 1977. As for change in the amount of production of ceramic, earthenware, and stone products; pig iron and crude steel; primary steel products; and general machinery, during both periods it was due largely to change in gross domestic fixed capital formation and particularly the change in gross domestic fixed capital formation due to change in the total amount of final demand. Furthermore, the industries in which there was considerable change in the amount of production due to exports were in both periods electrical machinery, transportation equipment, and general machinery, with the change in the item breakdown of exports being most responsible.

In both periods, the change in the amount of production of petroleum products mostly depends upon the consumption which is due to change in the total amount of final demand. As a result of energy-saving strategies, the change in the amount of production of petroleum products induced by change in the input

<sup>2</sup> In the following analysis, "consumption" and "investment" mean household consumption and gross domestic fixed capital formation, respectively. We include, therefore, the effects on change in the amount of production exerted by business consumption and by net increase in inventories in the cross term  $\epsilon_i$ .

coefficient is negative, but the positive change in the amount of production induced by change in the total amount of final demand is large enough for the overall change in the amount of production to be positive.

In the period 1975-77, the change in the amount of production induced by exports, which is due to change in the percentage of exports to final demand, is positive for all sectors. In the period 1975-78, however, it was negative for all sectors. This is a reflection of the fact that whereas one of the major factors in 1977 in recovery of business conditions after the oil crisis was a rise in the percentage of exports to final demand, that percentage declined again in 1978 owing to U.S.-Japan trade conflicts caused by too much amounts of Japanese exports. The industries for which this trend was particularly pronounced were pig iron and crude steel, primary steel products, and transportation equipment.

In the case of petroleum products, the change in the amount of production induced by all three categories of final demand, i.e., household consumption, gross domestic fixed capital formation, and exports, due to change in input coefficients scored a large negative change in the period 1975-78. This was not true, however, of any of the other sectors, the explanation being that the input coefficient change due to efforts to save energy was limited almost entirely to the petroleum products industry, the other industries being able to establish systems of stable supply of raw materials on that basis.

A detailed study of the empirical figures obtained from equation (5) above will put in relief the industrial adjustment that has been taking place since the oil crisis as well as the background thereof. As a general summation, it can be said, on the one hand, that around 1977 the Japanese economy staged a recovery in business conditions, being primarily supported by gross domestic fixed capital formation and exports. In this process, such industries as the machinery, metal products, iron and steel took an important role. At the same time, Japanese economy made progress in terms of energy conservation as required by the high price of petroleum. On the other hand, in 1977 and 1978, adjustment of the Japanese industrial structure took place as an aftermath of the first oil crisis, with transportation equipment and electrical machinery which had strong international competitiveness coming to account for a higher percentage of Japanese exports.

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