

**ASIAN-PACIFIC ECONOMIES  
AND  
SMALL BUSINESS**

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**INTERNATIONAL WORKSHOP 1**

November 18-19, 1995

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# **Chapter 9. A DPG(Deviation from Proportional Growth) Analysis of the Japanese, Korean and Taiwanese Economies \***

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## **1. Introduction**

The economic development of a country is usually accompanied with changes of the industrial structure including the output share or the employment share of each industrial sector, while so called leading sectors, which played important roles to bring around the economic development and the structural changes, switch on the process of the economic development.

Studies which treat relations between the structural changes of the economy and stages of the economic development began with the German “Historical School”. List assumed that the economy climbs up such five stages as (1) hunting era, (2) pasturage era, (3) agriculture era, (4) agriculture and manufacturing era, and (5) agriculture, manufacturing and commerce era, while Schmoller, who focused on the socio-economic structure, advocated the society evolution composed of such four stages as (1) village society, (2) city society, (3) feudal society and (4) nation society.

One of the first statistical works on this line of studies is Hofman(1931). Hofman divided the economic development into four stages by calculating Hofman-ratio, which is the ratio of the production of consumer goods over that of capital goods. According to Hofman’s observation, Hofman-ratio decreases during the economic development and an economy reached to the (last) industrialized stage when Hofman-ratio come to be less than one.

After the World War II, a lot of efforts for preparing economic statistical data were made by many economists and statisticians. Among them, Clark(1957) and Kuznets(1957, 1966), in particular, are well-known. They collected various types of long run economic statistics to follow the process of the economic developments, where they found there is a universal common structural transformation from a primary sector oriented economy to a manufacturing and service sector oriented economy. Since then, this empirical finding of the structural change of the economy in the development has been known as “Petty-Clark’s law”.

In the same period, Rostow(1960) published a new five stage theory of the economic

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\* This is a revised version of the paper of the same title which was contributed to the Journal of Applied Input-Output Analysis (Pan Pacific Association of Input Output Association, Keio University, Vol. 1, No. 1, 1992) collaborated with professor Chen, Kung-hui(Kobe University). And this revision was made as a part of a collaboration with Dr. Jin-Myon, Lee (Korea Development Institute). This paper is a part of studies which are supported by the Science Study Subsidy of Ministry of Education (1995 General Study (B) Number 07435006)

development which is armed with such new concepts as saving ratio and investment ratio. Rostow explained that the economic development proceeds on the ladder of such five stages as (1) traditional society, (2) transitional society, (3) take-off, (4) matured society and (5) consumers' society. Rostow put the stress especially on the stage of "take-off", where he related exogenous political or sociological changes take place causing large structural changes in the economy. However, since the timing of Rostow's publication was in the heart of East-West Cold War, the "exogenous changes" he mentioned were unfortunately regarded as development aids or technological supports from the developed countries to southern countries with some of political purposes. On the other hand, Garchencron(1962) questioned Rostow's optimistic philosophy which relays on development aids believing in a single truck development ladder. Garchencron asserted that countries which make ways to the industrialization can choose one among diversified courses depending on the situation of each country(Rostow-Garchencron debate).

The history afterward proved that patterns of economic development were actually diversified, and the direction of empirical studies on the economic development, therefore, shifted to those which try to classify patterns of the economic development and find main factors which lead the economy to the particular path in the economic development. One of the pioneering efforts was Chenery(1960)'s cross-country statistical analysis on the relation between the economic growth and changes of the income level, and he presented the wider approach in an historical study of Japan in Chenery, Shishido and Watanabe(1962), which first employed a multi-sectoral model coordinating the Input-Output analysis. Their methods is called **DPG(Deviation from Proportional Growth) analysis**, which specifies the leading industries which played important roles on the economic development and also demand factors which activated the leading industries

The purpose of this article is to explain the method of DPG analysis which explains quantitatively the causes of observed change in the sector composition of production and apply this method to the data of Japan, Korea and Taiwan in order to compare their patterns of the growth. Though Chenery and his colleagues found that import substitution is the key factor at the beginning economic development, this present paper will present another possibility of the economic development as to Asian NIEs.

We have a sizable number of DPG type studies which were applied to the data of Japan in Watanabe and Suruga(1977); of Korea in Aoki and Inada(1980) and Han(1994); of Japan, Korea and Taiwan in Chen and Fujikawa(1992). However, it is not easy to evaluate the results of these studies and to find patterns Japanese and Asian NIEs' economic development since, first of all, the version of the calculation methods, sector classification, and the period covered in these studies are not necessarily comparable, and secondly no study covers 1980's which experienced one of the most dynamic economic circumstances including the global exchange rate fluctuations. Therefore, this paper applies a modified version of DPG analysis commonly to the newest available data including 1980's of these economies. This study covers the period 1915-1990 of Japan, 1960-1990 of Korea and 1964-1990 of Taiwan. It is a quite meaningful attempt to summarize history of the economic evolution of these countries and main sources for them through a set of comparable data.

The method is explained in the next section, where a concept of “normalized deviation” is introduced in order to let the calculated results comparable. The results of the analysis on the Japanese, Korean, and Taiwanese economies are shown in section 3 through 5. Section 6 contains concluding remarks.

## 2. DPG Model

DPG is an index expressing changes in production shares of the industries in an economy. Before showing the mathematical model of DPG analysis, here let us review the basic idea of DPG analysis using an example shown in **Table 9-1(a)**. Suppose an imaginary economy has four industries ; A, B, C, and D, the production of which respectively changed from 2,500, 500, 4,000 and 3,000 in the period 1(column [1]) to 3,000, 1,500, 8,000 and 7,500 in the period 2(column [2]). In this case, industry A decreased its share from 25% to 15%, industry B increased its share from 5% to 7.5%, the share of industry C is unchanged and the share of industry D increased from 30% to 37.5%. The reason of these share change is the difference of growth speed of each industry. That is to say, the average growth speed( $\alpha$  in column [3]) is 2, while the growth speed of industry A is 1.2, which is less than  $\alpha$ , those of industry B and D are respectively 3.0 and 2.5, which are larger than  $\alpha$ , and the growth speed of industry C is the same as  $\alpha$ .

Now, let us suppose a situation where the production of all the sectors doubled, where the production of each sector is respectively 5,000, 1,000, 8,000 and 6,000 (column [4]). This situation is called the “proportional growth”. And the column [5] is the DPG (Deviation from Proportional Growth) of each sector, the figure of which is the difference of corresponding figures in the column [2](actual production in the period 2) and [4](production in the case of the proportional growth). If the sign of the DPG of a sector is negative, it means that the share of the sector decreased, and if the sign of the DPG of a sector is positive, it means that the share of the sector increased. And the DPG total of the whole economy is equal to zero.

**Table 9-1(a). Illustration of DPG Analysis (a)**

|            | [1]               | [2]               | [3]              | [4]     | [5]            |
|------------|-------------------|-------------------|------------------|---------|----------------|
|            | production<br>t=1 | production<br>t=2 | 1+growth<br>rate | [1]*2.0 | [2]-[4]<br>DPG |
| Industry A | ¥2,500            | ¥3,000            | 1.2              | ¥5,000  | ¥-2,000        |
| Industry B | ¥500              | ¥1,500            | 3.0              | ¥1,000  | ¥500           |
| Industry C | ¥4,000            | ¥8,000            | 2.0              | ¥8,000  | ¥0             |
| Industry D | ¥3,000            | ¥7,500            | 2.5              | ¥6,000  | ¥1,500         |
| Total      | ¥10,000           | ¥20,000           | $\alpha=2.0$     | ¥20,000 | ¥0             |

The DPG analysis measures the degree of change in sector composition of production as calculated using the numerical example and decomposes DPGs into some demand factors. The following demand-supply equilibrium of each sector holds : Supply = ( 1 - Import Ratio ) \* Demand. The demand of the right hand side is composed of intermediate demand, consumption, investment, and export. Therefore, some of the reason why all the sectors in the economy do not

grow proportionally are non-proportional growth of the above mentioned demand items and changes in import ratios. Meanwhile, the intermediate demands of a sector has a proportional relation with its own output of the sector in the framework of Input-Output analysis, and the proportional relation is expressed in terms of Technical Input Coefficients. Therefore, the another reason of non-proportional growth of the sectors is the changes in input coefficients. As a result, DPGs can be decomposed such five factors as deviations of consumption, investment, and export, changes of import ratio and changes in input coefficients as shown in **Table 9-1(b)**

**Table 9-1(b) Illustration of DPG Analysis (b)**

|            | Yen Base DPG | Consumption | Investment | Export  | Import Substitution | Technical Change |
|------------|--------------|-------------|------------|---------|---------------------|------------------|
| Industry A | ¥2,000       | ¥-1,600     | ¥800       | ¥-1,000 | ¥-500               | ¥300             |
| Industry B | ¥500         | ¥-400       | ¥300       | ¥700    | ¥-200               | ¥100             |
| Industry C | ¥0           | ¥-300       | ¥600       | ¥500    | ¥200                | ¥-1,000          |
| Industry D | ¥1,500       | ¥100        | ¥100       | ¥2,200  | ¥-100               | ¥-800            |
| Total      | ¥0           | ¥-2,200     | ¥1,800     | ¥2,400  | ¥-600               | ¥-1,400          |

The mathematical model of DPG analysis can be defined as follows. First of all, equation (9-1) is the DPG between period t and t+1.

$$(9-1) \quad \delta X = X_{t+1} - \alpha X_t$$

where  $X_t, X_{t+1}$ : the column vectors each element of which is gross production of each sector in the time period t and t+1,  $\alpha$ : the scalar which represents the (weighted) average ratio of expansion of production, obtained by the division of the total of the gross production in period t+1 by that of period t.

Each element of  $\delta X$  is DPG of each sector. It's element is positive when a sector has grown faster than the average speed  $\alpha$ , zero when the ratio of expansion of the sector is equal to  $\alpha$  and negative when it is less than  $\alpha$ . Hence, its sign shows whether a sector has increased its output share or not, and its absolute value depends on the actual growth rate and the production level of the sector. The DPGs thus defined are analogous to deviations around the mean. The sum of them therefore is zero<sup>1</sup>.

DPG analysis decomposes  $\delta X$  into several factors. The formula for the decomposition used in this paper is based on the following balance equation:

$$(9-2) \quad X_t = (u' - M_t^A) \otimes A_t X_t + [(I - M_t^C)C_t + (I - M_t^F)F_t + (I - M_t^J)J_t + (I - M_t^E)E_t]$$

where  $u'$ : the matrix all elements of which are 1 since  $i=[1,1,\dots,1]$ ,  $\otimes$ : Hadamard product of matrices<sup>2</sup>,  $A_t$ : the matrix of input coefficients,  $M_t^A$ : the matrix the (i,j)th element of which is the import coefficient of the (i,j)th intermediate transaction,  $I$ : the identity matrix,  $C_t, F_t, J_t, E_t$ : the vectors of final consumption, investment, increases in stocks and exports, respectively, and  $M_t^C, M_t^F, M_t^J, M_t^E$ : the diagonal matrices the (i,i)th elements of which are the import coefficients of the i-th

consumption, the i-th investment, the i-th increases in stocks and the i-the exports.

The first term of the equation represents intermediate demand for domestic industries. The second term and the third represent consumption and investment demand. The fourth and the fifth are increases in stocks and exports of domestic goods and services. The equation (9-2) states that the production of each sector is equal to the sum of demand for domestic products.

Solving equation (9-2) for  $X_i$ ,  $t=1$  and 2, gives:

$$(9-3) \quad X_1 = [I - (u' - M_1^A) \otimes A_1]^{-1} [(I - M_1^C)C_1 + (I - M_1^F)F_1 + (I - M_1^J)J_1 + (I - M_1^E)E_1]$$

$$(9-4) \quad X_2 = [I - (u' - M_2^A) \otimes A_2]^{-1} [(I - M_2^C)C_2 + (I - M_2^F)F_2 + (I - M_2^J)J_2 + (I - M_2^E)E_2]$$

It expresses that production is a function of final demand vectors,  $C$ ,  $F$ ,  $J$ , and  $E$ , with parameters of import coefficient matrices and an input coefficient matrix,  $M^A$ ,  $M^C$ ,  $M^F$ ,  $M^J$ ,  $M^E$ , and  $A$ . We can now attribute a change in production to changes in those vectors and/or parameter matrices, to which changes we can attribute the DPGs of production as well.

Substituting (9-3) and (9-4) into (9-1) yields the following decomposition formula:

$$(9-5) \quad \begin{aligned} \delta X = & B_2(I - M_2^C)\delta C + B_2(I - M_2^F)\delta F + B_2(I - M_2^J)\delta J + B_2(I - M_2^E)\delta E \\ & + (B_2(M_1^C - M_2^C)\alpha C_1 + B_2(M_1^F - M_2^F)\alpha F_1 + B_2(M_1^J - M_2^J)\alpha J_1 + B_2(M_1^E - M_2^E)\alpha E_1) \\ & + B_2(M_1^A - M_2^A) \otimes A_1 \alpha X_1 + B_2(u' - M_2^A) \otimes (A_2 - A_1) \alpha X_1 \end{aligned}$$

where  $B_2 = [I - (u' - M_2^A)A_2]^{-1}$  (Leontief's inverse matrix),  $\delta C = C_2 - \alpha C_1$ ,  $\delta F = F_2 - \alpha F_1$ ,  $\delta J = J_2 - \alpha J_1$ , and  $\delta E = E_2 - \alpha E_1$ .

The first term represents the DPGs of production attributable to the DPGs of consumption demand, which are weighted averages of the elements of  $\delta C$ . The second, third, and fourth terms are the same kind deviations of production resulted from the DPGs of investment demand,  $\delta F$ , the DPGs of increases in stock,  $\delta J$ , and the DPGs of exports,  $\delta E$ . The fifth, sixth and seventh terms represent the effects produced by changes in import coefficients of consumption,  $M_1^C - M_2^C$ , of investment,  $M_1^F - M_2^F$ , of stocks,  $M_1^J - M_2^J$ , of exports,  $M_1^E - M_2^E$ , and of intermediate demand,  $M_1^A - M_2^A$ . The last term is DPGs attributable to a change in input-output coefficients,  $A_2 - A_1$ .

However, equation (9-5) can be written by using the inverse matrix of  $t=1$  as follows:

$$(9-5') \quad \begin{aligned} \delta X = & B_1(I - M_1^C)\delta C + B_1(I - M_1^F)\delta F + B_1(I - M_1^J)\delta J + B_1(I - M_1^E)\delta E \\ & + (B_1(M_1^C - M_2^C)C_2 + B_1(M_1^F - M_2^F)F_2 + B_1(M_1^J - M_2^J)J_2 + B_1(M_1^E - M_2^E)E_2) \\ & + B_1(u' - M_1^A) \otimes (A_2 - A_1)X_2 + B_1(M_1^A - M_2^A) \otimes A_2 X_2 \end{aligned}$$

The difference between (9-5) and (9-5') is like that between Paasche type index and Laspeyres type index and there is no theoretical reason we should apply either formula. Therefore, the arithmetic mean of the both results will be used as a final result in this paper<sup>3</sup>.

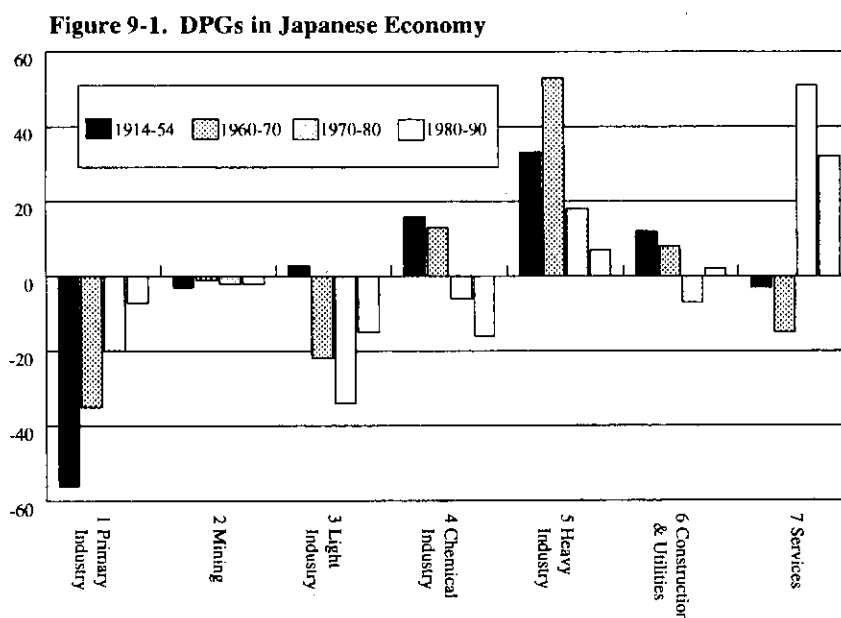
However, as far as the concern is the relative degree of the change and the relative magnitude of the sources of DPGs in the cross-country and overtime comparisons, they do not have to be measured by a specific money unit ; as a matter of fact, the currency unit is meaningless in the comparisons of this article <sup>4</sup>. They can be divided by the sum of DPGs that are positive and then multiplied by 100 <sup>5</sup>, thereby being normalized so that the sum of positive DPGs equals 100(and that of negative DPGs equals -100), as is shown in **Table 9-1c**. This normalization would make the meaning of the figures clearer and the evaluation of the cross-country comparisons easier. Figures in all the tables presented in the following sections show such normalized results of the DPG decomposition analysis which includes four periods of Japan(1914-1954, 1960-1970, 1970-1980 and 1980-1990), three periods of Korea(1960-1970, 1970-1980, and 1980-1990), and three periods of Taiwan(1964-1971, 1971-1981 and 1981-1991).

**Table 9-1(c) Illustration of DPG Analysis (c)**

|            | Normalized DPG | Consumption | Investment | Export | Import Substitution | Technical Change |
|------------|----------------|-------------|------------|--------|---------------------|------------------|
| Industry A | -100.0         | -80.0       | 40.0       | -50.0  | -25.0               | 15.0             |
| Industry B | 25.0           | -20.0       | 15.0       | 35.0   | -10.0               | 5.0              |
| Industry C | 0.0            | -15.0       | 30.0       | 25.0   | 10.0                | -50.0            |
| Industry D | 75.0           | 5.0         | 5.0        | 110.0  | -5.0                | -40.0            |
| Total      | 0.0            | -110.0      | 90.0       | 120.0  | -30.0               | -70.0            |

### 3. Major Findings in the Japanese Economy

**Figure 9-1** shows the historical changes of DPGs for Japan in the periods 1914-1954, 1960-1970, 1970-1980 and 1980-1990. We can see a decreasing trend in the output shares of Primary sector and Light Industry, and also that leading sectors shifted from Heavy and Chemical Industry to Service sectors after 1970's. The detailed results of the DPG decomposition analysis are given in **Tables 9-2, 9-3,9-4** and **9-5**.



## (1) The Japanese Economy 1914-1954

The total production became almost four times in this period. DPGs in **Table 9-2** indicate that manufacturing (Light Industry, Heavy and Chemical Industry and Construction) increased their output shares and that Mining, Services, and Agriculture, Forestry & Fisheries decreased their shares. Heavy Industry, Chemical Industry and Construction respectively accounted for 31.6%, 14.7% and 12.2% of the positive deviations, among which DPG in Metals is the largest (26.2%). Japan in this period is thus characterized by its overall industrialization.

**Table 9-2. Normalized DPGs of Japan, (1914-54) ( $\alpha=3.792$ )**

| 23 sectors                   | Deviation | Consumption | Investment | Stock | Export | Import<br>Substitution | Technical<br>Change |
|------------------------------|-----------|-------------|------------|-------|--------|------------------------|---------------------|
| 1 Agri., Forest. & Fish.     | -54.9     | -33.5       | 1.0        | 0.3   | -3.6   | -6.7                   | -12.3               |
| 2 Coal & Petroleum           | -4.1      | -0.9        | 0.4        | -0.1  | -1.3   | -1.5                   | -0.6                |
| 3 Other Mining               | 0.7       | -1.0        | 1.0        | -0.3  | 0.2    | 0.3                    | 0.6                 |
| 4 Food                       | -20.6     | -19.3       | 0.7        | -1.7  | -2.0   | -1.9                   | 3.5                 |
| 5 Fiber & Leather            | 12.4      | 3.0         | 1.2        | -1.5  | -4.6   | 3.7                    | 10.5                |
| 6 Wood & Wooden Products     | 0.4       | -1.0        | 1.1        | -0.3  | -1.1   | 0.4                    | 1.3                 |
| 7 Paper & Paper Products     | 6.9       | -0.6        | 0.5        | 0.1   | -1.6   | 1.8                    | 6.7                 |
| 8 Printing                   | 1.7       | 0.1         | 0.1        | 0.0   | -0.1   | 0.1                    | 1.5                 |
| 9 Rubber                     | 2.0       | 0.1         | 0.2        | 0.0   | 0.0    | 0.1                    | 1.7                 |
| 10 Chemicals                 | 8.5       | -6.9        | 1.0        | -0.4  | -0.5   | 11.0                   | 4.3                 |
| 11 Coal & Pet. Products      | 4.2       | -0.8        | 0.5        | -0.1  | -0.2   | 0.5                    | 4.2                 |
| 12 Non-Metal Products        | 2.0       | -0.9        | 1.2        | -0.4  | 0.1    | 0.2                    | 1.7                 |
| 13 Metals                    | 26.2      | -6.0        | 6.7        | -1.9  | 2.8    | 8.2                    | 16.3                |
| 14 General Machinery         | 5.5       | 0.0         | 2.7        | -0.1  | 0.8    | 0.8                    | 1.3                 |
| 15 Transportation Equipments | -0.1      | -4.6        | 1.3        | -0.2  | 0.5    | 0.6                    | 2.3                 |
| 16 Other Manufacturing       | 0.5       | -0.4        | 0.2        | -0.1  | 0.2    | 0.1                    | 0.6                 |
| 17 Construction              | 7.5       | -2.5        | 8.2        | 0.0   | 0.0    | 0.1                    | 1.8                 |
| 18 Elec., Gas, & Water       | 4.7       | 0.3         | 0.3        | -0.1  | -0.2   | 0.4                    | 3.9                 |
| 19 Wholesale and Retail      | 11.4      | 0.3         | 1.9        | -0.4  | -1.0   | 0.6                    | 10.0                |
| 20 Real Estate               | -2.9      | -3.7        | 0.1        | 0.0   | 0.0    | 0.0                    | 0.8                 |
| 21 Trans. & Comm.            | 2.8       | -2.4        | 1.2        | -0.3  | -2.9   | 1.0                    | 6.3                 |
| 22 Services                  | -17.5     | -24.0       | 3.1        | -0.2  | -0.6   | 1.0                    | 3.2                 |
| 23 Others                    | 2.5       | -6.7        | 1.7        | -0.4  | -2.4   | 1.9                    | 8.5                 |
| Total                        | 0.0       | -111.5      | 36.2       | -8.1  | -17.4  | 22.8                   | 78.1                |

| Aggregated 7 sectors       | Deviation | Consumption | Investment | Stock | Export | Import<br>Substitution | Technical<br>Change |
|----------------------------|-----------|-------------|------------|-------|--------|------------------------|---------------------|
| 1 Primary Industry         | -54.9     | -33.5       | 1.0        | 0.3   | -3.6   | -6.7                   | -12.3               |
| 2 Mining                   | -3.4      | -2.0        | 1.3        | -0.4  | -1.1   | -1.2                   | 0.0                 |
| 3 Light Industry           | 3.3       | -19.1       | 5.0        | -3.9  | -9.1   | 4.5                    | 25.9                |
| 4 Chemical Industry        | 14.7      | -7.6        | 1.7        | -0.5  | -0.7   | 11.6                   | 10.2                |
| 5 Heavy Industry           | 31.6      | -10.6       | 10.7       | -2.2  | 4.2    | 9.6                    | 19.9                |
| 6 Construction & Utilities | 12.2      | -2.1        | 8.5        | -0.1  | -0.2   | 0.5                    | 5.7                 |
| 7 Services                 | -3.6      | -36.5       | 8.0        | -1.3  | -7.0   | 4.4                    | 28.8                |
| Total                      | 0.0       | -111.5      | 36.2       | -8.1  | -17.4  | 22.8                   | 78.1                |



The last row of the **Table 9-2** shows the all sector total of each effect. It is obvious that the effect of the Technical Change(Change in Input Coefficients) played the most significant part in producing positive deviations(78.1%). Almost all sectors received its benefit except Agriculture, Forestry & Fisheries and Mining. This is because the development of various industries, some of which might be “newborn”, made a more complicated economic structure where those industries demand intermediate goods mutually. In this situation, an important fact to be pointed out is that Japan those days was in a stage where so-called “accumulation of small & middle size firms” around the main factory sites made it possible to satisfy these growing intermediate demands. It should be emphasized that this effect is regarded as an indicator of economic maturity or self completeness. We can guess that Japanese post World War II economic growth has its root in this inter-industry network.

The deviation of Investment was the second important positive factor(36.2%). Among four categories of final demands in **Table 9-2**, the investment was an only factor the total contribution of which was positive. The engine of the economy was the high investment rate supported by the high saving rate. Consumption and Exports, on the contrary, could not expand in a speed which is not as sufficient as they recorded the positive total contributions.

The third factor the total effect of which was positive was Change in Import Coefficients (22.8%), which suggests import substitution took place in some sectors. In fact, Import Substitution explained a fair part of the positive DPGs of Chemicals(11.0%), Metals(16.3%), and some Other light manufacturing. As Chenery(1960) showed that many countries experienced a period where import substitution was a main source of their economic development. This effect could be another key factor to measure economic maturity or self-completeness.

Even though Japan was force to be isolated from the international society because of its hard-line international policy and so-called Dodge’s Line after the Word War II almost compelled Japanese economy to substitute imported goods for it self, Japanese economic expansion in this period can be evaluated as an expansion with an improvement of the industrial structure by means of a leverage of the domestic demand growth.

## **(2) The Japanese Economy 1960-1970**

This period is the beginning of so-called “high speed economic growth”. The total production almost tripled during this decade. **Table 9-3** shows that Light Industry, the DPGs of which had been positive in the previous period, did not increase their shares any more. The sectors the deviations of which were large positive were Chemicals(7.8%), Steel & Iron(12.2%), Machinery(10.0%), Electric Machinery(11.9%), Machinery(11.3%), and Construction(7.9%). Japanese economy in this period was thus characterized by the expansion of Heavy Industries.

**Table 9-3. Normalized DPGs of Japan (1960-70) ( $\alpha=2.864$ )**

| 28Sectors                     | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|-------------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry            | -34.2     | -19.0       | 1.0        | -2.9  | -1.1   | -0.1               | -5.9             | -6.2                      |
| 2 Oil & Natural Gas           | -1.0      | -0.3        | 0.5        | -0.2  | 0.2    | 0.4                | -0.4             | -1.1                      |
| 3 Mining                      | 0.0       | 0.0         | 0.0        | 0.0   | 0.0    | 0.0                | 0.1              | -0.1                      |
| 4 Processed Food              | -22.5     | -26.0       | 0.1        | -1.2  | -0.5   | -0.7               | 7.4              | -1.6                      |
| 5 Fabrics, Garments & Apparel | -10.0     | -3.7        | 0.6        | -0.3  | -4.2   | -0.4               | -1.1             | -0.9                      |
| 6 Wooden & Paper Products     | -0.5      | -2.5        | 3.0        | 0.2   | 0.1    | -0.1               | -0.5             | -0.7                      |
| 7 Chemicals                   | 7.8       | -1.4        | 0.7        | 0.3   | 1.5    | -0.2               | 6.4              | 0.5                       |
| 8 Petroleum Products          | 3.7       | -0.1        | 0.8        | 0.0   | 0.7    | -0.2               | 2.3              | 0.2                       |
| 9 Non-Metallic Minerals       | 2.7       | 0.0         | 1.0        | 0.0   | -0.1   | 0.0                | 1.9              | 0.0                       |
| 10 Steel & Iron               | 12.2      | -0.8        | 5.8        | 0.8   | 6.9    | -0.2               | -2.7             | 2.4                       |
| 11 Non-Ferrous Metals         | 0.8       | 0.1         | 1.2        | 0.2   | 1.1    | -0.1               | -1.6             | -0.1                      |
| 12 Metal Products             | 7.1       | 0.3         | 1.5        | 0.7   | 0.4    | 0.0                | 4.4              | -0.1                      |
| 13 Machinery                  | 10.0      | -0.4        | 7.0        | 0.2   | 2.0    | -0.1               | 0.7              | 0.6                       |
| 14 Electric Machinery         | 11.9      | 1.7         | 4.9        | 1.2   | 3.1    | -0.5               | 1.7              | -0.2                      |
| 15 Transport Equipments       | 11.3      | 0.4         | 5.7        | 0.3   | 3.9    | -0.1               | 1.2              | 0.0                       |
| 16 Precision Apparatus        | 0.9       | 0.2         | 0.3        | 0.1   | 0.3    | -0.1               | 0.2              | 0.0                       |
| 17 Miscellaneous Products     | 6.0       | -0.9        | 1.4        | 0.1   | 0.4    | -0.4               | 5.4              | 0.0                       |
| 18 Construction               | 7.9       | -0.7        | 8.0        | 0.0   | 0.0    | 0.0                | 0.6              | -0.1                      |
| 19 Electricity & Gas          | -0.7      | -1.2        | 0.6        | 0.0   | 0.3    | 0.0                | -0.4             | 0.0                       |
| 20 City Water                 | 0.6       | 0.6         | 0.1        | 0.0   | 0.0    | 0.0                | -0.1             | 0.0                       |
| 21 Trade                      | 14.3      | -1.9        | 5.9        | 0.3   | 1.5    | -0.1               | 8.8              | -0.3                      |
| 22 Banking and Insurance      | -3.8      | -3.7        | 1.2        | 0.0   | 0.5    | -0.1               | -1.5             | -0.2                      |
| 23 Real Estate                | -3.8      | -3.5        | 0.5        | 0.0   | 0.2    | -0.1               | -0.9             | 0.0                       |
| 24 Transportation             | 0.4       | -2.0        | 1.5        | 0.0   | 3.1    | -0.2               | -1.8             | -0.2                      |
| 25 Communication              | 0.7       | -0.2        | 0.4        | 0.0   | 0.1    | 0.0                | 0.4              | 0.0                       |
| 26 Education and Medical      | -10.2     | -9.0        | 0.1        | 0.0   | 0.1    | 0.0                | -1.4             | 0.0                       |
| 27 Miscellaneous Services     | 1.7       | 1.6         | 0.8        | 0.0   | 0.4    | -0.2               | -0.8             | -0.1                      |
| 28 Others                     | -13.5     | -22.6       | 1.1        | 0.1   | 1.2    | -0.2               | 6.6              | 0.3                       |
| Total                         | 0.0       | -94.8       | 55.5       | 0.1   | 22.0   | -4.0               | 29.0             | -7.8                      |

| Aggregated 7 Sectors       | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry         | -34.2     | -19.0       | 1.0        | -2.9  | -1.1   | -0.1               | -5.9             | -6.2                      |
| 2 Mining                   | -1.0      | -0.3        | 0.5        | -0.2  | 0.2    | 0.4                | -0.3             | -1.2                      |
| 3 Light Industry           | -23.3     | -32.8       | 6.4        | -1.1  | -4.0   | -1.8               | 13.4             | -3.2                      |
| 4 Chemical Industry        | 11.5      | -1.5        | 1.5        | 0.4   | 2.2    | -0.4               | 8.7              | 0.7                       |
| 5 Heavy Industry           | 53.3      | 1.2         | 26.1       | 3.5   | 17.4   | -1.1               | 3.7              | 2.6                       |
| 6 Construction & Utilities | 7.8       | -1.3        | 8.7        | 0.0   | 0.4    | 0.0                | 0.1              | -0.1                      |
| 7 Services                 | -14.2     | -41.2       | 11.5       | 0.6   | 7.1    | -0.9               | 9.3              | -0.4                      |
| Total                      | 0.0       | -94.8       | 55.5       | 0.1   | 22.0   | -4.0               | 29.0             | -7.8                      |

A change is also observed in the sources of DPGs. The factors the total effects of which were positive were the deviations of Investment(55.5%), Exports(22.0%), and Change in Input Coefficients(29.0%). The expansion of Investment and Export was considerably large so that almost all sectors could receive its linkage effects thanks to Japanese relatively matured Input-Output structure. As the Keynesian economic theory teaches, the larger the propensity to consume,

the larger the value of multiplier becomes. Therefore, a heavy network of Input-Output intermediate consumption structure accelerates an expansion of the economic growth. The growth of Investment benefited all sectors, among which Machinery(7.0%) and Construction(8.0%) were conspicuous. There are two main reasons for this high growth of the Investment : rationalization of the production system through technological transfers from abroad and energy “revolution” from a coal oriented system to an oil oriented system.

And Exports benefited Transport equipment(3.9%) and Steel & Iron(6.9%). Though it is owing to the improvement of the export competitiveness through the above mentioned rationalization and energy revolution, another important factor fueled Japanese export was under-evaluation of Japanese Yen. Since 1949 Yen exchange rate against US Dollar had been fixed at 360 ¥/\$, but the PPP during 1960's was said to be 150~200 ¥/\$.

The effect on Changes in Input Coefficients has been the most significant source in the previous period, however, it was not the most important(29.0%) in 1960's. Nevertheless, it still explained a fair part of positive deviations of Chemicals (6.4%) and Metal Product(4.4%) and Miscellaneous Products(5.4%). As Watanabe and Suruga(1977) pointed out, rapid introduction of new technologies from abroad realized this positive effect.

### **(3) The Japanese Economy 1970-1980**

Japanese economic expansion dramatically slowed down because of Yen appreciation and two times of the Oil Crises. As a matter of fact, the growth rate of the total production in 1960's was almost 200%, but that in this period is merely 50%. In this situation, as DPGs shown in **Table 9-4** indicate, a new source of Japanese economic growth emerged in this period : enlargement of Service sectors is newly observed, while Chemicals no longer increased its share, though Heavy Industry growth still characterized Japanese economy.

Conspicuous in this decade is that the deviation of Investment, which had been a significant source of positive DPGs, turned to be a negative factor(-41.7%). The Investment experienced a serious slump after the quadrupling of the oil prices in 1973 and another oil crisis in 1979, therefore it could not continue to lead the growth of industries.

The most important sources of positive DPGs in this decade was the deviation of Exports (56.1%), which played a considerable role in the expansion of Electric Machinery(9.6%) and Transport Equipment(12.2%) and Steel & Iron(8.7%). The effect of Changes in Input Coefficients was an important source of the positive deviations of Transportation(15.7%) and Miscellaneous Services(7.0%), which suggests that a change took place in the pattern of intermediate demands which require more services than used to do. The enlargement of Service sectors was also supported by the deviation of consumption. The total effect of Consumption recorded positive for the first time. A change in favor of services seems to have taken place in the pattern of consumption as well.

Changes in Import Coefficients continued to be a factor the total effect of which was negative(-8.6% for the final demands and -13.3% for the intermediate demands), suggesting that imports had been increasing in a higher rate of average growth of the production.

**Table 9-4. Normalized DPGs of Japan(1970-80) ( $\alpha=1.563$ )**

| 28 sectors                    | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|-------------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry            | -19.9     | -7.2        | -0.5       | -0.2  | -0.7   | -2.2               | -6.8             | -2.4                      |
| 2 Oil & Natural Gas           | -1.6      | 0.0         | -0.3       | -0.5  | 0.2    | 0.1                | -0.4             | -0.5                      |
| 3 Mining                      | -0.2      | 0.0         | 0.0        | 0.0   | 0.0    | 0.0                | -0.1             | -0.1                      |
| 4 Processed Food              | -9.8      | -6.7        | -0.1       | -0.8  | -0.3   | -1.9               | 0.0              | 0.0                       |
| 5 Fabrics, Garments & Apparel | -9.4      | -2.4        | -0.3       | -0.9  | -1.6   | -1.0               | -2.2             | -1.0                      |
| 6 Wooden & Paper Products     | -10.8     | -0.4        | -2.2       | -0.8  | 0.4    | -0.3               | -5.9             | -1.6                      |
| 7 Chemicals                   | 0.8       | 1.3         | -0.5       | -1.7  | 1.2    | -0.3               | 2.6              | -1.7                      |
| 8 Petroleum Products          | -7.1      | -1.0        | -1.3       | -2.1  | 1.5    | -0.6               | -3.3             | -0.3                      |
| 9 Non-Metallic Minerals       | -2.1      | -0.3        | -1.0       | -0.3  | 0.4    | -0.1               | -0.6             | -0.3                      |
| 10 Steel & Iron               | -10.9     | 0.4         | -5.0       | -3.0  | 8.7    | 0.0                | -12.1            | 0.2                       |
| 11 Non-Ferrous Metals         | -0.4      | 0.4         | -0.3       | -0.2  | 3.0    | -0.1               | -2.2             | -1.0                      |
| 12 Metal Products             | 0.2       | 0.0         | -1.2       | -1.7  | 1.0    | 0.0                | 2.3              | -0.2                      |
| 13 Machinery                  | -1.0      | -0.2        | -8.6       | -0.5  | 6.4    | 0.4                | 1.8              | -0.3                      |
| 14 Electric Machinery         | 18.0      | 1.8         | 5.0        | -0.8  | 9.6    | -0.1               | 3.0              | -0.5                      |
| 15 Transport Equipments       | 11.8      | -0.5        | -6.2       | 0.3   | 12.2   | -0.3               | 6.5              | -0.2                      |
| 16 Precision Apparatus        | 2.9       | 0.6         | 0.6        | -0.1  | 1.7    | 0.2                | -0.2             | 0.0                       |
| 17 Miscellaneous Products     | -5.0      | -0.7        | -0.5       | -1.1  | 1.3    | -0.4               | -2.6             | -0.9                      |
| 18 Construction               | -11.9     | 0.9         | -10.0      | -0.1  | 0.2    | 0.0                | -2.8             | -0.1                      |
| 19 Electricity & Gas          | 2.7       | 0.4         | -0.6       | -0.4  | 1.0    | -0.1               | 2.7              | -0.3                      |
| 20 City Water                 | 1.4       | 0.1         | -0.1       | 0.0   | 0.1    | 0.0                | 1.3              | 0.0                       |
| 21 Trade                      | 6.2       | 3.5         | -4.3       | -1.4  | 3.1    | -0.3               | 6.2              | -0.7                      |
| 22 Banking and Insurance      | -2.2      | -5.5        | -0.8       | -0.4  | 1.7    | -0.1               | 3.1              | 0.0                       |
| 23 Real Estate                | 14.4      | 11.6        | -0.3       | -0.1  | 0.3    | 0.0                | 3.0              | -0.1                      |
| 24 Transportation             | 20.6      | 5.0         | -1.4       | -0.7  | 1.8    | -0.6               | 15.7             | 0.7                       |
| 25 Communication              | 0.9       | 0.8         | -0.2       | -0.1  | 0.4    | -0.1               | 0.2              | -0.1                      |
| 26 Education and Medical      | 20.2      | 15.2        | -0.2       | -0.1  | 0.3    | 0.0                | 4.9              | -0.1                      |
| 27 Miscellaneous Services     | -2.4      | -8.4        | -0.6       | -0.3  | 1.0    | -0.9               | 7.0              | -0.3                      |
| 28 Others                     | -5.5      | 5.9         | -0.6       | -1.0  | 1.2    | 0.0                | -9.3             | -1.6                      |
| Total                         | 0.0       | 14.7        | -41.7      | -18.9 | 56.1   | -8.6               | 11.8             | -13.3                     |

| aggregated 7 sectors       | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry         | -19.9     | -7.2        | -0.5       | -0.2  | -0.7   | -2.2               | -6.8             | -2.4                      |
| 2 Mining                   | -1.8      | 0.0         | -0.4       | -0.5  | 0.2    | 0.1                | -0.5             | -0.6                      |
| 3 Light Industry           | -34.1     | -10.0       | -3.6       | -3.9  | 1.9    | -3.4               | -11.4            | -3.8                      |
| 4 Chemical Industry        | -6.3      | 0.3         | -1.8       | -3.8  | 2.7    | -1.0               | -0.7             | -2.1                      |
| 5 Heavy Industry           | 17.7      | 2.0         | -16.3      | -5.8  | 40.7   | 0.0                | -0.9             | -2.0                      |
| 6 Construction & Utilities | -7.8      | 1.4         | -10.7      | -0.5  | 1.3    | -0.2               | 1.2              | -0.4                      |
| 7 Services                 | 52.2      | 28.2        | -8.5       | -4.1  | 9.9    | -1.9               | 30.9             | -2.2                      |
| Total                      | 0.0       | 14.7        | -41.7      | -18.9 | 56.1   | -8.6               | 11.8             | -13.3                     |

#### (4) The Japanese Economy 1980-1990

In this decade, Japanese economy experienced a great Yen appreciation, and as a result, a number of export goods lost their price competitiveness in the international market. It is only Electric Machinery that could keep expanding the export to the foreign market, as shown in **Table 9-5**.

**Table 9-5. Normalized DPGs of Japan(1980-90) ( $\alpha=1.490$ )**

| 28 sectors                    | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|-------------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry            | -7.7      | -4.3        | 0.3        | 0.7   | -0.2   | -0.4               | -3.7             | 0.0                       |
| 2 Oil & Natural Gas           | -1.5      | 0.0         | 0.2        | 0.0   | -0.1   | 0.0                | -1.2             | -0.5                      |
| 3 Mining                      | -0.1      | 0.0         | 0.0        | 0.0   | 0.0    | 0.0                | -0.2             | 0.0                       |
| 4 Processed Food              | -5.7      | -5.0        | 0.3        | 0.1   | -0.4   | -1.2               | 1.4              | -0.9                      |
| 5 Fabrics, Garments & Apparel | -6.4      | -1.3        | 0.5        | -0.1  | -1.7   | -1.4               | -1.7             | -0.7                      |
| 6 Wooden & Paper Products     | -4.1      | 0.1         | 1.8        | -0.3  | -0.2   | -0.4               | -4.3             | -0.8                      |
| 7 Chemicals                   | 0.2       | 1.1         | 0.8        | -0.1  | 0.1    | -0.6               | -0.3             | -0.8                      |
| 8 Petroleum Products          | -16.1     | 0.4         | 0.8        | 0.5   | -0.9   | 0.0                | -14.9            | -2.0                      |
| 9 Non-Metallic Minerals       | -3.7      | 0.1         | 0.8        | -0.1  | -0.4   | -0.1               | -3.8             | -0.3                      |
| 10 Steel & Iron               | -14.7     | 0.3         | 3.0        | 0.5   | -6.7   | -0.3               | -10.3            | -1.3                      |
| 11 Non-Ferrous Metals         | -2.4      | 0.4         | 0.7        | -0.1  | -0.2   | -0.1               | -1.8             | -1.2                      |
| 12 Metal Products             | 0.0       | -0.9        | 0.8        | 0.1   | -1.0   | -0.2               | 1.4              | -0.1                      |
| 13 Machinery                  | 3.3       | 0.3         | 8.9        | -0.4  | 0.7    | -0.1               | -5.9             | -0.3                      |
| 14 Electric Machinery         | 22.7      | 4.4         | 8.8        | -0.6  | 7.5    | -0.5               | 3.3              | -0.2                      |
| 15 Transport Equipments       | -1.9      | 4.3         | 0.1        | -1.2  | -2.1   | -1.4               | -1.9             | 0.3                       |
| 16 Precision Apparatus        | -0.3      | 0.0         | 0.6        | -0.1  | -0.2   | -0.1               | -0.4             | -0.1                      |
| 17 Miscellaneous Products     | 5.7       | 0.8         | 1.4        | 0.1   | 0.0    | -1.8               | 5.2              | -0.1                      |
| 18 Construction               | 6.2       | 0.2         | 6.0        | 0.0   | -0.1   | -0.1               | 0.3              | -0.1                      |
| 19 Electricity & Gas          | -5.8      | 0.2         | 0.8        | 0.0   | -0.3   | -0.2               | -6.0             | -0.3                      |
| 20 City Water                 | 0.5       | 0.2         | 0.2        | 0.0   | 0.0    | 0.0                | 0.2              | -0.1                      |
| 21 Trade                      | 0.6       | 3.0         | 6.2        | -0.1  | -1.0   | -0.6               | -6.6             | -0.3                      |
| 22 Banking and Insurance      | 8.0       | 4.1         | 1.1        | 0.0   | -0.3   | -0.4               | 4.1              | -0.6                      |
| 23 Real Estate                | 2.6       | 2.6         | 0.6        | 0.0   | -0.1   | -0.1               | -0.3             | -0.1                      |
| 24 Transportation             | -20.8     | -9.9        | 2.0        | 0.0   | -1.9   | -1.7               | -8.8             | -0.5                      |
| 25 Communication              | 2.1       | 1.6         | 0.4        | 0.0   | 0.0    | -0.1               | 0.2              | -0.1                      |
| 26 Education and Medical      | 8.5       | 3.4         | 0.8        | -0.1  | 0.3    | -0.1               | 4.4              | -0.2                      |
| 27 Miscellaneous Services     | 39.9      | 9.4         | 4.2        | -0.1  | 0.7    | -1.9               | 28.4             | -0.9                      |
| 28 Others                     | -8.7      | -2.1        | 0.6        | 0.4   | 0.1    | -0.2               | -6.0             | -1.5                      |
| Total                         | 0.0       | 13.1        | 52.8       | -0.8  | -8.4   | -13.9              | -29.2            | -13.5                     |

| Aggregated 7 sectors       | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry         | -7.7      | -4.3        | 0.3        | 0.7   | -0.2   | -0.4               | -3.7             | 0.0                       |
| 2 Mining                   | -1.7      | 0.0         | 0.2        | 0.0   | -0.1   | 0.1                | -1.4             | -0.4                      |
| 3 Light Industry           | -14.6     | -5.4        | 5.4        | -0.4  | -2.8   | -5.0               | -3.5             | -2.9                      |
| 4 Chemical Industry        | -15.9     | 1.5         | 1.6        | 0.4   | -0.8   | -0.6               | -15.2            | -2.8                      |
| 5 Heavy Industry           | 6.9       | 8.7         | 22.3       | -1.6  | -1.9   | -2.6               | -15.3            | -2.7                      |
| 6 Construction & Utilities | 0.8       | 0.6         | 6.9        | 0.0   | -0.4   | -0.3               | -5.5             | -0.4                      |
| 7 Services                 | 32.0      | 12.1        | 16.0       | 0.1   | -2.2   | -5.1               | 15.4             | -4.2                      |
| Total                      | 0.0       | 13.1        | 52.8       | -0.8  | -8.4   | -13.9              | -29.2            | -13.5                     |

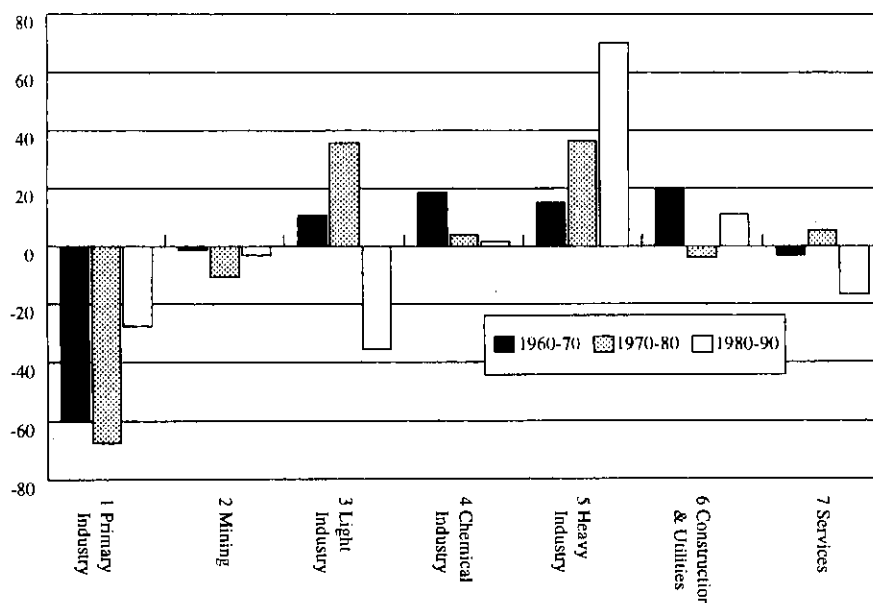
The factors the total effects of which were positive were the deviation of Investment and Consumption. The total effect of Investment(51.8%) was more than three times as large as that of Consumption(13.1%). Investment was an important source for Machinery(8.9%) and Electric Machinery(8.8%) and Consumption had a significant effect for Service(16.0%).

Through the Japanese economy before the first Oil Crisis was characterized by the industrialization of Heavy Industry, some new trends were observed in this decade. The first one is that the leading sectors were converging Electric Machinery only, which was favored by almost all factors such as the deviation of Consumption, Investment and Export and also the Changes of Input Coefficients. Another trend is the continuing enlargement of Service sectors. For example, Miscellaneous Service accounted for 39.9% of the positive deviations and Banking & Insurance and Education & Medical sector recorded considerable large positive DPGs(8.0% and 8.5%). The sources of positive DPGs of Service sectors were mainly the deviation of Consumption and Change in the I-O Coefficients, in other words, demand structure of intermediate inputs in Japanese economy seems to have changed to a new stage of service oriented economy.

#### 4. Major Findings in the Korean Economy

Figure 9-2 depicts overtime changes of DPGs in Korean economy. The weight of Heavy Industry has been increasing, while Light Industry and Chemical Industry have been losing their inference on the economic growth. Tables 9-6, 9-7 and 9-8 give the detailed results of the DPG decomposition analysis for Korean economy in 1960-1970, 1970-1980 and 1980-1990. Korea has been known as one of Asian NIEs which have achieved a rapid growth and realized the industrialization through an export-oriented policy. Several characteristics, which seems to have resulted from its development strategy, are found in the analysis.

Figure 9-2. DPGs in Korean Economy



## (1) The Korean Economy 1960-1970

Table 9-6 shows that DPGs total of manufacturing and Construction amount to 65% of the positive deviations. The Korean economy in this period is thus characterized by the overall expansion of its manufacturing sector.

**Table 9-6. Normalized DPGs of Korea(1960-70) ( $\alpha=3.954$ )**

| 28 sectors                    | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|-------------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Agriculture                 | -57.7     | -60.4       | 0.7        | 7.0   | -0.6   | -6.5               | -1.1             | 3.1                       |
| 2 Forestry                    | -1.7      | -0.8        | 2.6        | -0.4  | 1.9    | 0.5                | -2.7             | -2.7                      |
| 3 Fishery                     | -0.6      | -0.9        | 0.0        | 0.3   | 0.7    | 0.0                | -0.7             | 0.0                       |
| 4 Mining                      | -1.3      | -0.7        | 0.9        | 5.0   | 0.4    | -5.6               | 0.1              | -1.4                      |
| 5 Processed Food              | -1.1      | -4.8        | 0.1        | -0.1  | 1.0    | 0.0                | 2.2              | 0.5                       |
| 6 Beverages                   | -9.6      | -11.0       | 0.1        | -1.4  | 0.0    | 0.5                | 2.3              | 0.0                       |
| 7 Tobacco                     | 1.7       | 4.4         | 0.0        | -0.1  | 0.2    | 0.1                | -2.7             | -0.2                      |
| 8 Yarn                        | -6.1      | -9.6        | 0.1        | -0.5  | 2.4    | 0.7                | -0.8             | 1.7                       |
| 9 Fabrics                     | 0.4       | -3.5        | 0.1        | 0.1   | 2.0    | 0.1                | 2.3              | -0.7                      |
| 10 Garments & Apparel         | 14.1      | 7.9         | 1.3        | 0.0   | 6.9    | 1.7                | -3.5             | -0.2                      |
| 11 Leather                    | -1.0      | -0.5        | 0.0        | -0.5  | 0.1    | 0.0                | 0.0              | -0.1                      |
| 12 Wooden Products            | 4.6       | -1.0        | 0.8        | 0.0   | 2.5    | 0.0                | 2.1              | 0.2                       |
| 13 Paper and Paper Products   | -1.7      | -3.0        | 0.3        | 0.2   | 0.5    | 0.0                | 0.7              | -0.4                      |
| 14 Chemicals                  | 11.0      | -1.0        | 0.7        | -0.1  | 1.6    | 0.1                | 5.8              | 3.9                       |
| 15 Petroleum & Coal Product   | 7.6       | 0.0         | 0.5        | 0.2   | 1.2    | 0.0                | 0.6              | 5.0                       |
| 16 Non-Metallic Minerals      | 3.4       | -0.8        | 2.2        | 0.0   | 0.4    | -0.1               | 1.1              | 0.5                       |
| 17 Steel & Iron               | 6.0       | -0.3        | 2.1        | 0.5   | 0.8    | -0.3               | 3.9              | -0.6                      |
| 18 Non-ferrous Metal          | 0.4       | -0.1        | 0.3        | -0.3  | 0.4    | 0.0                | 0.4              | -0.4                      |
| 19 Metallic Products          | -1.3      | -0.6        | 1.3        | -0.1  | 0.6    | -0.3               | -1.2             | -1.0                      |
| 20 Machinery                  | -0.1      | -0.1        | 1.8        | 0.2   | 0.1    | -2.2               | 0.4              | -0.4                      |
| 21 Electric Machinery         | 5.0       | 0.3         | 1.0        | 0.2   | 1.3    | 0.7                | 1.3              | 0.2                       |
| 22 Transport Equipment        | 5.8       | 0.1         | 5.8        | 0.2   | 0.2    | -1.4               | 1.5              | -0.6                      |
| 23 Miscellaneous Products     | 6.0       | 0.3         | -0.4       | 0.0   | 3.4    | 1.3                | 0.9              | 0.5                       |
| 24 Construction               | 19.7      | -0.4        | 19.8       | 0.0   | 0.2    | 0.0                | 0.0              | 0.0                       |
| 25 Electricity, Gas & Water   | -0.2      | -1.1        | 0.6        | 0.2   | 0.5    | -0.2               | -0.4             | 0.1                       |
| 26 Trans., Comm., & Warehouse | 4.8       | 0.7         | 1.9        | 0.2   | 3.0    | -0.2               | -1.5             | 0.7                       |
| 27 Wholesale & Retail Trade   | 9.6       | -1.7        | 4.7        | 0.3   | 2.4    | -0.1               | 3.4              | 0.6                       |
| 28 Miscellaneous Services     | -17.7     | -22.1       | 3.6        | 0.4   | 4.2    | 0.3                | -4.8             | 0.7                       |
| Total                         | 0.0       | -110.8      | 53.2       | 11.7  | 38.2   | -11.0              | 9.6              | 9.2                       |

| Aggregated 7 sectors       | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry         | -60.0     | -62.1       | 3.4        | 6.9   | 2.0    | -6.0               | -4.5             | 0.4                       |
| 2 Mining                   | -1.3      | -0.7        | 0.9        | 5.0   | 0.4    | -5.6               | 0.1              | -1.4                      |
| 3 Light Industry           | 10.7      | -21.7       | 4.7        | -2.3  | 19.2   | 4.2                | 4.6              | 1.9                       |
| 4 Chemical Industry        | 18.6      | -1.0        | 1.3        | 0.1   | 2.9    | 0.0                | 6.4              | 8.9                       |
| 5 Heavy Industry           | 15.7      | -0.7        | 12.3       | 0.7   | 3.4    | -3.4               | 6.3              | -2.8                      |
| 6 Construction & Utilities | 19.4      | -1.4        | 20.4       | 0.2   | 0.7    | -0.2               | -0.4             | 0.2                       |
| 7 Services                 | -3.2      | -23.2       | 10.2       | 1.0   | 9.6    | 0.0                | -2.9             | 2.1                       |
| Total                      | 0.0       | -110.8      | 53.2       | 11.7  | 38.2   | -11.0              | 9.6              | 9.2                       |

The most significant source of the manufacturing expansion was the deviation of Investment(53.2%). The growth of investment was considerably rapid and almost all sectors, except Miscellaneous Products, received its linkage effect. However, the most conspicuous is the DPG of Construction(19.7%). Korea in 1960's is known by a boom of some large construction projects such as Seoul-Pusan high-way and apartment compounds around Seoul area. And it is also during 1960's that Korea began to construct such big plants as the first oil refiner at Ulsan and the first steel factory at Pohang. These construction projects were closely related with the government policies, that is to say, they were decided more or less with the president Park's political initiative of industrialization which was supported by the introduction of fund and technology from abroad such as Japan and the USA.

The second source of this manufacturing expansion was the deviation of Exports(38.2%). Although being inferior to the investment, Korea began to export a variety of manufactures and the exports also increased at a remarkable rapid rate. Since Korean government employed some export driving policies, such as export subsidies and tax reduction for exports, almost all sectors, especially such Light industry as Garments & Apparel, Wooden Products or Miscellaneous Products, were benefited from the exports(6.9%, 2.5% and 3.4%).

The effects of Changes in Import Coefficients and Changes in Input Coefficients, which explained a fair part of the positive deviations of Chemicals and Petroleum Products, were not significant on the whole. The deviation of consumption could not have any positive effects (-110.8%).

There are some similarities between the Korean pattern of growth in this period and the Japanese pattern in 1914-1954 in the respect that all the sectors which belong to manufacturing increased the shares, where the deviation of investment was a significant source. However, Exports played a distinguished role in the Korean case, whereas the effects of Changes in Input Coefficients and Import Coefficients were relatively more important in Japan. It is possible to find some reasons for this difference: (i) since Korean economic policy those days was export oriented and did not put an emphasis on promoting domestic economic circulation, economic resources were strategically provided to promote Heavy Industry and Construction, (ii) Korean domestic market (or, domestic demand) those days were not large enough for the import substitution could fuel the economic "take off", and (iii) supporting industries, which were mainly based on domestic intermediate demands in the case of Japan, did not exist like Japan at the beginning of Korean economy's "take off".



## (2) The Korean Economy 1970-80

In this decade, there took place a change in the pattern of economic expansion, while Construction decreased its output share. However, as shown in **Table 9-7**, the total DPG of manufacturing sectors still accounted for a large part(76.5%) of the positive DPGs. Primary Industry continuously lost its share.

**Table 9-7. Normalized DPGs of Korea(1970-80) ( $\alpha=3.481$ )**

| 28 sectors                    | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|-------------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Agriculture                 | -60.3     | -49.9       | -0.1       | -6.5  | 0.5    | 1.0                | -7.2             | 1.8                       |
| 2 Forestry                    | -4.7      | -2.4        | -1.6       | 0.3   | 0.1    | 0.3                | -1.5             | 0.1                       |
| 3 Fishery                     | -2.6      | -1.7        | 0.0        | 0.0   | -0.3   | -0.1               | -0.4             | 0.0                       |
| 4 Mining                      | -10.6     | -1.0        | -0.2       | 1.1   | -1.1   | -1.2               | -4.2             | -4.1                      |
| 5 Processed Food              | 12.9      | 8.7         | 0.0        | 0.0   | 0.5    | 0.1                | 3.2              | 0.4                       |
| 6 Beverages                   | 0.4       | 1.2         | 0.0        | 0.1   | 0.0    | 0.0                | -1.0             | 0.0                       |
| 7 Tobacco                     | 1.4       | 1.1         | 0.0        | 0.3   | 0.0    | 0.0                | 0.0              | 0.0                       |
| 8 Yarn                        | 12.2      | 0.5         | 0.0        | 0.3   | 5.9    | 0.1                | 5.3              | 0.1                       |
| 9 Fabrics                     | 2.8       | 1.4         | 0.1        | 0.2   | 2.4    | 0.0                | -1.4             | 0.2                       |
| 10 Garments & Apparel         | -2.5      | -2.4        | 0.0        | 0.2   | 0.4    | 0.0                | -0.8             | 0.1                       |
| 11 Leather                    | 5.3       | 1.3         | 0.0        | 0.3   | 3.9    | 0.0                | 0.0              | -0.2                      |
| 12 Wooden Products            | -1.3      | 0.1         | -0.1       | -0.5  | -0.8   | 0.1                | -0.2             | 0.0                       |
| 13 Paper and Paper Products   | 1.5       | 0.0         | 0.0        | 0.0   | 0.8    | 0.2                | 0.0              | 0.5                       |
| 14 Chemicals                  | 12.4      | -3.0        | 0.1        | -2.0  | 6.2    | 1.0                | 4.6              | 5.4                       |
| 15 Petroleum & Coal Product   | -8.2      | -6.1        | 0.0        | -1.2  | 2.7    | 0.9                | -3.2             | -1.2                      |
| 16 Non-Metallic Minerals      | 1.3       | 0.0         | -0.6       | -0.3  | 1.0    | 0.2                | 0.7              | 0.3                       |
| 17 Steel & Iron               | 12.0      | -0.1        | -0.1       | -0.7  | 7.7    | 0.9                | 0.6              | 3.8                       |
| 18 Non-ferrous Metal          | 1.3       | 0.1         | 0.3        | -0.8  | 1.2    | 0.9                | -0.8             | 0.4                       |
| 19 Metallic Products          | 2.5       | 0.0         | 0.0        | -0.1  | 1.7    | 0.1                | 0.2              | 0.7                       |
| 20 Machinery                  | 4.6       | -0.1        | 0.8        | 0.3   | 1.0    | 0.9                | 1.9              | -0.3                      |
| 21 Electric Machinery         | 12.0      | 0.8         | 2.0        | -9.9  | 5.0    | 10.8               | 2.4              | 0.8                       |
| 22 Transport Equipment        | 4.2       | 0.0         | 1.0        | 0.3   | 2.8    | 0.0                | 0.5              | -0.4                      |
| 23 Miscellaneous Products     | 2.0       | -0.5        | 0.3        | 0.1   | 0.7    | 0.3                | 1.1              | 0.0                       |
| 24 Construction               | -5.4      | -0.8        | -4.9       | -0.1  | -0.3   | 0.1                | 0.6              | 0.0                       |
| 25 Electricity, Gas & Water   | 1.5       | -0.2        | 0.1        | -0.3  | 1.5    | 0.4                | -0.5             | 0.6                       |
| 26 Trans., Comm., & Warehouse | 3.2       | -1.4        | 0.0        | -0.3  | 5.4    | 0.4                | -0.1             | -0.8                      |
| 27 Wholesale & Retail Trade   | -4.4      | -5.1        | 0.4        | -0.8  | 5.1    | 1.1                | -5.6             | 0.5                       |
| 28 Miscellaneous Services     | 6.7       | -1.2        | 0.9        | -0.9  | 2.3    | 1.1                | 4.3              | 0.3                       |
| Total                         | 0.0       | -60.9       | -1.4       | -20.7 | 56.1   | 19.6               | -1.6             | 9.0                       |

| Aggregated 7 sectors       | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry         | -67.5     | -53.9       | -1.7       | -6.2  | 0.2    | 1.2                | -9.1             | 2.0                       |
| 2 Mining                   | -10.6     | -1.0        | -0.2       | 1.1   | -1.1   | -1.2               | -4.2             | -4.1                      |
| 3 Light Industry           | 35.8      | 11.3        | -0.2       | 0.8   | 14.8   | 1.0                | 6.9              | 1.2                       |
| 4 Chemical Industry        | 4.1       | -9.1        | 0.1        | -3.2  | 8.9    | 1.9                | 1.4              | 4.2                       |
| 5 Heavy Industry           | 36.6      | 0.6         | 3.9        | -10.9 | 19.4   | 13.6               | 4.8              | 5.1                       |
| 6 Construction & Utilities | -3.9      | -1.1        | -4.8       | -0.4  | 1.2    | 0.5                | 0.0              | 0.6                       |
| 7 Services                 | 5.6       | -7.7        | 1.3        | -2.0  | 12.8   | 2.6                | -1.5             | 0.0                       |
| Total                      | 0.0       | -60.9       | -1.4       | -20.7 | 56.1   | 19.6               | -1.6             | 9.0                       |

A change also took place in the sources of DPGs. The significance of investment decreased. This is partly because the reconstruction demand after Korean War finished and also partly because the Oil Crises generated uncertainty for the future economic circumstances. However, it does not necessarily mean that economy on the whole was in a slump but the favorable effects from Exports began to work so as to boost the economy(56.1%). As a matter of fact, Korean economy in late 1970's was in a record-breaking boom called Middle-East boom(or Oil dollar boom). It is surprising that Korean goods expanded into international market in spite of world wide recession. This fact means that Korean goods had the export competitiveness enhanced by the export oriented policies which promoted technology introduction and also kept domestic costs(like wages) relatively cheap. The sectors which the deviation of Exports favored were not only Light Industry(Yarn 5.8%) but also Heavy and Chemical Industry(Chemical 6.2% and Steel & Iron 7.7%) though the main export goods in the previous period belonged to Light Industry. As a result, the growth of the Korean economy in this decade was as rapid as the previous period, while Japanese growth rate halved.

As various kinds of big plants began to work in this period, the Korean economy seems to have been more matured(in other words, more domestically self-complete) than the previous period. First of all, significant decrease of import rates was observed in both final and intermediate demands, especially in Chemicals, Iron & Steel and Electric Machinery(1.0%, 0.9% and 10.8% in intermediate demands and 5.4%,3.8% and 0.8% in final demands). And the effect of technical change explained a fair part of their growth in Electric Machinery and Chemicals(4.6% and 2.4%). These phenomena is of the proofs that Korean economy was shifting from a single truck economy(investment growth led by export) to a more complicated economic system where intensified inter-industrial linkage amplifies growth of domestic demands.

### **(3) The Korean Economy 1980-90**

At the beginning of the 1980's, a problem of accumulated foreign debt was actualized in Korea, while the domestic economy was also in a slump. However, a boom before Seoul Olympic Game held in 1988 which prepared a considerable investment opportunity and so called Boom of three "lows", which means low interest rate, low won rate against dollar, and low oil price, saved the Korean economy. Therefore, the growth of this period was, to some extent, domestic-export balanced growth, as shown in **Table 9-8**. Construction increased its output share again, and the total of DPGs of Heavy Industry and that of Construction explained 80% of the positive DPGs. The share of Light Industry shrank drastically. The main source of economic growth in this period was not Export but the Change in Input Coefficients(39.8%) and Investment(26.9%). It is for the first time that the change in input coefficients became the largest source of economic growth.

**Table 9-8. Normalized DPGs of Korea(1980-90) ( $\alpha=2.805$ )**

| 28 sectors                    | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|-------------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Agriculture                 | -20.5     | -23.2       | -0.1       | 1.9   | -0.4   | 5.3                | -2.0             | -1.9                      |
| 2 Forestry                    | -2.5      | -1.0        | -0.4       | 0.0   | -0.1   | 0.1                | -0.9             | -0.2                      |
| 3 Fishery                     | -4.6      | -3.1        | 0.0        | 0.2   | -1.6   | 0.0                | 0.1              | -0.3                      |
| 4 Mining                      | -3.0      | -0.4        | 0.4        | -0.2  | -0.1   | 0.0                | -1.8             | -1.0                      |
| 5 Processed Food              | -21.6     | -26.0       | 0.1        | 0.0   | 0.0    | 0.0                | 4.6              | -0.3                      |
| 6 Beverages                   | -2.1      | -3.4        | 0.0        | 0.1   | 0.1    | -0.2               | 1.6              | -0.3                      |
| 7 Tobacco                     | -2.4      | -2.1        | 0.0        | -0.4  | 0.0    | -0.2               | 0.3              | 0.0                       |
| 8 Yarn                        | -9.7      | -3.4        | 0.0        | -1.6  | -4.5   | -0.2               | 1.9              | -2.0                      |
| 9 Fabrics                     | -1.6      | -0.6        | 0.0        | -0.5  | -1.0   | 0.2                | 0.4              | -0.1                      |
| 10 Garments & Apparel         | -6.6      | -2.6        | 0.0        | -0.4  | -3.3   | -0.3               | 0.0              | 0.0                       |
| 11 Leather                    | 2.5       | -1.2        | 0.0        | -0.4  | 2.6    | -0.2               | 1.0              | 0.7                       |
| 12 Wooden Products            | -0.5      | 0.5         | 0.8        | 0.7   | -1.2   | 0.0                | -0.7             | -0.6                      |
| 13 Paper and Paper Products   | 1.5       | -0.8        | 0.2        | -0.7  | 0.1    | 0.0                | 2.4              | 0.3                       |
| 14 Chemicals                  | 9.9       | -1.2        | 0.8        | 1.2   | 1.3    | -0.7               | 7.8              | 0.7                       |
| 15 Petroleum & Coal Product   | -8.2      | -2.1        | 0.6        | -0.5  | 1.0    | -0.4               | -4.9             | -1.8                      |
| 16 Non-Metallic Minerals      | 2.2       | 0.0         | 1.1        | -0.8  | -0.7   | 0.1                | 2.3              | 0.1                       |
| 17 Steel & Iron               | 4.7       | 1.6         | 2.1        | -1.8  | -1.4   | 2.5                | -2.7             | 4.4                       |
| 18 Non-ferrous Metal          | 1.5       | 0.3         | 0.3        | 0.1   | 1.0    | 0.1                | -0.3             | -0.1                      |
| 19 Metallic Products          | 5.9       | 0.3         | 1.5        | -0.1  | 0.4    | 0.3                | 2.8              | 0.8                       |
| 20 Machinery                  | 18.2      | 0.9         | 2.1        | -0.6  | 4.1    | 4.6                | 3.1              | 3.9                       |
| 21 Electric Machinery         | 19.8      | 4.8         | 0.2        | 0.3   | 10.4   | 1.9                | 0.4              | 1.9                       |
| 22 Transport Equipment        | 19.9      | 7.0         | 3.9        | -0.4  | 1.3    | 2.7                | 3.0              | 2.5                       |
| 23 Miscellaneous Products     | 2.8       | 0.2         | 0.2        | -0.2  | 0.3    | -0.6               | 2.3              | 0.7                       |
| 24 Construction               | 9.3       | -1.2        | 8.6        | 0.0   | 0.1    | 0.0                | 1.7              | 0.1                       |
| 25 Electricity, Gas & Water   | 1.7       | -0.1        | 0.3        | -0.2  | 0.0    | 0.2                | 1.2              | 0.2                       |
| 26 Trans., Comm., & Warehouse | -5.0      | -4.9        | 0.7        | -0.2  | -1.6   | -0.1               | -0.1             | 1.3                       |
| 27 Wholesale & Retail Trade   | -1.0      | -2.4        | 1.1        | -0.4  | 0.7    | 0.6                | -1.7             | 1.1                       |
| 28 Miscellaneous Services     | -10.6     | -33.4       | 2.3        | -0.3  | 1.2    | -0.4               | 18.1             | 1.9                       |
| Total                         | 0.0       | -97.5       | 26.9       | -5.5  | 8.7    | 15.4               | 39.8             | 12.2                      |

| Aggregated 7 sectors       | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry         | -27.6     | -27.3       | -0.5       | 2.0   | -2.1   | 5.3                | -2.8             | -2.3                      |
| 2 Mining                   | -3.0      | -0.4        | 0.4        | -0.2  | -0.1   | 0.0                | -1.8             | -1.0                      |
| 3 Light Industry           | -35.5     | -39.5       | 2.5        | -4.2  | -7.7   | -1.3               | 16.1             | -1.4                      |
| 4 Chemical Industry        | 1.7       | -3.4        | 1.5        | 0.7   | 2.2    | -1.1               | 2.9              | -1.1                      |
| 5 Heavy Industry           | 70.1      | 15.0        | 10.0       | -2.6  | 15.9   | 12.1               | 6.3              | 13.4                      |
| 6 Construction & Utilities | 11.0      | -1.3        | 8.9        | -0.2  | 0.1    | 0.2                | 2.9              | 0.3                       |
| 7 Services                 | -16.6     | -40.7       | 4.2        | -1.0  | 0.3    | 0.1                | 16.2             | 4.3                       |
| Total                      | 0.0       | -97.5       | 26.9       | -5.5  | 8.7    | 15.4               | 39.8             | 12.2                      |

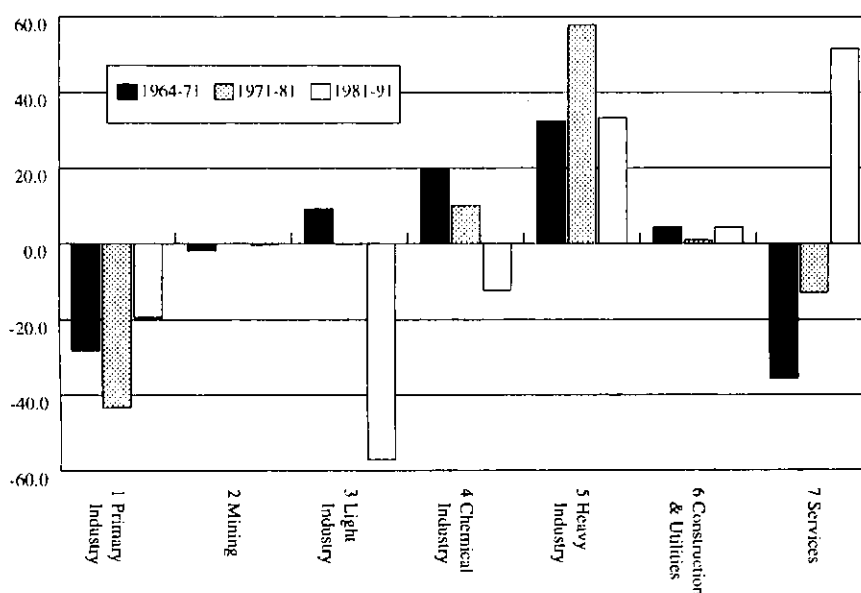
Korean growth in the above three periods can be characterized by its rapid growth rate and maturity of industrial structure. Korea seems to have succeeded in showing an example of export oriented economic development as a strategy of economic take off : enhancement of domestic circulation induced by strategic export expansion. Although these characteristics could be found in the post-war growth of Japan until the beginning of the 1970s, in the Korean case Exports played a

remarkable role. However, the export oriented policy that Korean government adopted was, on the other hand, at the mercy of domestic consumers. In Korean experience, the deviation of Consumption has never been a leading source of economic growth. Low wage and low domestic consumption demands were behind the high rate of investment growth and export expansion. The next target for Korean economy is to balance the economy between the producer base economic system and consumer base welfare society.

## 5. Major Findings in the Taiwanese Economy

Figure 9-3 shows the overtime changes of DPGs in the Taiwanese economy, another typical example of Asian NIEs, where several similarities with the Korean growth pattern can be observed. However, Service sector in Taiwan recently has relatively a large influence to the structural change of the economy. The detailed results of DPG decomposition analysis for Taiwan in 1964-1971, 1971-1981 and 1981-1991 are shown in Tables 9-9, 9-10 and 9-11.

Figure 9-3. DPGs in Taiwanese Economy



### (1) The Taiwanese Economy 1964-1971

When the new Taiwan government was founded in 1949, the industry in Taiwan were merely Agriculture and some Light Industries such as sugar making or fibers. The government, to begin with, nationalized ex-Japanese assets and implemented the development plan of “Four Year Economic Construction Plan”, the main policy of which was import substitution. However, this policy came to a dead lock soon because of the limitation of the Taiwanese domestic market size. Then, the direction of the economic policy turned to be export oriented by the beginning of 1960’s.

As Table 9-9 shows that manufacturing sectors in general expanded, especially Chemical and Heavy manufacturing(19.5% and 32.4% of DPG), though Processed Food exceptionally lost its share considerably(-22.3%). Like the case of Korea, the most significant source of positive DPGs

was the deviation of Exports(60.5%), which increased at a considerably rapid rate and benefited such clothing related sectors as Fabrics(9.9%), Garments & Apparel(8.4%), and Artificial Fibers & Plastics(7.3%), and also Electric Machinery(10.5%). Taiwanese Electric Machinery was a new horn industry based on the government's export oriented policy including technology and fund introduction from abroad. In the success of this policy, FAZ(Free Access Zone) in Kaoshun became well known as a symbol of Taiwanese export oriented development.

**Table 9-9. Normalized DPGs of Taiwan(1964-71) ( $\alpha=2.404$ )**

| 27 sectors                  | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|-----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Agricultural Products     | -27.7     | -16.1       | 0.2        | -2.0  | -3.0   | -1.0               | -1.0             | -4.8                      |
| 2 Forestry                  | 0.6       | -0.1        | 0.3        | 0.2   | 0.5    | -0.1               | 0.2              | -0.4                      |
| 3 Fisheries                 | -1.0      | -2.4        | 0.0        | 0.0   | 1.8    | 0.0                | -0.2             | -0.2                      |
| 4 Minerals                  | -1.8      | -0.5        | 0.4        | 0.7   | 0.4    | -0.5               | -1.9             | -0.3                      |
| 5 Processed Food            | -22.3     | -22.3       | 0.0        | -2.2  | -4.5   | 0.2                | 6.9              | -0.6                      |
| 6 Beverages & Tobacco       | -0.7      | -0.5        | 0.0        | -1.2  | 0.3    | 0.5                | 0.0              | 0.0                       |
| 7 Fabrics                   | 11.4      | -0.3        | -0.1       | 1.0   | 9.9    | -0.2               | 1.1              | 0.0                       |
| 8 Garments & Apparel        | 10.7      | 1.8         | 0.0        | 0.2   | 8.4    | -0.1               | 0.6              | -0.2                      |
| 9 Wood & Wooden Products    | 2.5       | -0.3        | 0.4        | 0.4   | 2.5    | 0.0                | -0.5             | -0.1                      |
| 10 Paper & Paper Products   | 2.6       | -0.4        | 0.1        | -0.6  | 1.0    | 0.1                | 2.1              | 0.3                       |
| 11 Chemical Materials       | 1.6       | -1.1        | 0.1        | 0.0   | 1.4    | -0.3               | 1.1              | 0.4                       |
| 12 Art. Fibers & Plastics   | 14.4      | -0.2        | 0.2        | 1.7   | 7.3    | 0.3                | 3.6              | 1.5                       |
| 13 Misc. Chemical Products  | -0.6      | -0.7        | 0.2        | -0.5  | 1.9    | 0.3                | -1.2             | -0.6                      |
| 14 Petroleum Products       | 4.1       | -0.7        | 0.2        | 0.6   | 1.6    | -0.1               | 2.9              | -0.4                      |
| 15 Non-Metallic Minerals    | 0.4       | -0.2        | 0.9        | -0.2  | 0.1    | 0.0                | -0.4             | 0.4                       |
| 16 Steel & Iron             | 1.5       | 0.1         | 0.9        | 0.6   | 1.6    | -0.3               | 0.2              | -1.5                      |
| 17 Misc. Metals & Metallic  | 4.4       | -0.2        | 0.2        | 0.5   | 2.5    | 0.0                | 0.8              | 0.5                       |
| 18 Machinery                | 4.2       | -0.1        | 1.6        | 0.1   | 1.6    | 1.1                | 0.8              | -0.9                      |
| 19 Electric Machinery       | 17.1      | 2.7         | 2.3        | 0.4   | 10.5   | 0.0                | 1.9              | -0.8                      |
| 20 Transport Equipments     | 5.2       | 0.9         | 2.6        | 0.1   | 1.3    | -0.7               | 0.7              | 0.3                       |
| 21 Miscellaneous Products   | 4.5       | 0.3         | 0.2        | 0.0   | 3.7    | -0.1               | 0.3              | 0.1                       |
| 22 Construction             | 3.6       | -0.5        | 4.0        | 0.0   | 0.2    | 0.0                | -0.1             | 0.0                       |
| 23 Electricity              | 0.6       | 0.1         | 0.3        | 0.1   | 1.3    | 0.0                | -1.0             | -0.1                      |
| 24 Gas & City Water         | 0.3       | 0.4         | 0.0        | 0.0   | 0.1    | 0.0                | -0.2             | 0.0                       |
| 25 Trans. & Comm.           | -2.2      | -3.3        | 0.5        | 0.2   | 2.9    | -0.3               | -1.6             | -0.6                      |
| 26 Wholesale & Retail Trade | -43.7     | -29.7       | -1.4       | 0.0   | 0.2    | -1.5               | -11.0            | -0.2                      |
| 27 Miscellaneous Services   | 10.2      | 9.3         | -0.3       | 0.1   | 5.0    | 1.7                | -3.8             | -1.8                      |
| Total                       | 0.0       | -63.7       | 13.9       | 0.0   | 60.5   | -1.0               | 0.3              | -9.9                      |

| Aggregated 7 sectors       | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry         | -28.1     | -18.6       | 0.5        | -1.8  | -0.7   | -1.1               | -1.1             | -5.4                      |
| 2 Mining                   | -1.8      | -0.5        | 0.4        | 0.7   | 0.4    | -0.5               | -1.9             | -0.3                      |
| 3 Light Industry           | 9.2       | -21.7       | 1.6        | -2.6  | 21.4   | 0.4                | 10.2             | -0.1                      |
| 4 Chemical Industry        | 19.5      | -2.7        | 0.7        | 1.8   | 12.1   | 0.3                | 6.4              | 1.0                       |
| 5 Heavy Industry           | 32.4      | 3.4         | 7.7        | 1.6   | 17.6   | 0.1                | 4.4              | -2.4                      |
| 6 Construction & Utilities | 4.5       | 0.0         | 4.3        | 0.0   | 1.6    | 0.0                | -1.3             | -0.1                      |
| 7 Services                 | -35.7     | -23.6       | -1.2       | 0.2   | 8.1    | -0.2               | -16.4            | -2.7                      |
| Total                      | 0.0       | -63.7       | 13.9       | 0.0   | 60.5   | -1.0               | 0.3              | -9.9                      |

On the other hand, the effect of the Changes in Input Coefficients gave scarcely important effects on manufacturing growth except Processed Food. And import ratios increased in intermediate goods of the almost all sectors(-9.9%). The pattern that some of the export-led expansion is offset by the increase of imports of intermediate goods is also observed in Taiwan.

## (2) The Taiwanese Economy 1971-1981

At 1973 the government started some industrialization projects, which clarified the direction of export oriented industrialization. In this period, there took place a change in the pattern of expansion of manufacturing, whereby clothing related sectors decreased their shares and such Chemical and Heavy Industry as Petroleum Products, Steel & Iron, Electric Machinery and Transport Equipment became leading sectors of economic growth, as shown in **Table 9-10**.

**Table 9-10. Normalized DPGs of Taiwan(1971-81) ( $\alpha=2.849$ )**

| 27 sectors                  | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|-----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Agricultural Products     | -32.9     | -13.3       | 0.1        | 0.3   | -5.2   | 0.1                | -9.9             | -4.9                      |
| 2 Forestry                  | -6.1      | -1.1        | 0.0        | -0.5  | -0.7   | 0.0                | -1.5             | -2.3                      |
| 3 Fisheries                 | -4.3      | -3.6        | 0.0        | 0.0   | -1.6   | 0.0                | 1.0              | 0.0                       |
| 4 Minerals                  | -12.6     | -2.4        | 0.6        | 0.0   | 0.5    | -0.5               | -9.5             | -1.4                      |
| 5 Processed Food            | -15.4     | -15.6       | 0.0        | 0.0   | -6.1   | -1.1               | 9.1              | -1.7                      |
| 6 Beverages & Tobacco       | -0.8      | -0.3        | 0.0        | 0.4   | -0.1   | -0.8               | 0.0              | 0.0                       |
| 7 Fabrics                   | 3.7       | -1.6        | 0.1        | -1.3  | 6.2    | -0.3               | -0.6             | 1.2                       |
| 8 Garments & Apparel        | 9.1       | -1.2        | 0.1        | -0.1  | 9.2    | -0.7               | 1.3              | 0.4                       |
| 9 Wood & Wooden Products    | -7.1      | -0.8        | 0.4        | -0.9  | -2.4   | 0.1                | -2.9             | -0.6                      |
| 10 Paper & Paper Products   | -0.3      | -2.2        | 0.3        | 2.3   | 1.5    | -2.7               | 0.0              | 0.5                       |
| 11 Chemical Materials       | 5.6       | -0.9        | 0.1        | -0.5  | 2.0    | -0.5               | 4.0              | 1.3                       |
| 12 Art. Fibers & Plastics   | -0.2      | -3.0        | 0.5        | -4.2  | 12.4   | 0.2                | -11.9            | 6.0                       |
| 13 Misc. Chemical Products  | -4.7      | -3.5        | 0.2        | -0.4  | -0.7   | -0.6               | -1.9             | 2.2                       |
| 14 Petroleum Products       | 9.3       | 0.2         | 0.4        | -0.4  | 1.8    | -0.3               | 6.8              | 0.9                       |
| 15 Non-Metallic Minerals    | 2.1       | -0.1        | 0.8        | 0.3   | 0.7    | 0.0                | 0.6              | -0.1                      |
| 16 Steel & Iron             | 15.0      | 0.4         | 1.3        | -1.0  | 3.9    | 0.7                | 0.9              | 8.8                       |
| 17 Misc. Metals & Metallic  | 6.8       | -0.2        | 1.1        | -0.4  | 5.2    | 0.1                | -0.8             | 1.8                       |
| 18 Machinery                | 4.5       | -0.2        | 1.9        | 0.0   | 3.1    | 0.8                | 0.1              | -1.2                      |
| 19 Electric Machinery       | 21.0      | 1.6         | 1.7        | 0.1   | 15.5   | 0.7                | 1.4              | 0.0                       |
| 20 Transport Equipments     | 10.6      | 2.8         | 0.6        | 0.5   | 3.6    | 2.1                | -0.2             | 1.2                       |
| 21 Miscellaneous Products   | 8.7       | 0.1         | 0.2        | 0.1   | 7.3    | -0.4               | 0.8              | 0.4                       |
| 22 Construction             | 3.6       | -0.7        | 3.9        | 0.0   | 0.1    | -0.1               | 0.4              | 0.0                       |
| 23 Electricity              | -1.6      | -2.4        | 0.4        | -0.2  | 2.0    | -0.1               | -2.3             | 1.1                       |
| 24 Gas & City Water         | -1.1      | -0.8        | 0.0        | 0.1   | 0.1    | 0.2                | -0.7             | 0.0                       |
| 25 Trans. & Comm.           | -4.6      | 1.8         | 0.3        | -0.2  | -3.3   | -0.6               | -2.4             | -0.1                      |
| 26 Wholesale & Retail Trade | -0.3      | -0.8        | 0.8        | -0.6  | 3.2    | 1.5                | -5.1             | 0.8                       |
| 27 Miscellaneous Services   | -8.0      | -17.1       | 1.0        | 0.1   | 4.5    | -4.2               | 8.4              | -0.6                      |
| Total                       | 0.0       | -64.8       | 16.7       | -6.4  | 62.8   | -6.8               | -14.9            | 13.6                      |

| Aggregated 7 sectors       | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry         | -43.3     | -18.1       | 0.1        | -0.1  | -7.5   | 0.0                | -10.4            | -7.3                      |
| 2 Mining                   | -12.6     | -2.4        | 0.6        | 0.0   | 0.5    | -0.5               | -9.5             | -1.4                      |
| 3 Light Industry           | -0.1      | -21.7       | 1.8        | 0.9   | 16.3   | -5.9               | 8.3              | 0.1                       |
| 4 Chemical Industry        | 10.1      | -7.2        | 1.2        | -5.5  | 15.4   | -1.3               | -3.0             | 10.4                      |
| 5 Heavy Industry           | 57.9      | 4.5         | 6.6        | -0.8  | 31.4   | 4.3                | 1.4              | 10.6                      |
| 6 Construction & Utilities | 0.9       | -3.9        | 4.3        | -0.1  | 2.2    | 0.0                | -2.6             | 1.1                       |
| 7 Services                 | -12.9     | -16.1       | 2.0        | -0.8  | 4.5    | -3.4               | 0.9              | 0.1                       |
| Total                      | 0.0       | -64.8       | 16.7       | -6.4  | 62.8   | -6.8               | -14.9            | 13.6                      |

In spite of the global recession in this decade, Exports could continue to be an outstanding cause of positive DPGs(62.4%). The export-led pattern of growth was particularly obvious. However, import substitution of both intermediate demands and final demands was also observed for Heavy industry. It seems that in Taiwan, as well as in Korea, the economy was steadily maturing.

### (3) The Taiwanese Economy 1981-1991

Taiwanese economy in this period was also basically led by Exports like the previous periods. However, its influence became moderate. Instead of Exports, the effect of Changes in I-O Coefficients emerged as the largest source of economic growth, as shown in **Table 9-11**.

Conspicuous is that Miscellaneous Service sector, which explained 56.3% of positive DPG, grew rapidly through the deviation in Consumption(38.0%) and increase of intermediate demands(15.6%). Taiwanese economy is becoming service oriented very rapidly. Another characteristic in this period is that the manufacturing sectors which had positive DPGs became only two sectors : Electric Machinery(29.4%) and Artificial Fibers & Plastics (5.1%), which were mainly fueled by the satisfactory performance of Export and secondly by favorable Changes in Input Coefficients, though other many manufacturing sectors had recorded positive DPGs in the previous period.

Total effect of Changes in Input Coefficients is large(31.4%), and this effect is especially important for the growth of Heavy and Chemical industry and Service sectors. It is for the first time, like Korean case, that the change in input coefficients became the largest source of economic growth. Taiwanese economy gives us another example that production expansion based on the effort of export-investment changed to more balanced development where the improvement of technology generates the domestic intermediate demands and also increase of domestic income absorbs the domestic supply.

**Table 9-11. Normalized DPGs of Taiwan(1981-91) ( $\alpha=2.472$ )**

| 27 sectors                  | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|-----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Agricultural Products     | -15.0     | -8.2        | -0.2       | -1.7  | -1.8   | -1.2               | -3.3             | 1.4                       |
| 2 Forestry                  | -1.3      | 0.0         | -0.3       | 0.1   | -0.2   | 0.0                | -0.2             | -0.6                      |
| 3 Fisheries                 | -3.1      | -0.4        | 0.0        | -0.1  | -2.1   | -0.2               | -0.3             | 0.0                       |
| 4 Minerals                  | -0.3      | -0.2        | 0.0        | 0.0   | 0.1    | -0.1               | 0.6              | -0.6                      |
| 5 Processed Food            | -20.5     | -12.4       | 0.0        | -0.5  | -2.8   | -2.0               | -2.2             | -0.4                      |
| 6 Beverages & Tobacco       | -2.4      | -1.8        | 0.0        | -0.3  | -0.1   | -0.3               | -0.1             | 0.1                       |
| 7 Fabrics                   | -4.0      | -1.0        | 0.0        | -0.6  | 1.8    | -0.7               | -0.7             | -2.8                      |
| 8 Garments & Apparel        | -16.6     | -1.7        | -0.1       | -0.6  | -12.7  | -0.9               | -0.1             | -0.4                      |
| 9 Wood & Wooden Products    | -7.3      | 0.2         | -0.2       | -0.1  | -4.2   | -0.3               | -0.8             | -1.8                      |
| 10 Paper & Paper Products   | -2.2      | -0.4        | 0.0        | 1.1   | 0.6    | -1.3               | -0.2             | -2.1                      |
| 11 Chemical Materials       | -2.4      | -0.4        | 0.0        | 0.1   | 1.7    | -0.4               | 2.6              | -6.0                      |
| 12 Art. Fibers & Plastics   | 5.1       | -0.5        | 0.0        | -0.5  | 5.4    | -0.6               | 3.9              | -2.6                      |
| 13 Misc. Chemical Products  | -0.8      | -0.3        | -0.1       | -0.4  | -0.3   | -0.4               | 1.8              | -1.0                      |
| 14 Petroleum Products       | -14.2     | -3.8        | -0.1       | 0.0   | -1.7   | -0.3               | -4.6             | -3.8                      |
| 15 Non-Metallic Minerals    | -2.4      | -0.2        | 0.0        | -0.5  | 0.0    | -0.2               | -1.1             | -0.4                      |
| 16 Steel & Iron             | 1.0       | -0.6        | -1.0       | 0.7   | 2.1    | -0.1               | -0.2             | 0.2                       |
| 17 Misc. Metals & Metallic  | 0.0       | -0.4        | -0.7       | -0.3  | 5.6    | -0.3               | -0.5             | -3.3                      |
| 18 Machinery                | 3.8       | -0.2        | -1.9       | -0.2  | 3.4    | 0.9                | -0.1             | 1.9                       |
| 19 Electric Machinery       | 29.4      | 0.8         | 1.3        | 0.2   | 23.8   | -2.0               | 5.3              | 0.1                       |
| 20 Transport Equipments     | -1.0      | 2.7         | -3.4       | -0.8  | 0.9    | -2.7               | 1.6              | 0.5                       |
| 21 Miscellaneous Products   | -1.7      | -0.1        | 0.0        | -0.3  | -0.1   | -0.5               | 0.2              | -1.0                      |
| 22 Construction             | 3.5       | 0.6         | 0.3        | 0.0   | 0.0    | 0.1                | 2.6              | -0.1                      |
| 23 Electricity              | 0.7       | -0.6        | -0.1       | -0.1  | 0.6    | -0.2               | 2.0              | -0.9                      |
| 24 Gas & City Water         | 0.2       | -0.4        | 0.0        | 0.0   | 0.0    | 0.0                | 0.7              | 0.0                       |
| 25 Trans. & Comm.           | -1.4      | -5.5        | 0.2        | -0.2  | 3.0    | -0.9               | 2.8              | -0.7                      |
| 26 Wholesale & Retail Trade | -3.3      | -5.2        | 0.4        | -0.9  | -2.7   | -0.6               | 6.3              | -0.7                      |
| 27 Miscellaneous Services   | 56.3      | 38.0        | 0.7        | -0.8  | -0.8   | 5.1                | 15.6             | -1.5                      |
| Total                       | 0.0       | -2.0        | -5.6       | -6.7  | 19.6   | -10.4              | 31.4             | -26.5                     |

| Aggregated 7 sectors       | Deviation | Consumption | Investment | Stock | Export | Final Substitution | Technical Change | Intermediate Substitution |
|----------------------------|-----------|-------------|------------|-------|--------|--------------------|------------------|---------------------------|
| 1 Primary Industry         | -19.4     | -8.7        | -0.5       | -1.7  | -4.1   | -1.4               | -3.8             | 0.7                       |
| 2 Mining                   | -0.3      | -0.2        | 0.0        | 0.0   | 0.1    | -0.1               | 0.6              | -0.6                      |
| 3 Light Industry           | -57.1     | -17.4       | -0.4       | -1.8  | -17.4  | -6.4               | -4.9             | -8.8                      |
| 4 Chemical Industry        | -12.3     | -4.9        | -0.2       | -0.8  | 5.1    | -1.7               | 3.7              | -13.4                     |
| 5 Heavy Industry           | 33.2      | 2.3         | -5.8       | -0.4  | 35.9   | -4.3               | 6.0              | -0.5                      |
| 6 Construction & Utilities | 4.4       | -0.4        | 0.2        | -0.1  | 0.6    | -0.1               | 5.2              | -1.0                      |
| 7 Services                 | 51.6      | 27.2        | 1.3        | -1.8  | -0.6   | 3.6                | 24.7             | -2.8                      |
| Total                      | 0.0       | -2.0        | -5.6       | -6.7  | 19.6   | -10.4              | 31.4             | -26.5                     |

## 6. Concluding Remarks

This paper presented a method to explain quantitatively the causes of observed change in the composition of industries. This method was applied to the data of Japan for 1914-1990, of Korea for 1960-1990, and of Taiwan for 1964-1991 to compare their patterns of economic growth. The



result of the analysis can be summarized as follows:

- i ) Japanese growth in the pre World War II period was characterized by the expansion of its manufacturing sectors and construction. The change in the pattern of intermediate demand(technical change), the growth of investment, and the import substitution supported the growth.
- ii ) After the World War II, Japanese industrialization shifted its center of gravity to heavy industries, among which the machinery sector became outstanding in the later period. The growth of investment and exports, of which the latter was more conspicuous in the later period, played a significant part.
- iii) In the period after the 1970's, Japan enlarged its Service sectors. Its enlargement was supported by changes in the patterns of intermediate demand and consumption demand.
- iv) Conspicuous in the Korean and Taiwanese economies was the overall expansion of their manufacturing sectors, for which expansion exports based on their export-oriented policy played a remarkably significant role.
- v ) It seems that the economies of Korea and Taiwan were becoming more matured, especially in the period after 1970's. The growing exports of Heavy Industry, the import substitution of both intermediate and investment goods and strengthened inter-industrial linkages were observed.
- vi) In Korea and Taiwan, the deviation of Consumption has never been a source of economic growth. That is because the low wage and the low domestic consumption demands were under the high rate of investment growth and export expansion. The next target for the economy of NIEs is to keep the balance between the producer base economic system and consumer base welfare society.

## **Appendix : Source of Data**

### **A. Sources of Input-Output Tables**

[Japanese tables for 1914 and 1954] Chenery, Shishido, and Watanabe(1962).

[Other tables of Japan] *Input Output Tables* compiled by Management and Coordination Agency, et al.

[Tables of Korea] *Input Output Tables* compiled by the Bank of Korea.

[Tables of Taiwan] *Input Output Tables* compiled by Directorate-General of Budget, Accounting and Statistics, Executive Yuan.

### **B. Sources of Price Indexes**

[Japanese tables for 1914 and 1954] Chenery, Shishido, and Watanabe(1962)

[Other tables of Japan] *Link Input Output Tables* compiled by the ministry of trade and industry.

[Tables of Korea] wholesale price index and consumer price index, *Economic Statistics Yearbook* compiled by Bank of Korea.

[Tables of Taiwan]wholesale price index and consumer price index, *Taiwan Statistical Data book* compiled by Directorate-General, Accounting and Statistics.

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- 1 These characteristics of the DPG resulted from our  $\alpha$  in equation (9-1) being the average ratio of expansion of industries. Though such statistics as the ratio of expansion of per capita income, total domestic demand, GNP or GDP has often been chosen instead of the average ratio of expansion of industries, these characteristics do not hold in these cases.
- 2 If  $A = (a_{ij})$  and  $B = (b_{ij})$ , then their Hadamard product is  $A \otimes B = (a_{ij}b_{ij})$ . See Rao(1973), p30.
- 3 Although equation (9-5) and (9-5') are the basic formulas for our DPG analysis, they require rather detailed information on imports, information which is not available in 1914-1954 Japanese case. Therefore, the following formula will be used in that case. The balance equation is

$$X_i = (I - M_i)(A_i X_i + C_i + F_i + J_i) + E_i,$$

where  $M_i$  is a diagonal matrix of import ratio and the deviation formula is

$$\begin{aligned} \delta X &= B_2(I - M_2)\delta C + B_2(I - M_2)\delta F + B_2(I - M_2)\delta J + B_2(I - M_2)\delta E \\ &+ B_2(M_1 - M_2)\alpha(A_1 X_1 + C_1 + F_1 + J_1 + E_1) + B_2(I - M_2)(A_2 - A_1)\alpha X_1, \end{aligned}$$

where  $B_2 = [I - (I - M_2)A_2]^{-1}$

- 4 *For example, Japanese 1960 IO table is reevaluated by 1970 base yen price index in the comparison between 1960-1970 and 1970 IO table is reevaluated by 1980 base yen price index in the comparison between 1970-1980, while Korean 1960 IO table is reevaluated by 1970 base won price index in the comparison between 1960-1970 and 1970 IO table is reevaluated by 1980 base won price index in the comparison between 1970-1980. Therefore, price units are different in each comparison.*
- 5 The sum of DPGs that are positive is equal to the absolute value of the sum of DPGs that are negative, since the sum of DPGs, according to the definition in this paper, is equal to zero.