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# Japanese Industrial Competitiveness revealed by Technology Factor

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## 1. Introduction

The purpose of this paper is to show the source of competitiveness of Japanese industry by JIDEA5 data, which are prepared for the forecasting purpose of Japanese Economy.

I revealed that there were some structural changes in Japanese manufacturing sectors around 1990 by using the parameter's changes of intermediate inputs last year[1]. Brief summary of the results is shown Table 1.

Table 1. Sectors whose parameters of intermediate inputs change

| Coefficient | Positive | Negative |
|---|---|---|
| Up | Transportation machinery (86) | General machinery, rubber and leather (90), Chemicals (87), food and beverages (91), Coal and oil (95) |
| Down | Iron, steel and non-ferrous metal (95) | Ceramics, pulp (90), precision machinery (91) |

Note: Figures in parentheses indicate the turning year.

This time, I will reveal which sectors are generating the competitiveness of Japanese industries by using following factor analysis[2].

The following conventional equation shows the relationship between the total output vector, x, of all the sectors of a particular economy and the corresponding final bill of goods, F.

$$X=AX+F$$

where A is a commodity-by-commodity matrix of input-output coefficients.

When solved for X in terms of F, it yields:

$X=(I-A)^{-1} F$

Suppose the outputs of the years 1 and 2 are $X_1$ and $X_2$ respectively.
Similarly the final demand of years 1 and 2 are $F_1$ and $F_2$. Suffixes 1 and 2 indicate the year1 and year2.

Then

$X_2=(I-A_2)^{-1} F_2$, $X_1=(I-A_1)^{-1} F_1$

When we put $(I-A_2)^{-1}$, $(I-A_1)^{-1}$as $B_2$ and $B_1$ respectively:

$X_2-X_1=B_2F_2-B_1F_1$

$=B_1(F_2-F_1)+(B_2-B_1) F_1$

This equation shows that the increase between year1 and year2 are divided into two factors: one caused by the changes of final demands and the other by the changes of coefficients of intermediate coefficients. Here I name the latter the technology factor because it relates to the changes of input structure.

## 2. Analysis of the technology factor

According to my previous analysis, I found there are some structural changes in input-output structure in the Japanese manufacturing sectors as shown Table 1.
The turning year differs by sector, though it is around 1990. Then I will apply the factor analysis for the following two periods: 1985-1990 and 1990-1999.

Table 2 and Table 3 show the results of factor analysis for the period from 1985 to 1990 and from1990 to 1999 respectively. Each figure shows the contributions to the increase of total for the period.

Table2. Results of factor analysis from 1985 to 1990 (unit:%)

| | | C | I | EX | IM | Tech | Output |
|---|---|---|---|---|---|---|---|
| 1 | Agriculture, forestry, fisheries | 1.2 | 0.3 | −0.0 | −0.4 | −1.3 | −0.2 |
| 2 | Mining | 0.5 | 0.7 | −0.0 | −0.9 | −0.1 | 0.2 |
| 3 | Food and beverages | 3.0 | −0.1 | −0.1 | −1.3 | −0.1 | 1.4 |
| 4 | Textiles | 1.4 | 0.3 | −0.2 | −0.8 | −0.3 | 0.5 |
| 5 | Wood products | 0.3 | 1.5 | 0.0 | −0.4 | −0.6 | 0.8 |
| 6 | Pulp | 1.8 | 1.0 | 0.1 | −0.6 | 0.3 | 2.7 |
| 7 | Chemicals | 1.8 | 0.9 | 0.5 | −0.9 | 0.6 | 3.0 |
| 8 | Coal and oil | 1.6 | 1.3 | 0.2 | −0.7 | −0.5 | 1.9 |
| 9 | Rubber and leather | 0.4 | 0.3 | 0.0 | −0.3 | 0.0 | 0.4 |
| 10 | Ceramics | 0.2 | 1.3 | 0.0 | −0.2 | −0.3 | 1.0 |
| 11 | Iron, steel and non-ferrous metal | 0.9 | 4.1 | −0.9 | −1.1 | −0.7 | 2.2 |
| 12 | General machinery | 0.7 | 4.9 | 0.4 | −0.6 | 0.4 | 5.6 |
| 13 | Electrical machinery | 2.5 | 4.0 | 2.5 | −1.1 | 0.9 | 8.8 |
| 14 | Transportation machinery | 3.2 | 3.2 | 0.6 | −1.0 | 0.5 | 6.6 |
| 15 | Precision machinery | 0.2 | 0.4 | 0.0 | −0.1 | −0.0 | 0.5 |
| 16 | Other manufacturing | 0.9 | 0.4 | −0.0 | −0.6 | 0.3 | 0.9 |
| 17 | Construction | 0.5 | 14.6 | 0.0 | −0.1 | −0.2 | 14.8 |
| 18 | Electricity, gas and water | 2.0 | 0.9 | 0.1 | −0.5 | −0.2 | 2.3 |
| 19 | Commerce | 6.6 | 4.7 | −0.4 | −0.7 | 0.9 | 11.0 |
| 20 | Finance | 3.6 | 1.3 | 0.1 | −0.7 | 2.5 | 6.8 |
| 21 | Real estate | 4.2 | 0.7 | −0.0 | −0.2 | −1.2 | 3.4 |
| 22 | Transportation and communication | 4.3 | 2.0 | −0.3 | −1.0 | −0.5 | 4.5 |
| 23 | Services | 10.2 | 5.8 | 0.6 | −1.5 | 2.1 | 17.2 |
| 24 | Hotel, restaurants, entertainment | 4.4 | 0.0 | 0.1 | −1.0 | 0.2 | 3.8 |
| 25 | Office supply | 0.1 | 0.1 | 0.0 | −0.0 | −0.0 | 0.2 |
| 26 | 0 ther | 0.3 | 0.5 | 0.1 | −0.4 | −0.7 | −0.3 |
| | Total | 56.8 | 55.1 | 3.4 | −17.2 | 1.8 | 100.0 |

Note; C: consumption, I: investment, EX: exports, IM: imports, Tech: technology factor

According to the Table 2, we understand that consumption and investment played equally an important role in the expansion of output between1985 and 1990.

However, it changed drastically between 1990 and 1999 that output expansion heavily relied on consumption and to less extent export. Investment did not contribute to the gain at all. This describes the stagnant Japanese economy in 1990s, which is called lost 1990s.

The sectors that experienced positive contribution for the both periods are as follows; Finance, Electrical machinery, Transportation machinery and Chemicals. (Table 4)

Other sectors except Transportation and communication show the negative contribution. Especially, Agriculture, forestry, fisheries, Services and Real estates register large negative contributions.

Table3. Results of factor analysis from 1990 to 1999 (unit:%)

| | | C | I | EX | IM | Tech | Output |
|---|---|---|---|---|---|---|---|
| 1 | Agriculture, forestry, fisheries | 41.6 | −8.4 | 9.6 | −41.6 | −8.8 | −7.6 |
| 2 | Mining | 2.5 | −1.0 | 0.9 | −2.3 | −2.5 | −2.3 |
| 3 | Food and beverages | 17.8 | −3.5 | 2.5 | −14.9 | −3.1 | −1.1 |
| 4 | Textiles | −6.7 | −1.2 | −0.0 | −3.9 | −2.2 | −13.9 |
| 5 | Wood products | 0.1 | −4.9 | 0.1 | −1.1 | −1.8 | −7.6 |
| 6 | Pulp | 5.8 | −1.3 | 1.0 | −2.7 | −6.3 | −3.5 |
| 7 | Chemicals | 7.0 | −3.4 | 6.4 | −5.3 | 0.1 | 4.7 |
| 8 | Coal and oil | 6.8 | −2.2 | 2.3 | −2.7 | −1.1 | 3.0 |
| 9 | Rubber and leather | −0.2 | −0.5 | 0.1 | −0.9 | −1.7 | −3.3 |
| 10 | Ceramics | 0.6 | −1.3 | 0.3 | −0.5 | −3.3 | −4.2 |
| 11 | Iron, steel and non−ferrous metal | 2.6 | −12.8 | 2.4 | −1.3 | −2.0 | −11.0 |
| 12 | General machinery | 2.2 | −12.3 | 2.2 | −2.0 | −5.7 | −15.6 |
| 13 | Electrical machinery | 16.3 | 21.2 | 15.6 | −18.7 | 3.6 | 38.1 |
| 14 | Transportation machinery | 1.2 | −10.6 | −1.2 | −1.1 | 2.9 | −8.8 |
| 15 | Precision machinery | 0.2 | 0.0 | −0.1 | −1.3 | −0.4 | −1.6 |
| 16 | Other manufacturing | −1.1 | −0.8 | 1.0 | −0.0 | −1.4 | −2.3 |
| 17 | Construction | 2.4 | −22.1 | 0.3 | −0.6 | −3.2 | −23.1 |
| 18 | Electricity, gas and water | 11.8 | −1.7 | 1.5 | −2.0 | −1.3 | 8.3 |
| 19 | Commerce | 42.9 | −2.2 | 6.7 | −9.8 | −2.8 | 34.8 |
| 20 | Finance | 10.3 | −1.6 | 2.4 | −5.7 | 8.0 | 13.5 |
| 21 | Real estate | 27.6 | −0.1 | 0.5 | −1.1 | −6.8 | 20.2 |
| 22 | Transportation and communication | 40.7 | −2.8 | 3.7 | −11.1 | 6.8 | 37.4 |
| 23 | Services | 47.4 | 11.3 | 4.9 | −7.9 | −7.7 | 48.0 |
| 24 | Hotel, restaurants, entertainment | 0.8 | −0.0 | 0.2 | −0.3 | −0.5 | 0.1 |
| 25 | Office supply | 0.6 | −0.0 | 0.1 | −0.3 | −0.4 | 0.2 |
| 26 | 0 ther | 2.2 | −0.5 | −0.7 | −0.7 | −2.6 | −2.2 |
| | Total | 283.6 | −62.5 | 62.9 | −139.4 | −44.5 | 100.0 |

When we see further detail in the sectors that contributed positively by 100 sectors classification, 74 Financial and insurance services, 54 Semi-conductor devices and integrated circuits, 55 Electronics parts, 58 Motor vehicles, 25 Medicaments contributed to the gain. This corresponds to the increase of intermediate input and output coefficients, this means that the sectors whose coefficients increased show positive contributions of the technology factor and vice versa.

Table 4. Contribution of the Technical Factors to the output (by 26sectors classification) (unit:%)

| 85–90 | | | 90–99 | | |
|---|---|---|---|---|---|
| Sectors | | contribution | Sectors | | contribution |
| 20 | Finance | 2.45 | 20 | Finance | 8.05 |
| 23 | Services | 2.10 | 22 | Transportation and communication | 6.77 |
| 13 | Electrical machinery | 0.92 | 13 | Electrical machinery | 3.59 |
| 19 | Commerce | 0.89 | 14 | Transportation machinery | 2.86 |
| 7 | Chemicals | 0.61 | 7 | Chemicals | 0.08 |
| 14 | Transportation machinery | 0.49 | 25 | Office supply | −0.35 |
| 12 | General machinery | 0.36 | 15 | Precision machinery | −0.44 |
| 6 | Pulp | 0.29 | 24 | Hotel, restaurants, entertainment | −0.52 |
| 16 | Other manufacturing | 0.27 | 8 | Coal and oil | −1.15 |
| 24 | Hotel, restaurants, entertainment | 0.23 | 18 | Electricity, gas and water | −1.32 |
| 9 | Rubber and leather | 0.04 | 16 | Other manufacturing | −1.43 |
| 25 | Office supply | −0.00 | 9 | Rubber and leather | −1.74 |
| 15 | Precision machinery | −0.03 | 5 | Wood products | −1.76 |
| 2 | Mining | −0.09 | 11 | Iron, steel and non-ferrous metal | −2.04 |
| 3 | Food and beverages | −0.12 | 4 | Textiles | −2.16 |

Table 5 shows the differences of the sums of the column of the coefficients of the inverse matrix for the sectors that Technology factors contributed to the expansion. It shows that all the sectors have negative figures. This means that the sector reduced its inputs to produce a unit and increased its efficiency. In case of 54 Semi-conductor devices and integrated circuits, we can see the sector increased its efficiency through the periods; namely, 18 Publishing and printing, 29 Plastic products, 55 Electronics parts, 69 Electric power, 73 Trade, 86 Research Institute and 93 Car and other machinery repair. For other sectors, 94 Business service is also seen for both periods. These sectors seem to contribute to the efficient Japanese production systems.

Table 5. Difference of sums of the column that showed high rate of contribution by technical factor

| Sectors | | Dif. of Sums | | Sector number that showed large decrease in coefficients | |
|---|---|---|---|---|---|
| | | 85–90 | 90–99 | 85–90 | 90–99 |
| 25 | Medicaments | −0.30 | −0.22 | 17,75,94 | 90 |
| 54 | Semi-conductor devices and integrated circuits | −0.90 | −0.83 | 18,29,43,55,69,73,74,75,86,93,94 | 18,29,55,57,69,73,86,93 |
| 55 | Electronics parts | −0.39 | −0.24 | 73,74 | 29,55 |
| 58 | Motor vehicles | −0.08 | −0.03 | | 73 |
| 74 | Financial and insurance services | −0.04 | −0.10 | 75 | 94 |

Note: inverse matrix: $(I-A)^{-1}$

3. Relationship with competitiveness

In this section, I will study if these sectors can be attributed to the competitiveness of Japanese industries.

As a measure of competitiveness, I used two index; Import penetration rate and index of trade specialization.

Table 6 shows the result of Import penetration rate, which is defined by import divided by domestic demand. This ranges from 0 to 1. When the rate is small, we regards competitiveness is strong[3].
In the service sectors, the rates are generally low. It is because the international transaction of the sectors is less common or institutionally restricted. However, among the tradable sectors such as sector 1-64, rates of increase are observed. The dependence of imported items to satisfy the domestic demand is increasing.
When we see the import penetration rate for the sectors whose technology factor's contributions are high, generally they remained low except 54 Semi-conductor devices and integrated circuits.

| | |
|---|---|
| 74 Financial and insurance services | (85:0.02, 99:0.03) |
| 54 Semi-conductor devices and integrated circuits | (85:0.06, 99:0.26) |
| 55 Electronics parts | (85:0.02, 99:0.03) |
| 58 Motor vehicles | (85:0.01, 99:0.04) |
| 25 Medicaments | (85:0.07, 99:0.09) |

For the tradable sectors, we can find most of them still hold competitiveness as the rates are not increasing so much and still low.

Table 7 shows the index of trade specialization.
It is defined by (EX-IM)/ (EX+IM)*100. The index varies from –100 to 100.
When there is no domestic production and it is satisfied by import, the index shows –100. As domestic production starts and import substitution takes place and export begins, it gradually increases toward 100. When export product becomes less competitive, then it starts decrease[4].
When we see the index for the sectors whose technology factor's contribution are high, we can find most of them still hold competitiveness.

| | |
|---|---|
| 74 Financial and insurance services | (85:-21.6, 99:-33.0) |
| 54 Semi-conductor devices and integrated circuits | (85:70.4, 99:37.0) |
| 55 Electronics parts | (85:78.7, 99:55.5) |
| 58 Motor vehicles | (85:95.2, 99:79.8) |
| 25 Medicaments | (85:-61.5, 99:-59.9) |

For the tradable sectors, Medicaments is gaining competitiveness, and other sectors are gradually losing it though index still show positive and sectors are still regarded competitive.

Table 6. Import Penetration Rate

| | Sectors | 1985 | 1990 | 1999 |
|---|---|---|---|---|
| 1 | Agriculture for crops | 0.11 | 0.13 | 0.16 |
| 2 | Livestock raising and sericulture | 0.03 | 0.03 | 0.02 |
| 3 | Agricultural services | 0.00 | 0.00 | 0.00 |
| 4 | Forestry and logging | 0.33 | 0.33 | 0.26 |
| 5 | Fishery | 0.25 | 0.09 | 0.05 |
| 6 | Metal ores | 0.94 | 0.97 | 0.99 |
| 7 | Non-metal ores | 0.06 | 0.09 | 0.10 |
| 8 | Coal and lignite | 0.71 | 0.84 | 0.92 |
| 9 | Crude petroleum and gas | 0.97 | 0.98 | 0.98 |
| 10 | Food products | 0.05 | 0.09 | 0.13 |
| 11 | Beverages and tobacco | 0.04 | 0.07 | 0.08 |
| 12 | Feeds and organic fertilizers | 0.01 | 0.04 | 0.09 |
| 13 | Fabricated textile products | 0.07 | 0.09 | 0.16 |
| 14 | Wearing and other textile products | 0.06 | 0.12 | 0.34 |
| 15 | Timber and wooden products | 0.08 | 0.14 | 0.22 |
| 16 | Wooden and metal furniture, fittings | 0.03 | 0.04 | 0.11 |
| 17 | Pulp and paper | 0.04 | 0.04 | 0.05 |
| 18 | Publishing and printing | 0.00 | 0.01 | 0.00 |
| 19 | Chemical fertilizer | 0.06 | 0.10 | 0.14 |
| 20 | Inorganic basic chemicals | 0.09 | 0.09 | 0.10 |
| 21 | Petrochemical basic products | 0.01 | 0.01 | 0.00 |
| 22 | Organic chemical products | 0.18 | 0.18 | 0.19 |
| 23 | Synthetic resin | 0.05 | 0.06 | 0.09 |
| 24 | Chemical fibers | 0.03 | 0.04 | 0.07 |
| 25 | Medicaments | 0.07 | 0.07 | 0.09 |
| 26 | Final chemical products | 0.06 | 0.07 | 0.10 |
| 27 | Petroleum refinery products | 0.13 | 0.15 | 0.11 |
| 28 | Coal products | 0.00 | 0.01 | 0.02 |
| 29 | Plastic products | 0.00 | 0.01 | 0.04 |
| 30 | Rubber products | 0.03 | 0.05 | 0.13 |
| 31 | Leather and fur products | 0.12 | 0.28 | 0.46 |
| 32 | Glass and glass products | 0.04 | 0.06 | 0.08 |
| 33 | Cement and cement products | 0.00 | 0.00 | 0.00 |
| 34 | Pottery, tiles and earthenware | 0.03 | 0.06 | 0.08 |
| 35 | Other ceramic, stone and clay products | 0.07 | 0.07 | 0.10 |
| 36 | Pig iron and crude steel | 0.03 | 0.03 | 0.03 |
| 37 | Steel bar and sheet | 0.01 | 0.03 | 0.03 |
| 38 | Steel castings and forging | 0.00 | 0.00 | 0.01 |
| 39 | Non-ferrous metals refinery products | 0.45 | 0.55 | 0.46 |
| 40 | Processed non-ferrous metal products | 0.03 | 0.04 | 0.09 |
| 41 | Metal products for construction | 0.00 | 0.01 | 0.01 |
| 42 | Heating equipment | 0.00 | 0.00 | 0.01 |
| 43 | Other metal products | 0.02 | 0.03 | 0.04 |
| 44 | General machineery | 0.03 | 0.04 | 0.05 |
| 45 | Machine tool and robot | 0.03 | 0.03 | 0.03 |
| 46 | Special industry machinery | 0.05 | 0.06 | 0.11 |
| 47 | Other general machines and tools | 0.04 | 0.04 | 0.06 |
| 48 | Machinery for office and for vending | 0.01 | 0.03 | 0.05 |
| 49 | Machinery for service | 0.01 | 0.01 | 0.03 |

| | | | | |
|---|---|---|---|---|
| 50 | Household electric and electronic equipment | 0.01 | 0.04 | 0.09 |
| 51 | Electronic computing equipment and | 0.08 | 0.12 | 0.30 |
| 52 | Communication equipment | 0.02 | 0.04 | 0.05 |
| 53 | Electronic appliances & measuring equipment | 0.05 | 0.08 | 0.19 |
| 54 | Semi-conductor devices and integrated | 0.06 | 0.10 | 0.26 |
| 55 | Electronics parts | 0.02 | 0.03 | 0.05 |
| 56 | Heavy electrical equipment, generators, | 0.04 | 0.05 | 0.14 |
| 57 | Electric illuminator, batteries and other light | 0.05 | 0.05 | 0.11 |
| 58 | Motor vehicles | 0.01 | 0.03 | 0.04 |
| 59 | Ships and repair | 0.02 | 0.02 | 0.06 |
| 60 | Railway equipment | 0.00 | 0.01 | 0.02 |
| 61 | Aircraft and repair | 0.29 | 0.46 | 0.41 |
| 62 | Other transportation equipment | 0.01 | 0.03 | 0.10 |
| 63 | Precision instruments, medical instrument, | 0.11 | 0.13 | 0.28 |
| 64 | Miscellaneous manufacturing products | 0.12 | 0.21 | 0.24 |
| 65 | Dwelling construction | 0.00 | 0.00 | 0.00 |
| 66 | Other construction | 0.00 | 0.00 | 0.00 |
| 67 | Civil engineering public | 0.00 | 0.00 | 0.00 |
| 68 | Civil engineering private | 0.00 | 0.00 | 0.00 |
| 69 | Electric power | 0.00 | 0.00 | 0.00 |
| 70 | Gas and hot water supply | 0.00 | 0.00 | 0.00 |
| 71 | Water supply | 0.00 | 0.00 | 0.00 |
| 72 | Waste treatment | 0.00 | 0.00 | 0.00 |
| 73 | Trade | 0.01 | 0.01 | 0.01 |
| 74 | Financial and insurance services | 0.02 | 0.02 | 0.03 |
| 75 | Real estate agencies and rent | 0.00 | 0.00 | 0.00 |
| 76 | House rent | 0.00 | 0.00 | 0.00 |
| 77 | Railway transport | 0.01 | 0.01 | 0.01 |
| 78 | Road transport | 0.01 | 0.01 | 0.01 |
| 79 | Water transport | 0.22 | 0.23 | 0.35 |
| 80 | Air transport | 0.34 | 0.34 | 0.33 |
| 81 | Transportation related service and storage | 0.03 | 0.03 | 0.04 |
| 82 | Communication | 0.01 | 0.01 | 0.01 |
| 83 | Broadcasting | 0.00 | 0.00 | 0.00 |
| 84 | Public administration | 0.00 | 0.00 | 0.00 |
| 85 | Education | 0.00 | 0.00 | 0.00 |
| 86 | Research Institute | 0.00 | 0.00 | 0.00 |
| 87 | Medical service, health and social security | 0.00 | 0.00 | 0.00 |
| 88 | Social security service | 0.00 | 0.00 | 0.00 |
| 89 | Other public service | 0.01 | 0.01 | 0.01 |
| 90 | Advertising agencies | 0.05 | 0.04 | 0.03 |
| 91 | News and information service | 0.03 | 0.03 | 0.03 |
| 92 | Renting and leasing | 0.02 | 0.02 | 0.01 |
| 93 | Car and other machinery repair | 0.00 | 0.00 | 0.00 |
| 94 | Business service | 0.02 | 0.02 | 0.03 |
| 95 | Amusement service, films, theater, sports | 0.01 | 0.02 | 0.03 |
| 96 | Hotel | 0.02 | 0.04 | 0.04 |
| 97 | Restaurant | 0.10 | 0.21 | 0.23 |
| 98 | Personal service, washing, barber, etc. | 0.00 | 0.00 | 0.00 |
| 99 | Office supply | 0.00 | 0.00 | 0.00 |
| 100 | Not elsewhere classified | 0.04 | 0.12 | 0.10 |

Note: Import penetration rate: IM / domestic demand

Table 7. Index of Trade Specialization

| | 部門 | 1985 | 1990 | 1999 |
|---|---|---|---|---|
| 25 | Medicaments | −61.5 | −60.9 | −59.9 |
| 54 | Semi-conductor | 70.4 | 63.9 | 37.0 |
| 55 | Electronics parts | 78.7 | 71.9 | 55.5 |
| 58 | Motor vehicles | 95.2 | 82.4 | 79.8 |
| 74 | Financial and | −21.6 | −27.4 | −33.0 |

## 4. Conclusion

When we see the sectors whose technology factor's contributions are high, they seem to be competitive judging from two different competitive measures.

Though the competitive measures are not perfect because they do not assume the intra-industry trade of the intermediate products, which is now becoming popular such as IC sectors.

Jacob Kol and Paul Rayment pointed out that few researchers have paid attention to the intermediate goods when it comes to intra-industry trade[5].

However, the fact that the sectors that have high technology factor's contribution coincide with the sectors assumed to have competitiveness in large, we can conclude that technology factor represents the competitiveness.

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