Sectoral Productivity and Economic Growth in Japan: 1970-98

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Kyoji Fukao*
Hitotsubashi University, ESRI and RIETI

Tomohiko Inui
Nihon University and ESRI

Hiroki Kawai
Keio University, ESRI and RIETI

Tsutomu Miyagawa
Gakushuin University and ESRI

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* Correspondence: Fukao, Institute of Economic Research, Hitotsubashi University, Naka 2-1, Kunitachi, Tokyo 186 JAPAN. Tel.: +81-42-580-8359, Fax.: +81-42-580 -8333, e-mail: k.fukao@srv.cc.hit-u.ac.jp
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1. Introduction

For the last three years, we, the four scholars, several economists of ESRI, and graduate students from Keio, Hitotsubashi, Tsukuba and other universities have struggled to develop a new set of sectoral statistics called the Japan Industrial Productivity (JIP) database as part of an ESRI (Economic and Social Research Institute, Cabinet Office, Government of Japan) research project. The first version of the database is scheduled to be completed by the summer of 2002. The JIP database contains annual information on 84 sectors, including 49 non-manufacturing sectors, from 1970 to 1998. These sectors cover the whole Japanese economy. The database includes detailed information on factor inputs, annual input-output tables, relatively reliable deflators, and some additional statistics, such as R&D stock, Japan's international trade statistics by trade partner, inward and outward FDI, etc. at a detailed sectoral level.

Probably the Keio Database (KDB) is the best known database on Japan's sectoral productivity. The database covers 42 sectors (including 20 non-manufacturing sectors). Compared with the KDB, the JIP database contains information on a detailed sectoral basis, especially in the case of non-manufacturing sectors.[1]

In this paper we will analyze Japan's sectoral TFP (total factor productivity) growth over the last three decades using a preliminary version of this database. Making use of the advantages of the statistics, we conduct a study on Japan's economic growth at a detailed sectoral level, which was almost impossible before the compilation of this database. Since the database includes information on sectoral capital stock by detailed type of capital and R&D stock, we can also examine how IT investments and R&D expenditures affected Japan's sectoral TFP growth.

The paper is organized as follows: In the succeeding section, we analyze sectoral TFP growth. We also decompose changes of output prices into TFP growth, changes of factor prices, and changes of the mark-up rate. In section 3, we check whether the sectoral distribution effects had negative impacts on Japan's TFP growth in recent years. We will show that the reallocation effect became negative, and this negative reallocation effect have reduced macro-TFP growth rates by 0.15% per annum since 1985. In section 4, we study how IT capital has been accumulated in Japan and examine the effects of IT investment on sectoral productivity growth. In section 5, we will modify the standard, reduced-form R&D productivity growth equation to test whether productivity growth is a function of investments in R&D and IT capital. We will also take account of spillover effects from investment in R&D and IT capital by each sector's suppliers.

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[1] In order to get access to the KDB, scholars need to get permission from Keio University. The JIP database will be made open to the public in the near future.

2. Sectoral Productivity Growth and the Quantity/Price Decomposition

2.1 Methodology

In this section, we analyze sources of sectoral output and price changes. Moreover, we derive total factor productivity (TFP) growth in each industry. Our methodology of decomposition is based on the economic theory of production. The economy is divided into J sectors producing J different commodities. Gross output of sector *j* in period *t* is assumed to be produced with a production function using various types of input [capital ($K_1,\ldots K_k$), labor ($L_1,\ldots,L_l$) and intermediate commodities ($M_1,\ldots,M_m$)] and the state of technology, T.

$$Y_{jt} = F\,(K_{1jt},\ldots K_{kjt}, L_{1jt},\ldots,L_{ljt}, M_{1jt},\ldots,M_{mjt}, T_{jt}) \qquad (1)$$

We assume that this function is separable in such a way that the various types of capital, labor and intermediate inputs may be aggregated into indices K_{jt}, L_{jt} and M_{jt} respectively, so we may write the production function as

$$Y_{jt} = F\,(K_{jt}, L_{jt}, M_{jt}, T_{jt}) \qquad (2)$$

The index of capital input is derived by aggregation of several types of assets, structures and equipment. The labor input is an aggregate of the number of workers cross-classified by sex, age, and educational attainment.[2] The material input index is derived by aggregation of 90 commodities. These intermediate goods are supplied by the 90 sectors. The construction of these input aggregates is described in the appendix.

We assume that (2) is described by a translog form and is differentiated by time as follows:

$$d\ln Y_{jt} = \bar{s}_{Kjt}\, d\ln K_{jt} + \bar{s}_{Ljt}\, d\ln L_{jt} + \bar{s}_{Mjt}\, d\ln M_{jt} + d\ln A_{jt} \qquad (3)$$

where $d\ln Y_{jt} = \ln Y_{jt} - \ln Y_{jt-1}$ and the s_{jt}'s are the two-period average share of the subscripted input in nominal gross output,

$$\bar{s}_{Kjt} = (s_{Kjt} + s_{Kjt-1})/2$$

etc. In this derivation we use the optimal conditions for producers:

$$\frac{\partial \ln F}{\partial \ln K} d\ln K = \frac{\partial F}{\partial K}\frac{K}{Y} = \frac{w_K}{p}\frac{K}{Y} = s_K$$

etc.

The last term on the right-hand side of equation (3) denotes the contribution of technological change on the production increase,

$$\mathrm{dln}A_{jt} = \frac{\partial \ln F}{\partial \ln T} d \ln T .$$

It is difficult to measure and observe the states of technology T but it is easy to measure the contribution of technological change on production in the following way.

$$\mathrm{dln}A_{jt} = \mathrm{dln}Y_{jt} - \left(\bar{s}_{Kjt}\, \mathrm{dln}K_{jt} + \bar{s}_{Ljt}\, \mathrm{dln}L_{jt} + \bar{s}_{Mjt}\, \mathrm{dln}M_{jt} \right) \qquad (4)$$

On the other hand, we specify the dual cost function of various input price, output levels, and states of technology as follows:

$$C_{jt} = G\left(w_{Kjt}, w_{Ljt}, w_{Mjt}, Y_{jt}, T_{jt}\right) \qquad (5)$$

where w_K: users' cost of capital, w_L: price of labor input, and w_M: price of intermediate input. We assume that (5) is described by a trans-log form and is differentiated by time as follows:

$$\mathrm{dln}C_{jt} = \bar{s}_{Kjt}\, \mathrm{dln}w_{Kjt} + \bar{s}_{Ljt}\, \mathrm{dln}w_{Ljt} + \bar{s}_{Mjt}\, \mathrm{dln}w_{Mjt} + \bar{e}_{Yjt}\, \mathrm{dln}Y_{jt} + \mathrm{dln}B_{jt} \qquad (6)$$

where

$$e_{Yjt} = \frac{\partial \ln C}{\partial \ln Y}$$

denotes scale elasticity. In this derivation we also use the optimal conditions for producers (Shepard's Lemma), that is

$$\frac{\partial \ln G}{\partial \ln w_K} d \ln w_K = \frac{\partial G}{\partial w_K} \frac{w_K}{C} = \frac{w_K K}{C} = s_K ,$$

etc. The last term on the right hand side of equation (6) denotes the contribution of technological change on its cost,

$$\mathrm{dln}B_{jt} = \frac{\partial \ln G}{\partial \ln T} d \ln T .$$

When we assume mark-up pricing, that is, $p=\mu C/Y$, p: output price, μ: excess profit rate, it is easy to measure the contribution of technological change and economies of scale to the reduction of cost in the following way:

$$\mathrm{dln}B'_{jt} = \mathrm{dln}B_{jt} + \left(1 - \bar{e}_{Yjt}\right) \mathrm{dln}Y_{jt}$$

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[2] In this paper, we could not take account of the difference of educational attainment.

$$= \bar{s}_{Kjt}\, \mathrm{dlnw}_{Kjt} + \bar{s}_{Ljt}\, \mathrm{dlnw}_{Ljt} + \bar{s}_{Mjt}\, \mathrm{dlnw}_{Mjt} + \mathrm{dln}\mu - \mathrm{dlnp}_{jt} \qquad (7)$$

Total Factor Productivity is known as an efficiency measure, which is defined as the output *Y* divided by total input *X*,

$$\mathrm{TFP} = Y/X.$$

From the definition of production cost, we have

$$C = S_i w_i x_i = WX,$$

w_i : factor price, x_i: input. By differentiating the above equation over time, we get

$$\mathrm{dln}C = S s_i \mathrm{dln}w_i + S s_i \mathrm{dln}x_i = \mathrm{dln}W + \mathrm{dln}X,\ s_i = w_i x_i / C \qquad (8)$$

The growth rate of TFP is derived by its definition and an accounting balance.

$$\mathrm{dln}TFP = \mathrm{dln}Y - \mathrm{dln}X = \mathrm{dln}Y - S s_i \mathrm{dln}x_i = \mathrm{dln}\mu + S s_i \mathrm{dln}w_i - \mathrm{dln}p \qquad (9)$$

The above equation shows that TFP is identical with the index *A* in equation (4) and the index *B'* in equation (7). These relationships imply that the efficiency measure, the TFP index, can be regarded both as the contribution of technological change on its production and as the contribution of technological change and scale economies on its cost.

2-2 Output Growth and Price Change Decomposition

Using equation (9), we conduct a decomposition analysis of Japan's output growth and price changes from 1970 to 1998.

Figure 2-1 shows the result of the decomposition analysis for overall sectors for three sub-periods: the 1970s, 1980s, and 1990s. The growth rate of output was 4% for the '70s and '80s. However, in the '90s, this slowed down dramatically to only 0.6%. The development of TFP growth mirrors that of output growth, slowing down from 0.5% in the '70s and '80s to 0.2% in the '90s. However, this result seems to indicate that TFP does not play such an important role in explaining the growth rate of output. Yet, TFP is still important in current output growth because the share of TFP growth in output growth is one third (0.2/0.6). Without TFP growth, the output growth rate would have been even lower.

(Insert Figure 2-1)

The description above of growth in aggregate output masks a wide variation in growth among industries. Figure 2-2 and Figure 2-3 present the output growth decomposition for manufacturing sectors and non-manufacturing sectors. These figures show that there was a wide variation in TFP growth among industries. The following sectors recorded very high TFP growth.

(insert Figure 2-2 and Figure 2-3)

In the 1970s: Food, textiles, chemicals, other steel, metal, machinery, insurance, transportation, medical services.

In the 1980s: Furniture, leather, chemicals, steel, machinery, metal mining, utilities, railways, air transportation, insurance, telephone, advertising.

In the 1990s: Food, textiles, leather, other electric and precision machinery, marine products, finance, insurance, research, restaurant and inns

On the other hand, the following sectors recorded negative TFP growth.

In the 1970s: Coal, leather, steel, ships, rice/wheat, forestry, crude oil/gas, utilities, railways, mail, entertainment, laundry etc.

In the 1980s: Processed marine products, silk, water supply, real estate, rental equipment, inns.

In the 1990s: Rice/flour production, silk, electric machinery, rice/wheat, mining, gas, rental of office equipment and goods, inns, medical services.

2-3 Price Change Decomposition

Next, we study the change of output price using duality. Figure 2-1 shows how drastically Japan moved from the high inflation era (1970s) to the low inflation era (1980s and 1990s). In the '80s and '90s, TFP growth was an important factor behind the low inflation rate. It is also interesting to note that in the '90s the decline in the user's cost of capital was also an important factor. On the other hand, the mark-up rate has increased in the '90s. This counter-cyclical pattern of mark-up is consistent with Rotemberg and Saloner's (1986) findings.

These macro-economic output price changes conceal a wide variation of price changes among industries. Figure 2-2 and Figure 2-3 present the decomposition of output price changes in manufacturing and non-manufacturing sectors. The two figures show that there was a wide variation in TFP growth among industries. Especially in the '80s and the '90s, the variation of both TFP growth and price changes of intermediate inputs played an important role in the determination of output price changes in each sector.

Finally, let us check the counter-cyclical pattern of the mark-up. In the 1970s, the mark-up rate declined in most sectors. In the '80s, mark-up rates declined in one half of all the sectors and they increased in the other half of the sectors. In the '90s, half of all manufacturing sectors experienced a decline in the mark-up. On the other hand, in most of the service sectors, the mark-up rate continued to rise.

3. The Sectoral Distribution Effects on Macro-TFP Growth

In this section, we examine whether the sectoral distribution effects had a negative impact on Japan's TFP growth in recent years. If we define the "hollowing-out" phenomenon as a decline in the share of output by the manufacturing industry and an increase in the share of that by the tertiary industry, the Japanese economy experienced this phenomenon in the '90s. Table 3-1 shows the sector's value added share in total (in constant price) in 1970, 1980, 1990 and 1998.[3] Our 84 industries were re-categorized into 10 broader industries. As this table shows, the manufacturing sector's share declined from 28.7% to 26.6% in the period from 1990-98. On the other hand, the service and government sector's share increased slightly from 26.8% to 27.1% during the same period.

(Insert Table 3-1)

Table 3-2 shows TFP growth rates in the above 10 industries. Since the concept of value-added based TFP is more convenient for the analysis of sectoral distribution effects on the macro-economy, we will mainly use this concept in the present section.

The macro-TFP growth rate has declined from around 1.0 % per annum in the 1970s and 1980s to 0.3 % per annum between 1990 and 1998. There were declines in average annual TFP growth rates in sectors such as services and government, and electricity, gas and water supply between 1990 and 1998. On the other hand, the TFP growth rates in the manufacturing sector

[3] The outputs (value added) in two industries (housing and "activity not elsewhere specified") are not included.

stayed positive during this period, although the rates were substantially lower than those in the 1970s and 1980s. Hence, we can conjecture that the source of the decline in total TFP growth in the 1990s in Japan can be attributed to the structural shift in production from a high productivity sector, such as the manufacturing sector to a low productivity sector, such as the service sector. The "hollowing out" phenomenon seems to play a role in the slowdown in Japan's TFP growth rate in the 1990s.

(Insert Table 3-2)

In order to examine this hypothesis, we decomposed the effect of the change in the industrial structure on TFP growth rates. The formula used here is the same as the one employed in Syrquin (1986):

$$TFPG - \sum_i S_{Yi} TFPG_i = \sum_i S_{Yi} a_i (G(K_i) - G(K)) + \sum_i S_{Yi} b_i (G(L_i) - G(L))$$

where TFPG is the value-added base TFP growth rate in the economy, $TFPG_i$ is the value-added base TFP growth rate in sector i, S_{Yi} is the share of sector i's output (value added) in total output, a_i is the factor share of capital in sector i, $ß_i$ is the factor share of labor in sector i, G(K) is the growth rate of capital in the economy, $G(K_i)$ is the growth rate of capital in sector i, G(L) is the growth rate of labor in the economy, and $G(L_i)$ is the growth rate of labor in sector i respectively.

The right-hand side of the equation denotes the gap between the rate of TFP growth at the macro-level and the weighted average of sectoral TFP growth. This is the measure of the contribution of structural change to the growth of macro-economic productivity. Following Syrquin we call this term the total reallocation effect. The right hand side of the equation can be approximated in the following way:

$$\sum_i S_{Yi} a_i (G(K_i) - G(K)) + \sum_i S_{Yi} b_i (G(L_i) - G(L))$$
$$\approx \frac{1}{Y} \sum_i (P_{Ki} - P_K) \, dK_i / dt + \frac{1}{Y} \sum_i (P_{Li} - P_L) \, dL_i / dt$$

where Y is total output, P_{Ki} and P_K are the factor prices of capital in industry i and total industry respectively and, P_{Li} and P_L are the factor prices of labor in industry i and total industry respectively.

As this equation shows, the reallocation effect can be divided into the two effects, the capital reallocation effect (the shift of capital stock toward the high marginal productivity sector will increase the productivity of the economy) and the labor reallocation effect (the shift

of labor toward the high marginal productivity sector increases the productivity of the economy).

(Insert Table 3-3)

Table 3-3 shows the results of the decomposition based on the above equation. Because of the linear approximations, there are some gaps between the estimated value of the left hand side of the equation and the estimated value of the right hand. The gaps became wider in the 1970s.

Between 1970 and 1985, the total reallocation effect was positive, implying that the factors moved toward the higher productivity sector. But since 1985, the reallocation effect has been negative, and this negative reallocation effect reduced macro-TFP growth rates by 0.15% per annum in that period. In the last two rows in the table, this negative reallocation effect is further decomposed into the two effects, the labor reallocation effect and the capital reallocation effect. The table shows that the reallocation of labor was the main source of the negative reallocation effect in the 1990s. That is, the amount of labor input in the high productivity sectors (high wage sectors) has declined and that in the lower sectors has increased.

High productivity industries can be industries that have the higher export ratios or either higher R&D expenditures or higher IT-related investments. Based on the data of the export-output ratio in 1996, R&D intensity in 1995 and the IT capital stock ratio in 1995, we listed sectors that have high export-output ratios, high R&D intensity or high IT capital stock ratios. In addition, we calculated the marginal productivity of capital and labor in each sector in 1995 by multiplying each factor's share to each factor's average productivity. Then we compared the listed sectors and their marginal productivities and found that many of these sectors displayed higher marginal labor and/or capital productivities than the productivities in the economy. Hence if the factors move toward these sectors, then productivity in the economy can be improved. The sectors listed in the Table 3-4 are sectors that have higher export-output ratios, R&D intensity or IT capital stock ratios and at the same time higher marginal labor and/or capital productivities. Among the listed sectors, most of the manufacturing sectors, as well as the finance sector and insurance sector showed a negative contribution to productivity in the economy as a whole through a decreasing labor share in the economy in the 1990s. On the other hand, the telephone/telegraph sector is the only sector that showed a positive contribution to productivity through an increasing labor share in the economy.

(Insert Table 3-4)

From the analysis in this section, we can conclude that there are two sources of the slowdown in the TFP growth rate in 1990s. The slowdown in each sector's TFP growth rate, which is analyzed in the previous section in this paper, is one, and the resource reallocation effect the other. The latter was responsible for a slowdown in the total TFP growth rate by 0.15 percentage points in the period from 1985. The resource reallocation effect is decomposed into the two effects, and we found the labor resource reallocation effect is the main source of the slowdown. The high productivity sectors, mainly from the manufacturing sectors, could not increase the amount of labor in 1990's and this is the reason for the negative contribution of the labor resource reallocation.

4. IT Investment and Sectoral Productivity

4.1 Aggregate IT Investment and IT Stock

Recently, many researchers have focused on the effects of IT (Information Technology) investment on productivity growth. In the U.S., Jorgenson and Stiroh (2000) and Jorgenson (2001) showed that IT-related "capital deepening" contributed to the high economic growth rate in the late 1990s in the U. S. Van Ark and Timmer (2000) examined output in IT industries and IT investment in developed and Asian countries. Miyagawa, Itoh and Harada (2002) studied the effects of IT investment on Japanese economic growth using a sectoral database which is at more aggregated level than the JIP database. In this section, we examine the effects of IT investment on productivity growth by sector in Japan.

IT capital goods consist of two types: Tangible assets (hardware) and intangible assets (software). Our definition of IT capital goods is similar to that used by the Bureau of Economic Analysis of the U. S. government. Tangible IT assets include office machines, computers, computer peripherals, communications equipment, optical instruments and medical instruments. Intangible IT assets include not only order-made software but also in-house software and general application software.[4] IT investment of tangible assets in Japan has increased by 7.1% per annum from 1970 to 1998 (Table 4-1), exceeding the average growth rate of total investment (3.0%). The ratio of IT investment to total investment increased from 2.6% in 1970 to 26.2% in 1998. In the 1990s, investment in computer and peripheral equipment and communications equipment increased rapidly.

[4] While we estimate the tangible IT investment series by sector at 1990 prices, we estimate the aggregate software investment series at the nominal price.

(Insert Table 4-1)

The rapid increase in investment in computer and peripheral equipment and communications equipment was induced by the price fall of these capital goods. Table 4-2 shows that the price of computer and peripheral equipment and communications equipment decreased by 9.5% and 3.8% per annum in the 1990s respectively.

(Insert Table 4-2)

The IT capital stock of tangible assets also increased rapidly. In 1970, the IT capital stock at 1990 prices was only 31 trillion yen. In 1998, it reached 113 trillion yen. According to Table 4-3, it grew at 13% per annum in the late 1990s. The real growth rate was similar to the nominal growth rate until 1990. However, the price fall in IT capital goods contributed to the real growth of IT capital stock. In the late 1990s, half of the growth rate in real capital can be attributed to the price fall in IT capital goods.

(Insert Table 4-3)

In the National Accounts of Japan, only order-made software investment is estimated by making use of the Survey on Specified Service Industries. As shown in Table 4-4, in countries like the U. S., the U. K. and Australia, GDP statistics cover in-house software and general application software as well as order-made software. Making use of the Survey on Information Processing and the Survey on Specified Service Industries, we estimated software investment in Japan in a fashion which is comparable to that of the U. S., the U. K. and Australia.

(Insert Table 4-4)

In Table 4-5, we show nominal software investment by type from 1970 to 1998. Total investment increased by 15.1% per annum from 1970 to 1998 and reached 12 trillion yen which represented 9.9% of total investment.

(Insert Table 4-5)

The ratio of order-made software investment to total software investment increased from 5% in 1970 to 48% in 1998. However, this ratio implies that official Japanese software

investment is underestimated. Based on the official software investment data, many economists judge that the ratio of software investment to total investment in Japan is much smaller than that in the U. S. According to the statistical appendix in the Economic Report of the President of the United States, software investment in the U. S. in 1998 was 123.4 billion dollars which was 8.5% of total investment[5]. Our estimation shows that the difference in software investment between the U. S. and Japan vanishes when we consider in-house software and general application software.

4.2 Sectoral IT Investment Trends

Our database includes IT investment and IT capital stock by sector.[6] IT investment increased in many sectors from 1970 to 1998 (Figure 4-1). The banking sector, the insurance sector, and the telephone and telegraph sector were responsible for the high growth rate in the non-manufacturing sector. While the growth rate of IT investment in the 1990s declined in many sectors, there are several sectors, such as tobacco, chemical products, steel manufacturing, and motor vehicles, in which the growth rate of IT investment in the 1990s exceeds the average growth rate for the 28 years covered by our database. This implies that high technology investment based on computer and information technology increased in the traditional manufacturing sector in the 1990s.

(Insert Figure 4-1)

However, the ratio of IT investment to total investment increased even in the 1990s because non-IT investment also decreased in the 1990s. In 1998, the ratio exceeded 30% in 18 sectors (5 in the manufacturing sector). In the banking and insurance sector, the ratio reached 74.3%.

As a result, the ratio of IT stock to the total stock increased in many sectors. In 1998, the ratio exceeded 50% in the rental of office equipments and goods sector and the broadcasting sector (Figure 4-2). As a whole, the non-manufacturing sector holds more IT capital goods than the manufacturing sector.

(Insert Figure 4-2)

4.3 Contribution of IT Capital to Productivity Growth

[5] In this comparison, we did not take account of government investment in the case of the U. S., while our data on Japan includes a part of government investment. The ratio in the U. S. will become lower if we include the corresponding part of government investment.

Our interest is whether the recent IT capital accumulation has made a positive contribution to Japanese economic growth. There are two possible ways in which the accumulation of IT capital contributes to economic growth.

One way is labor productivity growth through capital deepening. The other way is total factor productivity (TFP) growth through network externalities generated by IT capital accumulation.

Jorgenson and Stiroh (2000) and Jorgenson (2001) stressed the IT capital deepening effects in the U. S. economy. In Japan, Miyagawa, Itoh and Harada (2002) also confirmed that IT capital deepening effects have increased in the late 1990s in Japan. On the other hand, network effects were not found in the U. S. economy as shown by Stiroh (2001), Nishimura, Shirai, Minetaki and Kurosawa (2001) reached the same conclusion as Sitroh (2001) when examining the Japanese economy. However, Miyagawa, Itoh and Harada (2002) came to the opposite conclusion for the Japanese economy.

The previous studies were based on the estimation of the production function. Our approach here is different. We examine the correlation between productivity growth in five years and the initial ratio of IT capital stock to total capital stock in each of five years. As for productivity growth, we chose labor productivity growth and TFP growth. The results are shown in Table 4-6 and Table 4-7. In Table 4-6, the correlation between labor productivity growth and the ratio of IT capital stock in the late 1990s is the highest and positive in all sectors. The correlation in the manufacturing sector is higher than in all sectors in the late-1970s and the 1980s. These results imply that IT capital accumulation has promoted labor productivity growth in the manufacturing sector since the late-1970s. In addition, in the late-1990s, IT capital accumulation contributed to labor productivity growth in the non-manufacturing sector (for example telephone and telegraph sector).

(Insert Table 4-6 and 4-7)

The positive correlation in Table 4-6 implies that both capital deepening effects and network effects exist. The analysis in Table 4-7 enables us to separate network effects from mixed effects in Table 4-6. A positive correlation between TFP growth and the ratio of IT capital stock means that there exists a network effect.

As Table 4-6 shows, there are positive correlations between TFP growth and the ratio of IT capital stock in the case of the manufacturing sector in the late 1970s and in the 1980s. The result is led by high TFP growth with positive IT capital accumulation in the electric machinery

[6] The following analysis is limited to tangible assets.

sectors (JIP industrial activity classification No.39 and No.40). However, the results in the 1990s show that IT capital accumulation does not induce network externalities.[7]

The results of the simple analysis above can be summarized as follows. First, evidence of an IT-related capital deepening effect in Japan can be observed. On the other hand, robust evidence of a network effect is not found in the 1990s. This result implies that IT capital accumulation does not guarantee long-run economic growth because of the diminishing rate of return on IT capital.

Second, contributions of IT capital accumulation to productivity growth in the manufacturing sector are larger than in the non-manufacturing sector. In particular, we can observe the network effect in the manufacturing sector in the late 1970s and the 1980s. The effect was led by the rapid productivity growth with IT investment in the electric machinery sectors. Our results indicate that for a revival of the Japanese economy it is necessary to utilize the IT capital stock in the non-manufacturing sector more effectively.

5. The Impact of R&D Expenditures and IT Investment on TFP Growth

In the previous section we have explained how IT capital stock has been accumulated in Japan and examined how investment in IT capital has contributed to sectoral TFP growth. In this section we take a more formal approach and test whether TFP growth is affected by IT capital input using an econometric model.

5.1. The Model

Following Siegel (1997), we modify the standard, reduced-form R&D productivity growth equation[8] to test whether productivity growth is a function of investments in R&D and IT capital. We also take account of spillover effects from investment in R&D and IT capital by a sector's suppliers. The following TFP growth equation will be estimated.

[7] The result might be influenced by the extraordinary low capacity utilization rate of capital in the 1990s. We did not take this into account because we think that fluctuations of the capacity utilization rate are not an important determinant of TFP growth in the medium or long term.
[8] For a more detailed discussion of the micro-economic foundation of this equation, see Grilliches (1998) and Goto and Suzuki (1989).

$$GTFP_{j,year(i)} = a_0 + a_1 RDOWN_{j,year(i)} + a_2 RDSUP_{j,year(i)} + a_3 ITOWN_{j,year(i)} + a_4 ITSUP_{j,year(i)} + \sum_m b_m X^m{}_{j,year(i)} + \sum_n g_n YEARDUM^n{}_{j,year(n)} + \sum_s d_s INDDUM^s{}_{j,year(i)} + u_{j,year(i)} \quad (1)$$

where $GTFP_{j,year(i)}$ denotes average annual growth rate of TFP in sector j from *year* (i) to *year* (i+1). $YEARDUM^n{}_{j,year(i)}$ and $INDDUM^s{}_{j,year(i)}$ are year and industry dummies. Since the characteristics of R&D activities and importance of intermediate inputs seem to be completely different in the manufacturing and non-manufacturing sectors, we estimated equation (1) for the manufacturing sectors and the non-manufacturing sectors separately.[9]

$X^m{}_{j,year(i)}$ denotes other factors which might affect TFP growth. In the case of manufacturing industry, we used the average annual growth rate of the capacity utilization index ($GUTI_{j,year(i)}$), the ratio of the sum of exports and imports to gross output as a measure of openness ($OPEN_{j,year(i)}$), the ratio of exports to gross output as a measure of the importance of competition in foreign markets ($EXP_{j,year(i)}$), and the ratio of imports to gross output as a measure of the importance of import competition ($IMP_{j,year(i)}$) as $X^m{}_{j,year(i)}$. The capacity utilization index is taken from METI statistics. In the case of the non-manufacturing sector, we used the average annual growth rate of the ratio of real intermediate input to real capital stock ($GUTI2\ X^m{}_{j,year(i)}$) as a proxy of the growth rate of capacity utilization.

$RDOWN_{j,year(i)}$ in equation (1) denotes the ratio of the annual net increase in R&D stock to sector j's gross output from *year* (i) to *year* (i+1), while $RDSUP_{j,year(i)}$ denotes the ratio of the annual net increase in R&D stock owned by sector j's suppliers to sector j's gross output.[10] The two variables are defined by

$$RDOWN_{j,year(i)} = (LN(RDK_{j,year(i+1)} / RDK_{j,year(i)}) * RDK_{j,year(i)}) / ((year(i+1) - year(i)) * OUT_{j,year(i)})$$

and

[9] In equation (1) we assume that R&D expenditures and IT investments are exogenous. We should note that if there exists a feedback effect from high TFP growth to R&D expenditures and IT investments, our estimates will be biased. Because of the lack of appropriate instrumental variables, we could not take account of this problem.

[10] This measure of suppliers' R&D stock was used by Terleckyj (1980), Wolff and Nadiri (1993), and Kwon (2002).

$$RDSUP_{j,year(i)} = \sum_{m} (a_{year(i)}(m, j) * (LN(RDK_{m,year(i+1)} / RDK_{m,year(i)}) * RDK_{m,year(i)}) / (year(i+1) - year(i))) / OUT_{j,year(i)}$$

.

respectively. $RDK_{j,year(i)}$ and $OUT_{j,year(i)}$ are real R&D stock and real gross output of sector *j*. $a_{,year(i)}(m,j)$ denotes the ratio of sector *m*'s sales to sector *j* to total gross output of sector *m*.[11]

Similarly, $ITOWN_{j,year(i)}$ in equation (1) denotes the ratio of the annual net increase in IT capital stock to sector *j*'s gross output, and $ITSUP_{j,year(i)}$ denotes the ratio of the annual net increase in IT capital stock owned by sector *j*'s suppliers to sector *j*'s gross output. The two variables are defined by

$$ITOWN_{j,year(i)} = (LN(ITK_{j,year(i+1)} / ITK_{j,year(i)}) * ITK_{j,year(i)}) / ((year(i+1) - year(i)) * OUT_{j,year(i)})$$

and

$$ITSUP_{j,year(i)} = \sum_{m} (a_{year(i)}(m, j) * (LN(ITK_{m,year(i+1)} / ITK_{m,year(i)}) * ITK_{m,year(i)}) / (year(i+1) - year(i))) / OUT_{j,year(i)}$$

.

5.2. Data Sources and Empirical Results

Table 5-1 lists the variables used in the estimation. Most of the variables can be derived from the JIP database. At the most, we have data for seven benchmark years, 1970, 75, 80, 85, 90, 95, 98. R&D stock is estimated by the perpetual inventory method. Data on sectoral R&D investment flows we obtained from IO tables and the *Survey of Research and Development*, Management and Coordination Agency. In the case of non-manufacturing, R&D investment data are available only for 20 sectors.[12]

(Insert Table 5-1)

[11] $a_{,year(i)}(j,j)$ is set to zero in order to avoid double counting.

[12] In the case of the non-manufacturing sectors, R&D data are available for the primary sectors (JIP classification codes 2, 4, 5, 6, 7, 8, 9, 10), the construction and utility sectors (46, 47, 48, 49), the transportation and communication sectors (59, 60, 61, 62, 63, 64), other services for businesses (72), and broadcasting (74).

The capacity utilization rate we obtained from METI statistics. The statistics are available from 1973 onwards. Therefore, when we include *GUTI* as an explanatory variable in the estimation for the manufacturing sector, observations from 1975 are used. In the case of the non-manufacturing sector, there is no capacity utilization index. We used the growth rate of the ratio of real intermediate input to real capital stock as a proxy for the growth rate of the capacity utilization rate.

In order to take account of possible heteroscedasticity among sectors and autocorrelation within panels, we estimated equations by Feasible GLS. The results for the manufacturing sectors and for the non-manufacturing sectors are summarized in Table 5-2 and Table 5-3 respectively.

(Insert Table 5-2 and 5-3)

The key parameters of our estimation are the coefficients on *RDOWN*, *RDSUP*, *ITOWN*, and *ITSUP*. In the case of the manufacturing sectors, all the coefficients on the four variables are significant. In the case of non-manufacturing sectors, coefficients on the three variables, *RDOWN*, *RDSUP*, and *ITOWN* are significant in the model with sectoral dummies. In the case of the non-manufacturing sectors we do not observe significant spillover effects from IT investment by suppliers.

K in our original production function, which we explained in Section 2, includes both the outlays for R&D and IT capital. Similarly, *L* in our production function includes the outlays for R&D personnel. Due to this double-counting, the estimated significant coefficients on *RDOWN* and *ITOWN* should be interpreted as the excess rate of return (see Goto and Suzuki (1989)) or the externality effect within each sector. The estimation results shown in Table 5-2 indicate that the excess rate of return or the externality effect within each sector is very high in the manufacturing sectors.[13]

Table 2-1 also shows that spillover effects from IT investment by suppliers are large in the manufacturing sectors. The sample means of *ITOWN* and *ITSUP* are 0.00030 and 0.00016 respectively in the case of the manufacturing industry. Let us consider a hypothetical manufacturing sector whose *ITOWN* and *ITSUP* are identical with these sample means. Suppose that all the manufacturing and non-manufacturing sectors, including this hypothetical sector, increase their annual IT investment by 10%. According to the coefficients of equation (5) in Table 5-2, this sector's TFP growth rate will be increased by 0.81 percentage points. Of

[13] We should note that our results might be biased upwards by the simultaneity problem which we have already discussed.

this, a 0.17 percentage point increase derives from *ITOWN* effects (0.0003*0.1*5.7*100) and a 0.64 percentage point increase stems from *ITSUP* effects (0.00016*0.1*39.8*100).

The sample means of *RDOWN* and *RDSUP* are 0.0054 and 0.0013 respectively in the case of the manufacturing industry. By a similar calculation to the one above, we expect that a 10% increase in R&D expenditures by all the sectors will increase the TFP growth rate of the hypothetical manufacturing sector by 0.04 percentage points. Of this increase, 0.03 percentage points stem from *RDOWN* effects and 0.01 percentage points from *RDSUP* effects.

According to these calculations we can conclude that spillover effects play a more important role in the case of IT investment.

6. Conclusions

TO BE COMPLETED

Appendix: Data Sources and Estimation Methods of the JIP Database

A.1. Estimation of Real Net Capital Stock by Industry and by Capital Goods

To construct real net capital stock by industry and by capital goods, we begin by estimating the net capital stock in 1970 as a benchmark. For the capital stock from 1971 to 1998, we used the perpetual inventory method, making use of the series for annual capital formation by industry and by capital goods and applying a constant depreciation rate for each type of fixed capital stock.

All real series are valued at 1990 prices. Our database consists of 84 industries based on SNA-IO published by the Economic and Social Research Institute (ESRI). As for capital goods, we arrange 37 capital goods in our database based on the commodity flow data in ESRI of the Japanese government. We name our own industry and capital goods classification as in the JIP classification.

Our capital stock database covers not only the private sector but also the public enterprise sector and the government service sector. In addition, it includes residential stocks.

Estimation of Benchmark Capital Stock Data (for 1970)

We construct the benchmark stock by industry and by capital goods based on the National Wealth Survey of 1970. We transform the original data in the following four processes.

First, the statistics in the National Wealth Survey of 1970 is compiled in terms of firms and organizations. On the other-hand the sectoral statistics in the Fixed Capital Formation Matrix, which we used as the most basic statistics for our estimation of capital formation series, is compiled in terms of production activities. In order to make adjustments for this difference of the two statistics, we transformed the original data of the National Wealth Survey of 1970 into activity-based data by making use of the information on distribution of each asset among sectors, which is available at the Fixed Capital Formation Matrix of 1970.

Second, the sectoral classification in the National Wealth Survey of 1970 is rougher than the JIP industry classification. Therefore, we construct the benchmark stock data which corresponds to the JIP industry classification by using the production data in the Input –Output Table for 1970 or the employee data in the Establishment Census of 1969 and 1972.

Third, the original data in the National Wealth Survey of 1970 are nominal values. Using price deflators for capital goods in the commodity flow statistics in ESRI, we converted the nominal values into values at 1990 price.

Fourth, in the National Wealth Survey of 1970, the statistics on public sectors are for the end of the fiscal year of 1970. Using data on investment flows, we converted the statistics into calendar year basis.

Estimation of Capital Formation Series

We estimate the capital formation series from 1970 to 1998 by industry and by capital goods. Classifications of industry and capital goods are based on the JIP classifications. We construct the capital formation series by the following three steps: (1) We estimate the capital formation series by industry, (2) the capital formation series by capital goods, and (3) the fixed capital formation matrix every year based on capital formation data constructed in (1) and (2). In the following subsections, we will explain each estimation method in detail.

Estimation of Capital Formation Series by Industry

In the manufacturing sector, we compile the annual series of the capital formation using the Census of Manufacturing. In the non-manufacturing sector, we construct the data by examining statistics in each industry or closing accounts of public enterprises. These statistics are based on sample surveys and do not cover all establishments in each industry.

Next, using data of the Fixed Capital Formation Matrix, which is more reliable but only available for every five years, we adjusted the above annual series of capital formation.

Estimation of the Capital Formation Series by Capital Goods

Basically, we compiled the capital formation series by making use of the commodity flow data of ESRI. The commodity flow data is arranged in an eight-digit classification system. We rearrange this data into the JIP capital goods classification.

The commodity flow data do not include data on construction and buildings which are classified in the JIP capital goods classification Nos. 32-37. We estimate the capital formation series for these capital goods using mainly the statistics published by the Ministry of Land, Infrastructure and Transport etc. Finally using the Fixed Capital Formation Matrix, we adjusted the above capital formation series by industry.

We should note that our database does not cover capital formation of intangible assets, because it is based on 68SNA.

Estimation of the Annual Series of Fixed Capital Formation Matrix

As we have explained above, we have obtained annual capital formation data by industry or by capital goods. However, we do not have fixed capital formation matrix for

non-benchmark years. We estimated the fixed capital formation matrix for the intermediate years by the RAS method.

Construction of Real Net Capital Stock for 1970-1998

The fixed capital formation estimated in section 2 is expressed in nominal terms. We convert the series in nominal terms into 1990 prices by using deflators in the commodity flow data of ESRI.

Next, we accumulate capital stock from the benchmark stock in 1970 by the perpetual inventory method. Using this method, we have to consider depreciation. We assume a constant depreciation rate for each capital good. We use the depreciation rate adopted by the Bureau of Economic Analysis in the U. S. The depreciation rate for each capital good is expressed in Table A1.

(Insert Table A-1)

The estimated real net capital stock is summarized in Table A2. Table A2 shows that the amount of capital stock reached 1295 trillion yen in 1998.

(Insert Table A-2)

Table A3 presents the average annual growth rate of capital stock by industry. It shows that the accumulation rate was high in the 1970s, but the average growth rate then declined in the 1990s.

(Insert Table A-3)

A.2. Estimation of Labor Input by Industry and by Type of Labor

Data Description

The labor input variables of the JIP database are constructed by combining the value estimates from the IO matrices and data from several labor force surveys. Our final goal is to construct a detailed data set of the number of workers N_{kjt}, hours worked H_{kjt}, and the hourly wage W_{kjt}. (k: type of worker, j: sector, t: year)

We divide the work force cross-classified by sex, age and educational attainment.

Sex (2): male, female

Age (12): -17, 18-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-

Education (4): Junior high school, High school, College, University or more

Occupation (3):Specialized white color, Other white color, Blue color

Status (2):Employed, Self-employed

Sectors (89): JIP classification

Year:1970-2000

However we have only estimated the two types of workers (Employed and Self-employed) by sectors in the present version of the database. We will finish our estimation this summer.

Estimation of the Quality of Labor Input

We assume that effective labor services of each category of labor in sector j is proportional to the hours worked by all the workers in that category

$$L_{ljt} = q_l^L H_{ljt}$$

q denotes the proportionality constant and is assumed to be constant over time. The total annual number of hours worked is ideally the product of the number of workers, the average hours per week, and the average weeks per year:

$$H_{ljt} = N_{ljt} h_{ljt} w_{ljt}$$

However, we do not have data on hours and weeks by category of worker. Therefore we had to assume:

$$H_{ljt} = N_{ljt} \text{ *constant}$$

We define the growth of total real labor input as a weighted average of the growth rates of all the categories

$$d \ln L_{jt} = \sum_l \overline{v}_{ljt}^L d \ln L_{ljt} = \sum_l \overline{v}_{ljt}^L d \ln N_{ljt} ,$$

$$v_{ljt}^L = \frac{P_{Lljt} L_{ljt}}{\sum_{a=1}^{70} P_{Lajt} L_{ajt}}$$

The value shares are the compensation shares, where P_{Lljt} is the annual cost of a category *l* worker. The actual value of P_{Lljt} is scaled such that the sum over all categories of workers is equal to the total value of labor compensation in *j* as given by the Input-Output table.

This labor input index, L_{jt} is for the sectoral productivity calculation, and P_{Ljt} is the price index of this labor input. We may now define an index of "quality of sectoral labor input", or index of compositional change, as the ratio of labor input to a simple linear sum of hours:

$$q_{jt}^{L} = \frac{L_{jt}}{H_{jt}}, \qquad H_{jt} = \sum_{l} H_{ljt}$$

A rising q_{jt}^{L} means that the percentage of work-force of higher paid categories has increased overtime.

A.3. Estimation of Annual Input-Output (IO) Tables

Data Sources and Compilation Process

Major data source of our annual IO tables for the benchmark years are

1970-1975-1980 Linked Input-Output Tables, Management and Coordination Agency;
1980-1985-1990 Linked Input-Output Tables, Management and Coordination Agency;
1985-1990-1995 Linked Input-Output Tables, Management and Coordination Agency;
1998 Input-Output Tables, Research and Statistics Department, Economic and Industry Policy Bureau, Ministry of Economy, Trade and Industry.

First, we constructed converters to make adjustments for changes in industry classifications over time and aggregated the IO data into our 84 sectors. We compiled annual IO tables in real terms (1990 prices) in the following way. 1970-1975-1980 IO tables contain real IO tables at 1980 prices. Similarly, 1980-1985-1990 IO tables contain real IO tables at 1980 prices. We linked these two real IO tables at year 1980. The second and the third IO statistics are linked at year 1990. The third and the forth IO statistics are linked at year 1995.

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Figure 2-1 Sources of Output Growth and Price Change

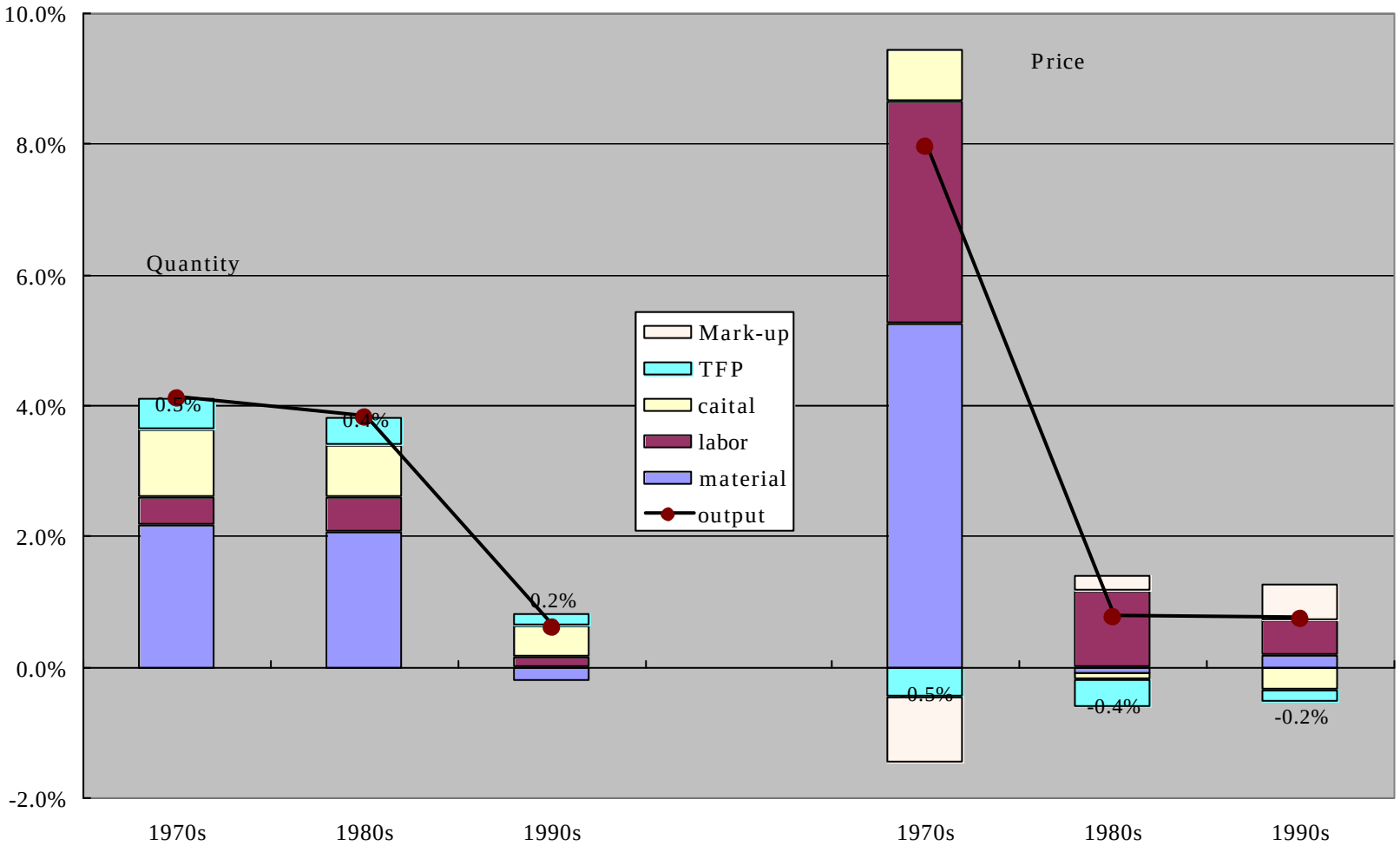
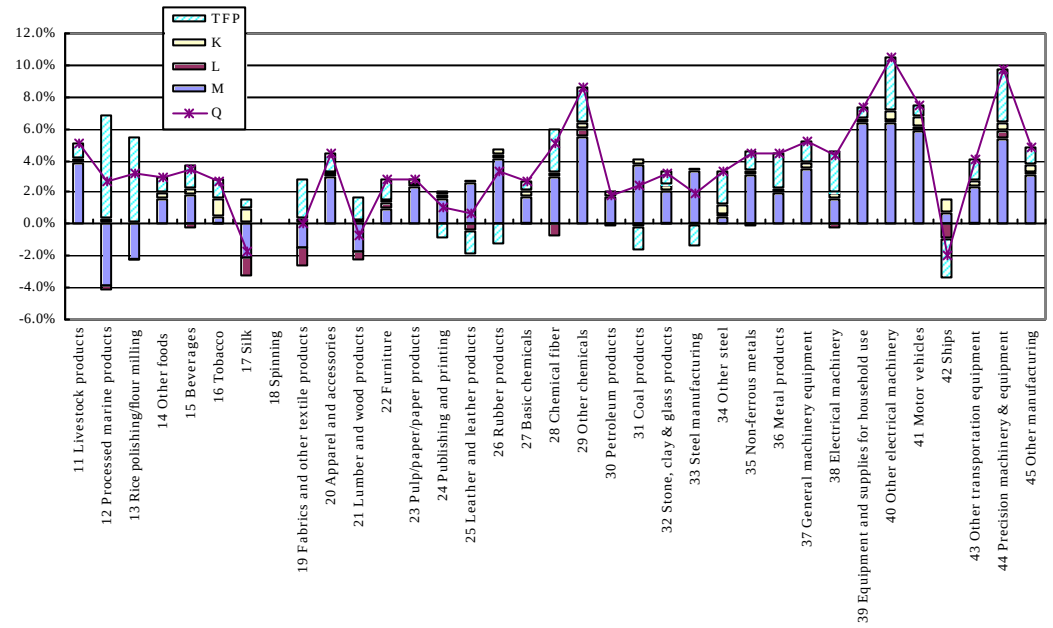
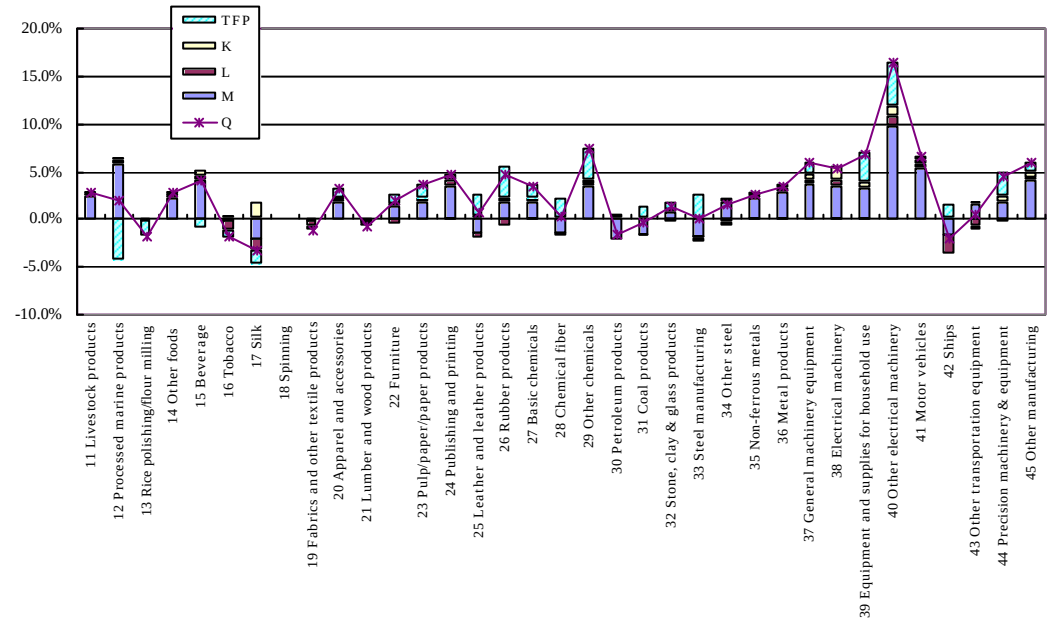


Figure 2-2 Sources of Sectoral Output Changes: Manufacturing

(1) 1970-80



(2) 1980-90



(3) 1990-1998

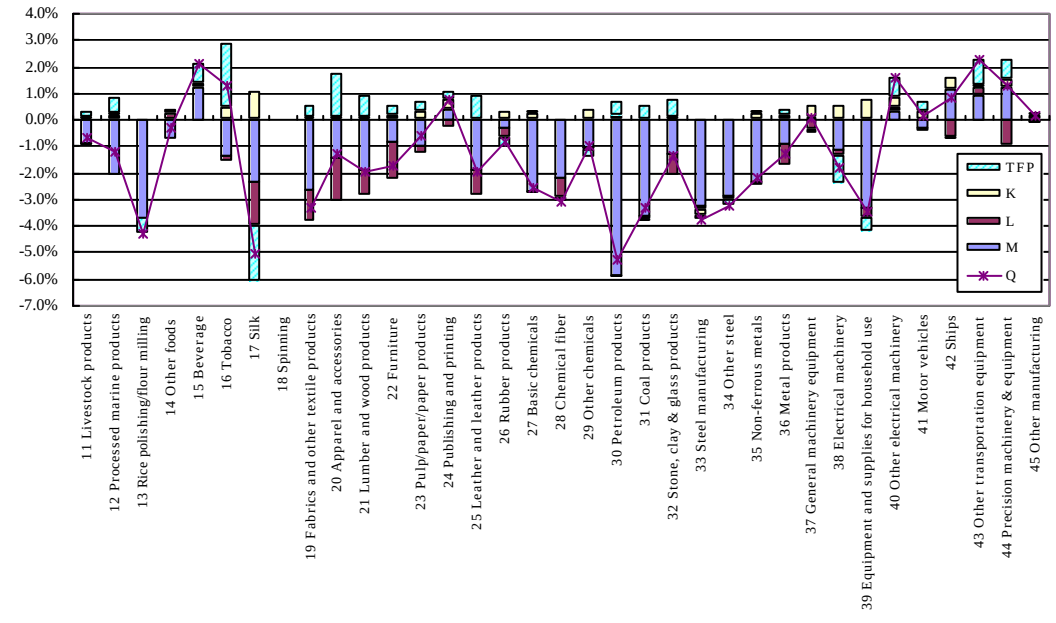
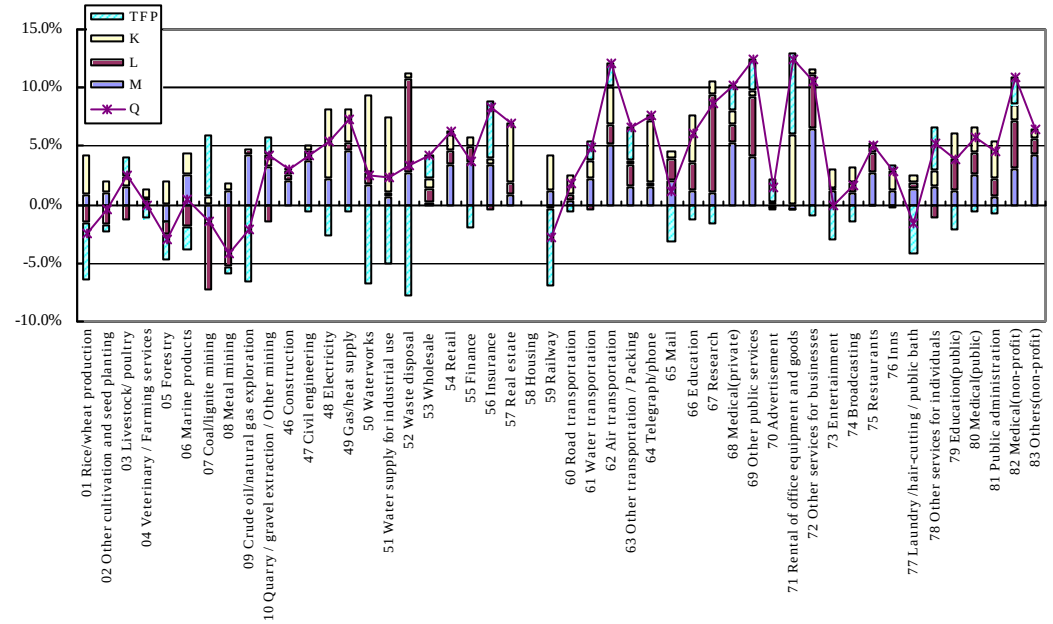
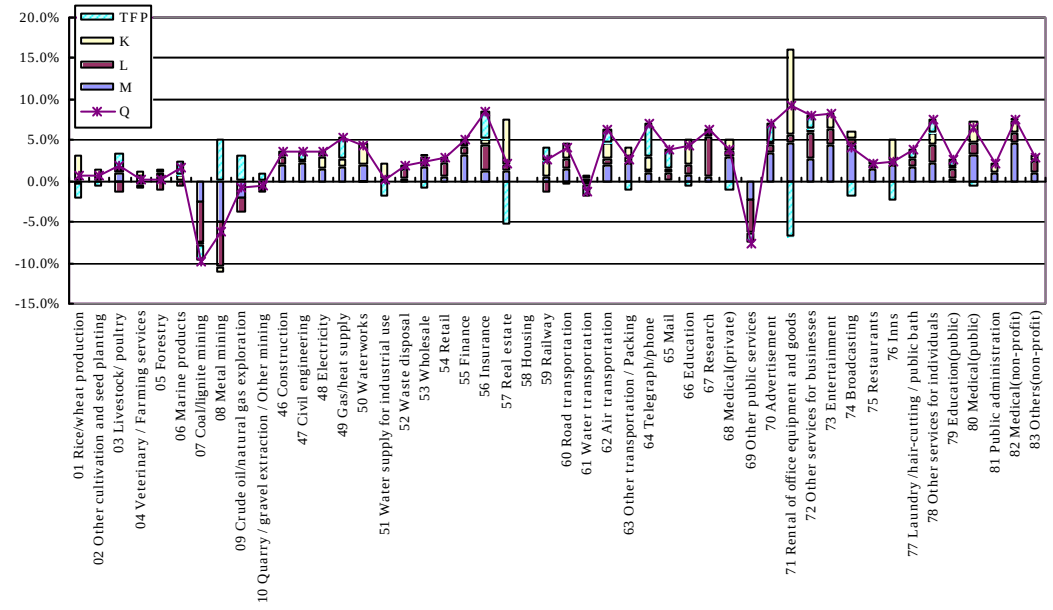


Figure 2-3 Sources of Sectoral Output Changes: Non-Manufacturing

(1) 1970-80



(2) 1980-90



(3) 1990-98

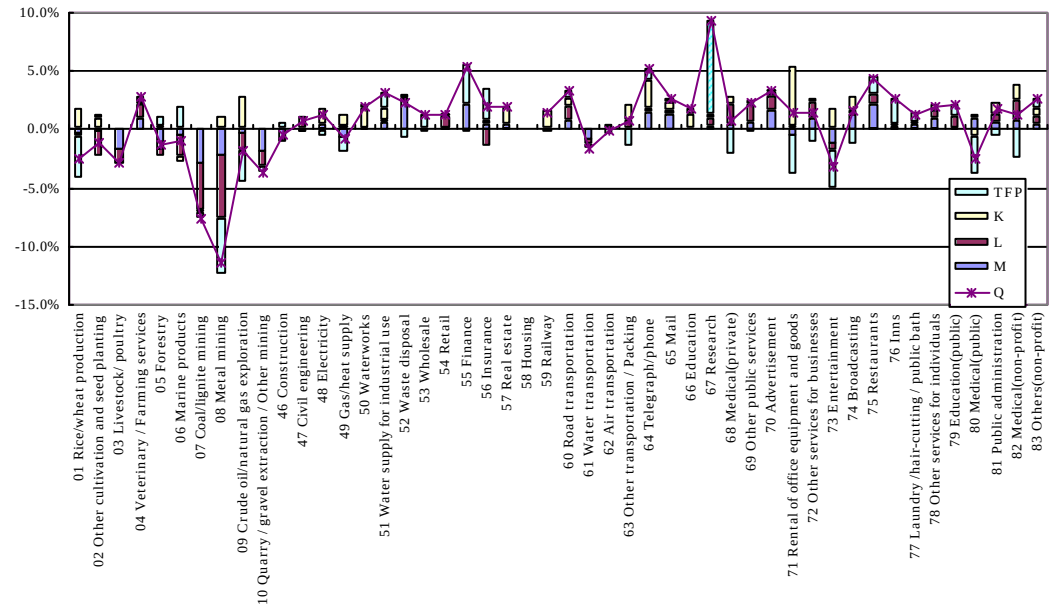
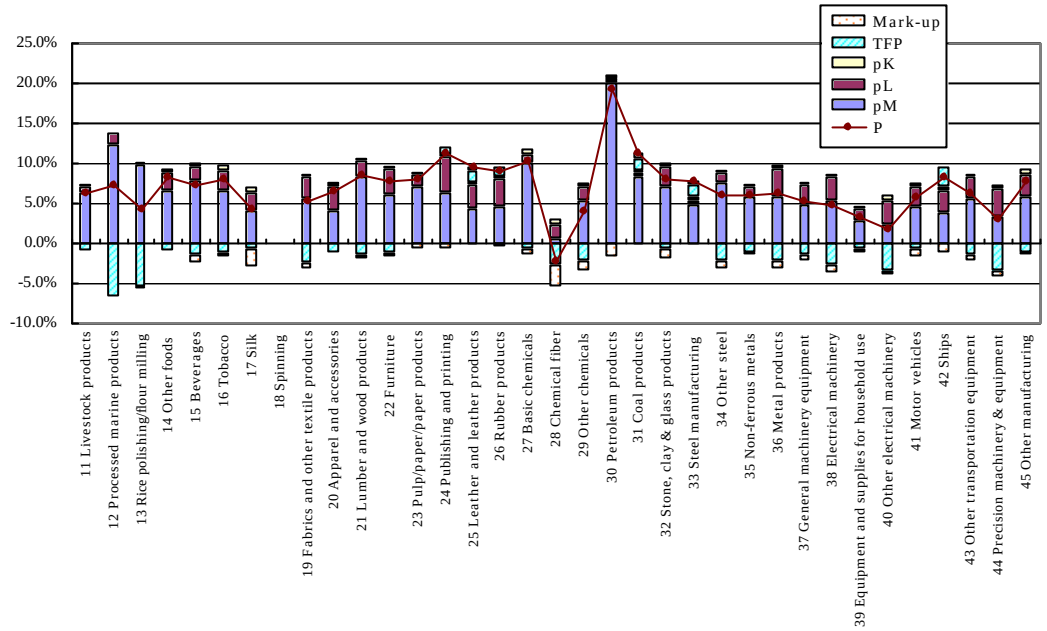
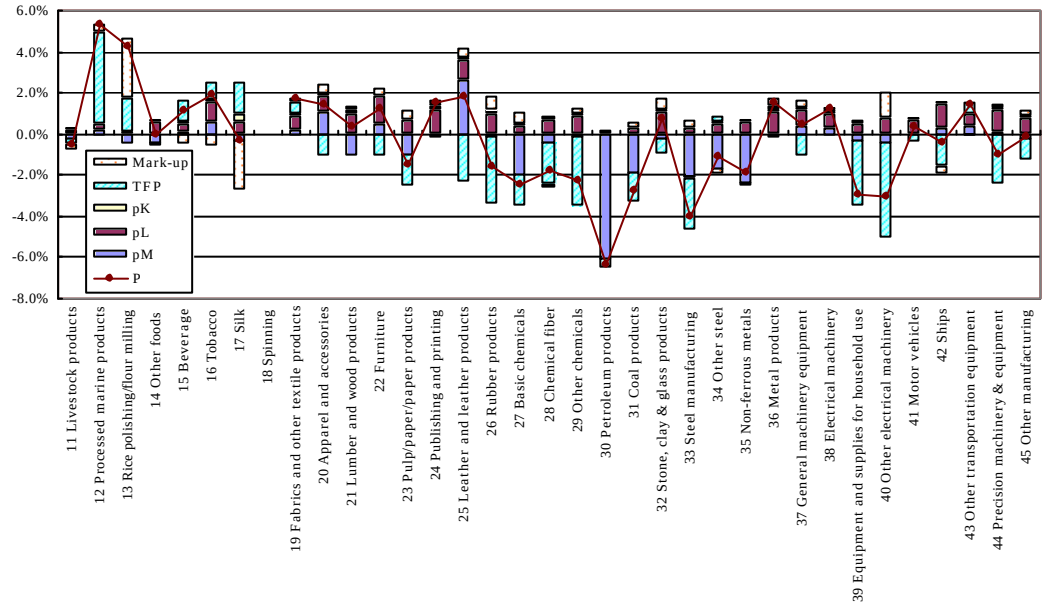


Figure 2-4 Sources of Sectoral Price Changes: Manufacturing

(1) 1970-80



(2) 1980-90



(3) 1990-98

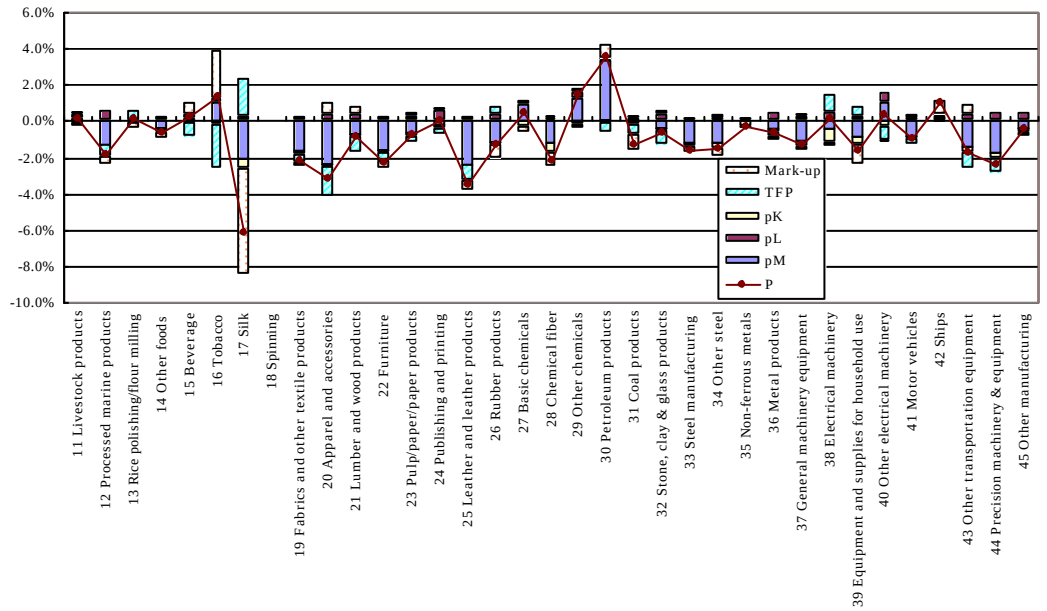
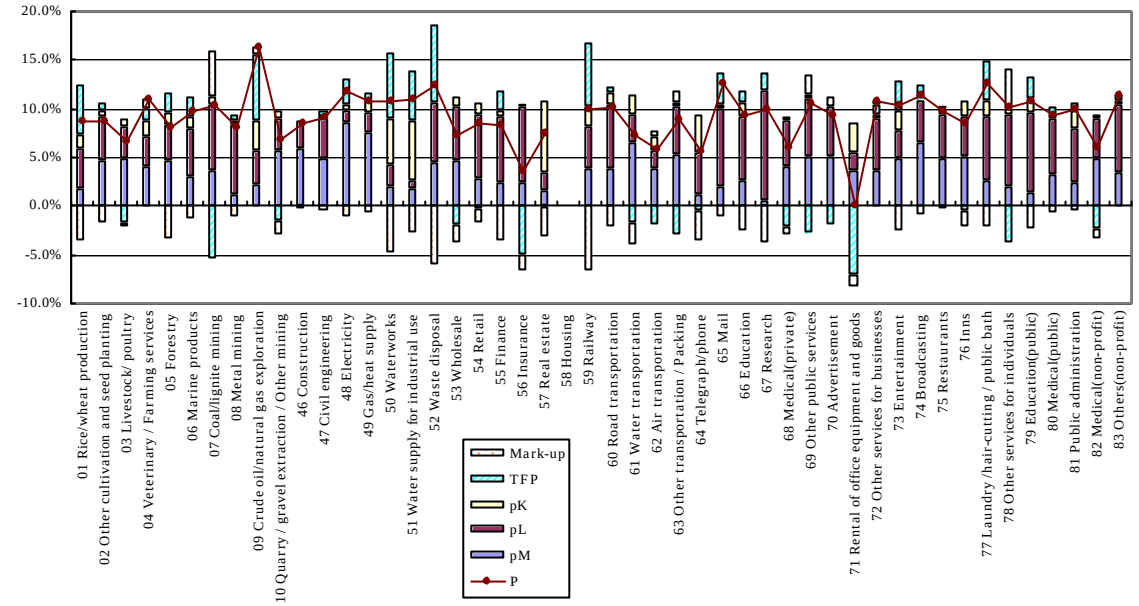
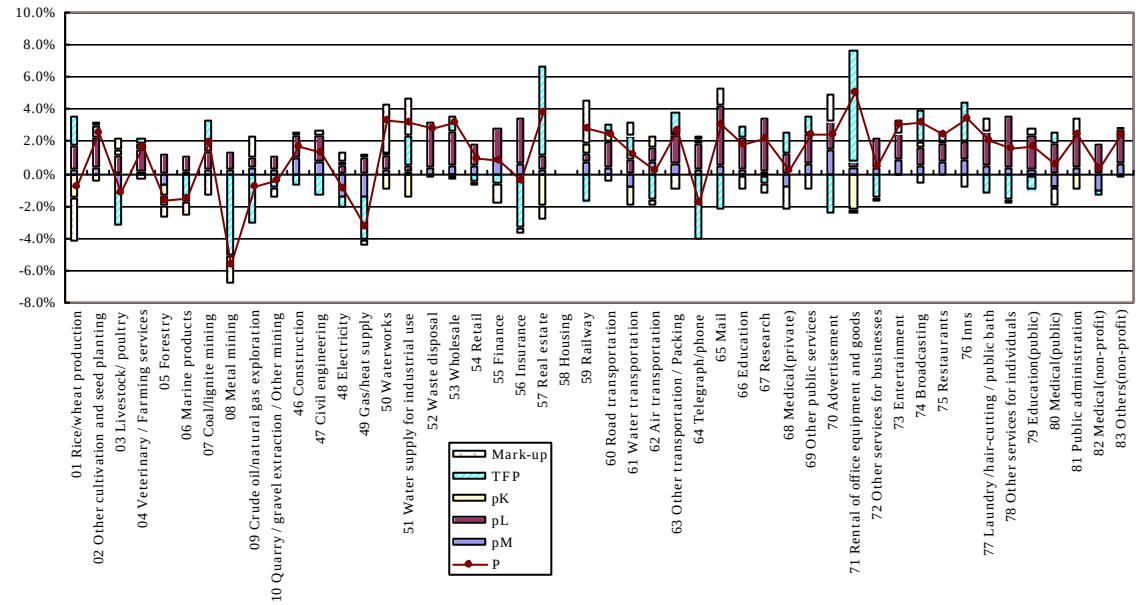


Figure 2-5 Sources of Sectoral Price Changes: Non-Manufacturing

(1) 1970-80



(2) 1980-90



(3) 1990-98

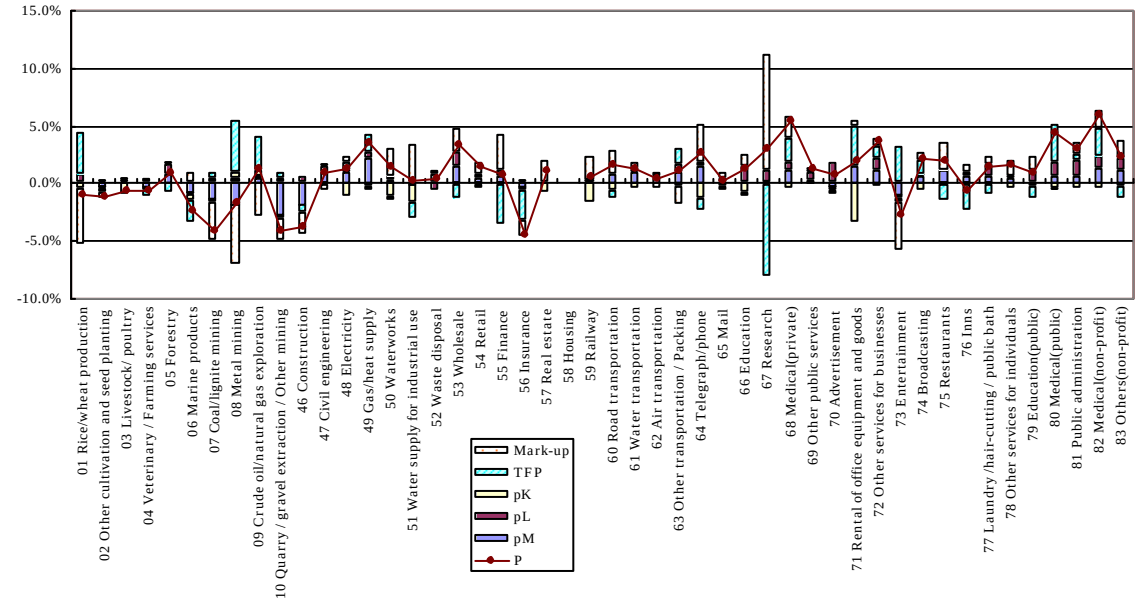


Table 3-1: Sectoral shares in total value added (%)

	1970	1980	1990	1998
Agriculture, forestry, fisheries	6.7	3.3	2.6	2.0
Mining	0.6	0.4	0.3	0.2
Manufacturing	21.0	25.1	28.7	26.6
Electricity, gas and water	2.1	2.2	2.4	2.4
Construction	11.9	10.0	10.4	10.1
Transport	7.4	5.5	4.9	5.3
Communication	1.2	1.3	1.8	2.3
Wholesale and retail trade	15.2	16.7	14.2	14.6
Finance, insurance and real estate	8.2	8.3	8.0	9.6
Services and government	25.5	27.0	26.8	27.1

Note: Services and government sector includes waste disposal industry.

Table 3-2 Value-added based TFP growth rates in 10 sectors (per cent per annum)

	1970-80	1980-90	1990-98
Agriculture, forestry, fisheries	-2.1	0.3	-0.6
Mining	4.9	2.8	-1.2
Manufacturing	4.9	3.2	0.5
Electricity, gas and water	-5.1	1.4	-0.9
Construction	-0.3	2.6	0.3
Transport	-2.1	-0.4	0.4
Communication	-1.2	4.6	1.3
Wholesale and retail trade	2.0	-0.5	1.1
Finance, insurance and real estate	0.8	-1.8	3.3
Services and government	-0.5	0.0	-0.9
Total	1.1	0.9	0.2

Table 3-3 Decomposition of the reallocation effects (per cent per annum)

	1970-75	1975-80	1980-85	1985-90	1990-95	1995-98
TFPG	0.55	1.84	0.87	1.23	-0.30	1.07
Reallocation Effect	0.28	0.14	0.03	0.34	-0.15	-0.17
The sum of Capital and Labor reallocation effects	0.39	0.07	0.04	0.39	-0.15	-0.15
Capital reallocation effect	0.01	-0.03	0.08	0.13	0.01	-0.01
Labor reallocation effect	0.38	0.10	-0.04	0.26	-0.16	-0.15

Table 3-4 Selected industries' contribution to the reallocation effect in 1990s (per cent per annum)

	1990-1995		1995-1998	
	Capital reallocation effect	Labor reallocation effect	Capital reallocation effect	Labor reallocation effect
Manufacturing				
Other electrical machinery	0.008	0.023	0.022	-0.017
Electrical machinery	0.004	-0.003	-0.001	-0.010
General machinery equipment	0.016	-0.092	0.009	0.008
Chemical fiber	-0.001	-0.001	-0.001	-0.001
Motor vehicles	0.004	-0.039	0.003	-0.004
Precision machinery & equipment	-0.003	-0.020	0.001	-0.002
Fabrics and other textile products	-0.002	-0.013	-0.004	-0.019
Rubber products	0.000	-0.004	0.000	-0.005
Equipment and supplies for household use	0.022	-0.030	0.012	-0.014
Other chemicals	0.008	-0.011	0.004	0.001
Non-manufacturing				
Telegraph/telephone	0.005	0.048	-0.007	0.036
Gas/heat supply	0.002	-0.001	0.002	-0.001
Insurance	0.004	-0.001	-0.062	-0.020
Finance	-0.013	-0.001	-0.010	-0.061

Table 4-1 IT Investment in Japan (1990 prices)

(million yen)

JIP Capital Goods Classification Number	14	15	18	19	20	21	31	
	Photocopy and related equipment	Other computing and accounting machinery	Computer and peripheral equipment	Communica-tion equipment	Video and applied electric equipment	Electric transmission and distribution apparatuses	Optical instruments, medical instruments and etc.	Total
1970	8040	36626	114973	462109	76779	289446	332373	1320345
1971	9792	38584	130916	523059	73979	293355	378584	1448269
1972	7914	35638	173346	608230	94334	276828	401090	1597380
1973	16407	60299	215524	715344	123691	307137	475585	1913989
1974	21767	51584	227089	667475	136033	268213	489232	1861395
1975	28536	55393	218681	608020	140105	234359	451869	1736963
1976	34972	58317	202222	536726	161132	237963	498217	1729549
1977	51556	69118	222133	681049	257113	250095	565846	2096910
1978	47281	105612	292555	802200	265111	269710	677384	2459851
1979	54631	101696	404422	881173	319426	304050	769789	2835187
1980	58312	122782	608163	1081283	405265	341272	874801	3491878
1981	73725	151055	799725	968391	619161	400498	918902	3931457
1982	97672	156083	952167	886680	729171	457766	920344	4199882
1983	148753	177324	1447697	1206753	862014	508025	931884	5282450
1984	198667	224227	2062426	1273608	1012860	726973	1148827	6647588
1985	339200	253005	2751841	1349572	1486017	853568	1190415	8223618
1986	406664	287086	3112904	1633433	1588820	758010	1288423	9075340
1987	535329	371723	3766910	1903631	1722109	781004	1427047	10507755
1988	795405	473685	4770469	2230761	2009485	940095	1611030	12830930
1989	887387	569164	5822931	2210902	2165654	1020966	1745621	14422625
1990	903021	602659	6448511	2679351	2130574	1085117	2062965	15912198
1991	931972	689350	6752465	2895179	2128099	1019335	2174094	16590495
1992	967986	723485	7066249	2558283	1908684	926304	2159350	16310341
1993	703083	702749	7408415	2660134	1834546	874404	1993964	16177294
1994	682331	748692	7684980	2959898	1690914	881785	1915801	16564401
1995	735822	800134	10069416	3631352	1822416	1009484	2051124	20119748
1996	816071	888754	17310655	5672251	2130978	1126479	2193054	30138242
1997	942474	967746	19746243	5794998	2122780	1120560	2118557	32813358
1998	1016655	1013199	17902838	5485754	2084792	1146997	2256860	30907096

* In JIP classifications No. 19, No. 21and No. 31, we excluded a few goods which are not related to IT capital goods.

Table 4-2 Price Indices for IT Capital Goods(1990=100)

JIP Capital Goods Classification Number	14 and 15	18	19	
	Office machines	Computers and related equipment	Communication equipment	Total
1970	4.04	3.39	1.13	1.15
1971	3.80	3.36	1.11	1.15
1972	3.33	3.18	1.09	1.15
1973	3.09	2.94	1.10	1.19
1974	3.54	3.66	1.20	1.43
1975	3.38	3.59	1.27	1.50
1976	2.98	4.19	1.24	1.53
1977	2.72	4.38	1.26	1.55
1978	2.50	3.73	1.26	1.51
1979	2.38	3.18	1.25	1.48
1980	2.24	2.46	1.26	1.44
1981	2.08	1.97	1.25	1.40
1982	1.85	1.68	1.22	1.33
1983	1.71	1.46	1.19	1.26
1984	1.60	1.31	1.17	1.20
1985	1.37	1.29	1.15	1.17
1986	1.28	1.24	1.07	1.12
1987	1.15	1.13	1.02	1.06
1988	1.01	1.01	0.98	1.00
1989	0.99	1.01	0.99	0.99
1990	1.00	1.00	1.00	1.00
1991	0.98	0.94	0.98	0.97
1992	0.94	0.89	0.97	0.94
1993	0.92	0.85	0.97	0.91
1994	0.90	0.75	0.94	0.86
1995	0.89	0.64	0.92	0.78
1996	0.88	0.51	0.85	0.67
1997	0.88	0.47	0.81	0.63
1998	0.86	0.45	0.73	0.61

Table 4-3 Growth Rate of the IT Capital Stock

	1970-75	1975-80	1980-85	1985-90	1990-95	1995-98
Nominal IT capital stock	22.0	12.3	14.5	11.7	4.2	6.4
Price in IT capital goods	0.5	1.7	-1.4	-2.6	-2.4	-6.0
Real IT capital stock	21.4	10.5	16.1	14.7	6.8	13.2

Table 4-4 Treatment of Computer Software as an Intangible Fixed Asset by Country

	United States	United Kingdom	Canada	Australia	Japan
Order-made software	included	included	included	included	included
In-house software	included	included	not included	included	not included
General application software	included	included	included	included	not included

Source : Department of National Accounts, Economic and Social Research Institute, Cabinet Office, Government of Japan (Apr 1999)

Table 4-5 Software Investment

million yen

Year	Total	In-house software	Order-made software	General application software
1970	173434	161389	10331	1714
1971	260756	238272	19284	3199
1972	299203	281667	15041	2495
1973	381583	356228	21747	3608
1974	563369	524838	33049	5483
1975	649080	603569	39035	6476
1976	866479	811268	47355	7856
1977	1414467	1330392	72112	11963
1978	1539540	1438084	87020	14437
1979	1791089	1649867	121127	20095
1980	1591101	1414735	151270	25096
1981	2256233	2002004	218053	36175
1982	2405627	2075895	282813	46919
1983	2760373	2347643	354001	58730
1984	3141206	2569678	497012	74517
1985	3610354	2867362	636864	106129
1986	4317079	3309795	879721	127563
1987	4818190	3505699	1181498	130994
1988	6375655	4316313	1842654	216688
1989	8287960	5427746	2538952	321261
1990	10329660	6519164	3331429	479067
1991	12094537	7650449	3870069	574020
1992	12859294	8352161	3974823	532309
1993	11225036	7196613	3582388	446036
1994	10252728	6486715	3325323	440689
1995	9209783	5160745	3575611	473427
1996	9485884	4895227	4069146	521511
1997	10047567	4837758	4646681	563128
1998	12035973	5566208	5786994	682771
1999	12130731	5344354	6150076	636302

Table 4-6 Correlation between IT Capital Stock and Labor Productivity Growth

	70-75	75-80	80-85	85-90	90-95	95-98
All sectors	-0.111	0.265	0.113	0.029	-0.054	0.575
	(0.110)	(0.103)	(0.110)	(0.111)	(0.111)	(0.074)
Manufacturing sector	-0.175	0.535	0.472	0.313	0.013	0.446
	(0.166)	(0.122)	(0.133)	(0.155)	(0.171)	(0.137)

* Standard errors in parenthesis.

Table 4-7 Correlation between IT Capital Stock and Total Factor Productivity Growth

	70-75	75-80	80-85	85-90	90-95	95-98
All sectors	-0.209	0.256	0.029	-0.005	-0.011	-0.087
	(0.106)	(0.104)	(0.111)	(0.111)	(0.111)	(0.110)
Manufacturing sector	0.079	0.187	0.266	0.317	-0.359	-0.011
	(0.170)	(0.165)	(0.159)	(0.154)	(0.149)	(0.171)

* Standard errors in parenthesis.

Figure 4-1 Growth Rate of IT Investment(Manufacturing)

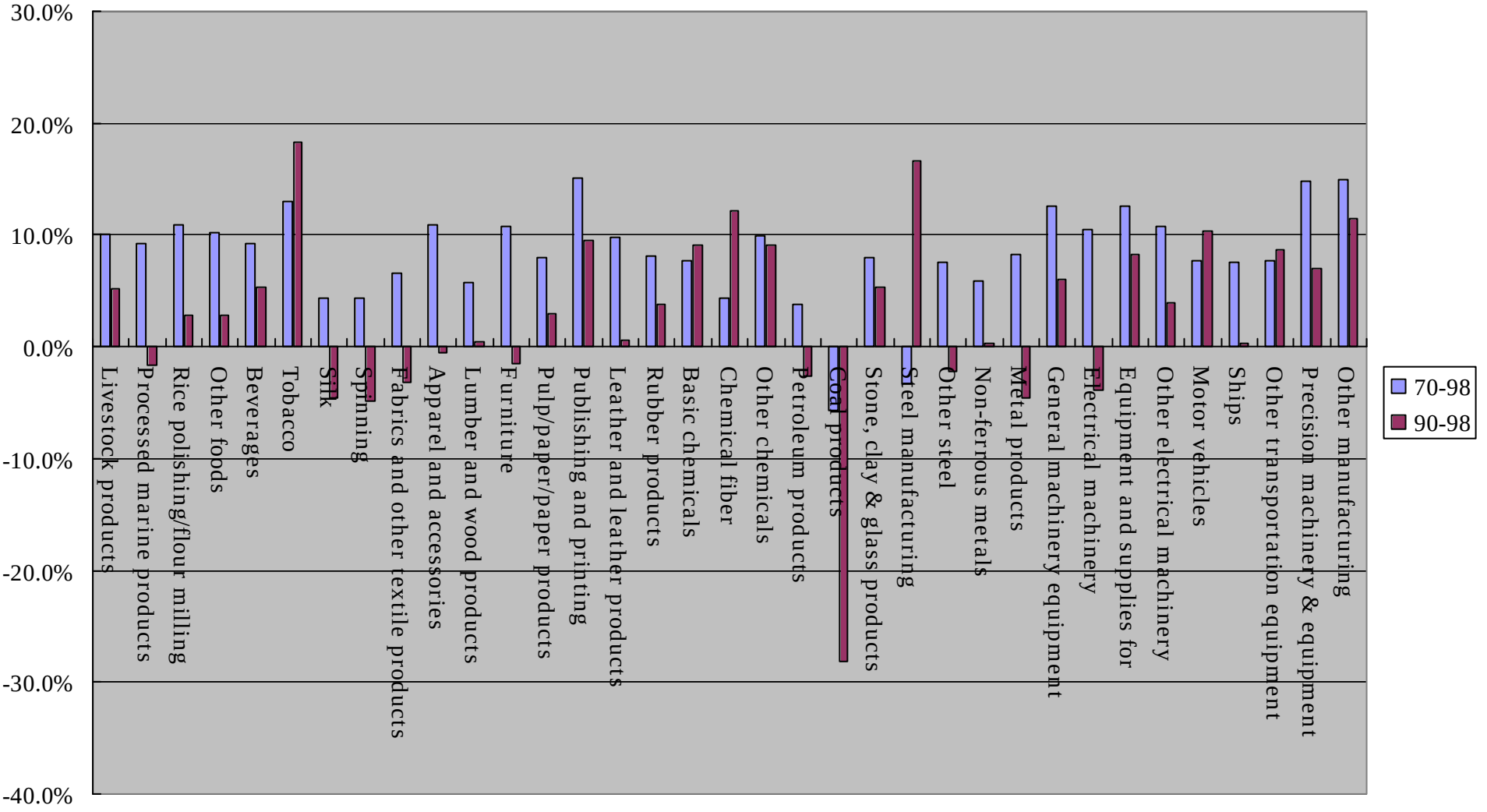


Figure 4-1 Growth Rate of IT Investment(Non-Manufacturing)

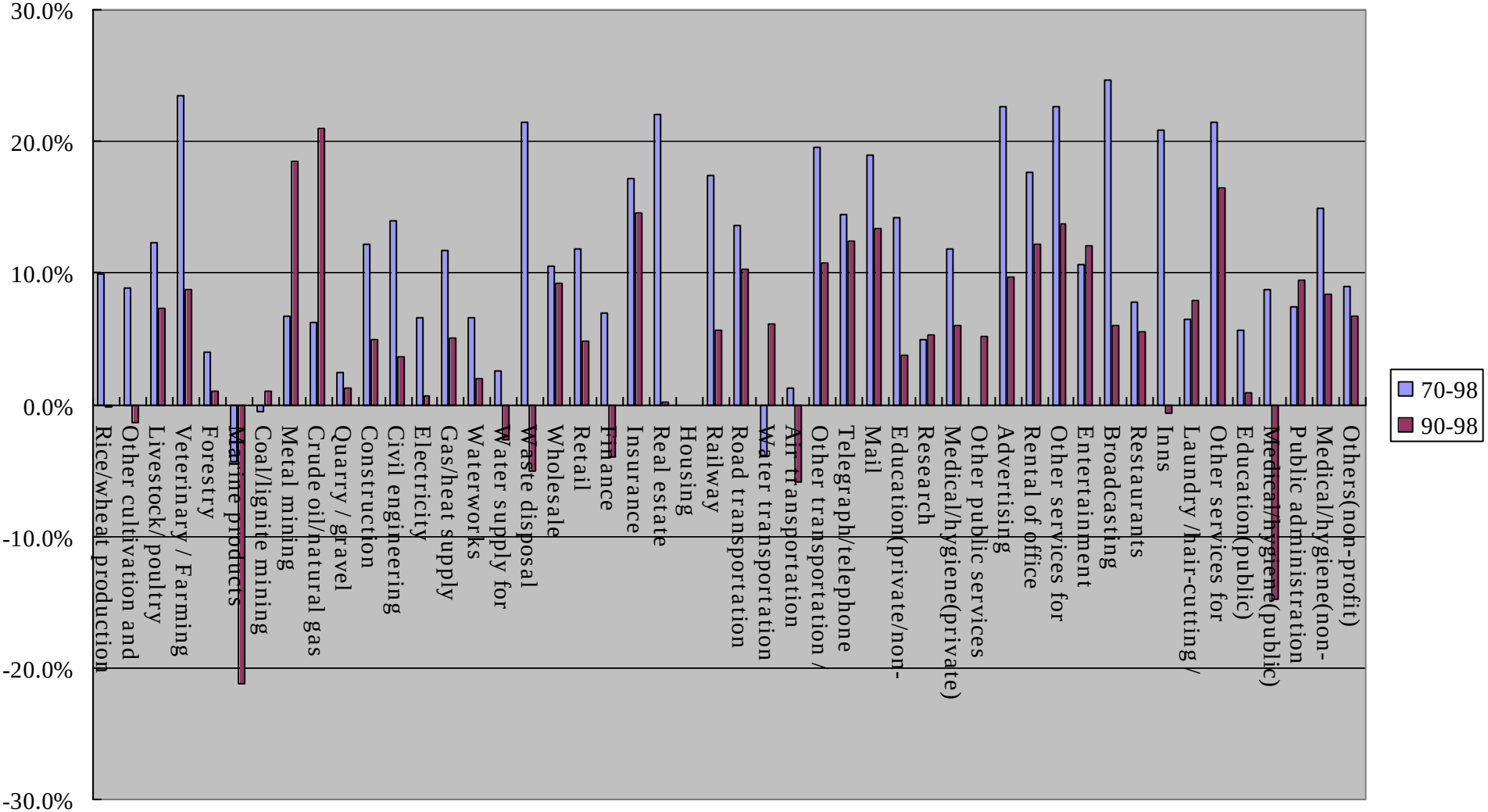


Figure 4-2 The Ratio of IT Capital Stock to Total Capital Stock (Manufacturing)

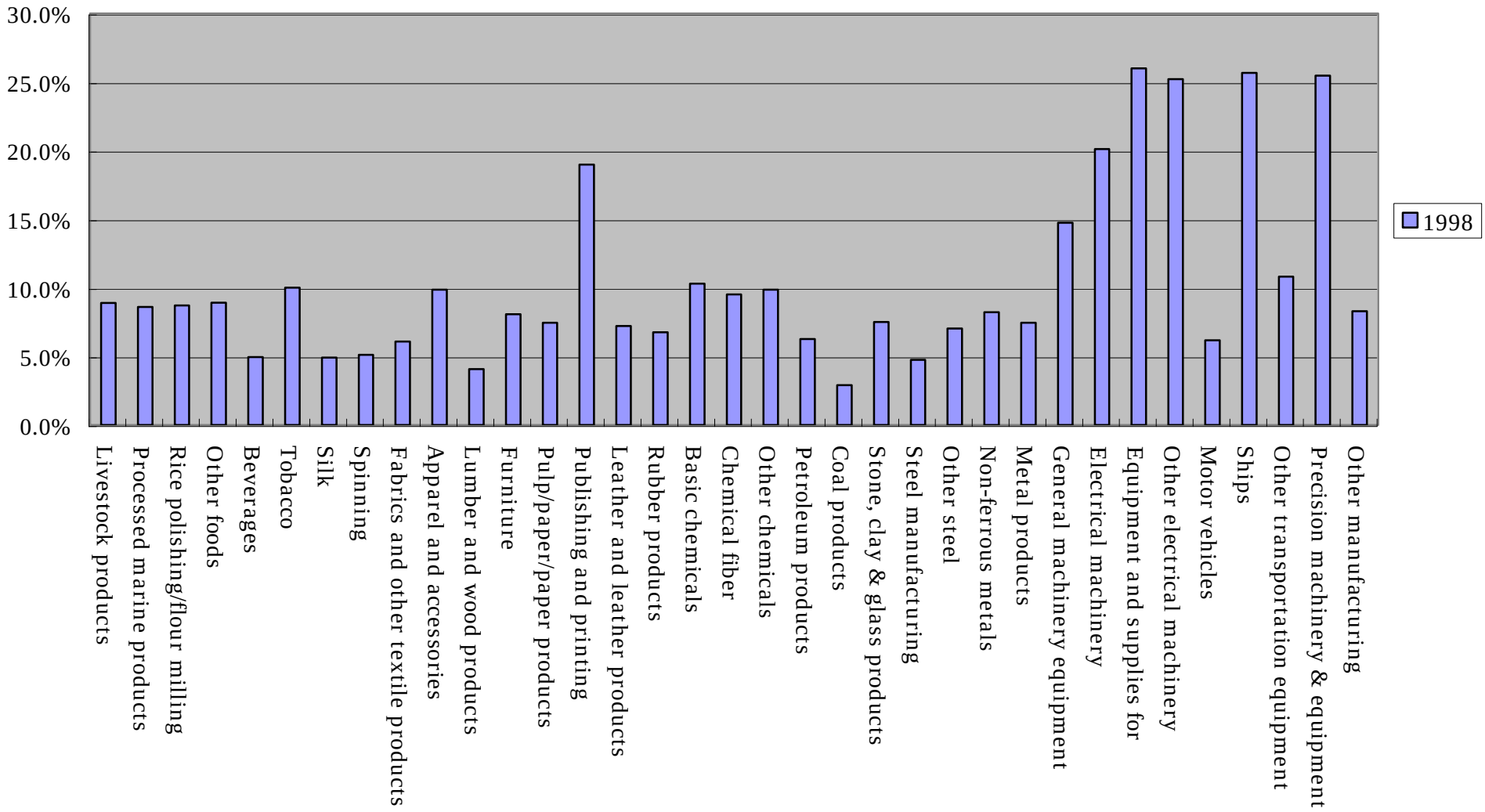


Figure 4-2 The Ratio of IT Capital Stock to Total Capital Stock (Non-Manufacturing)

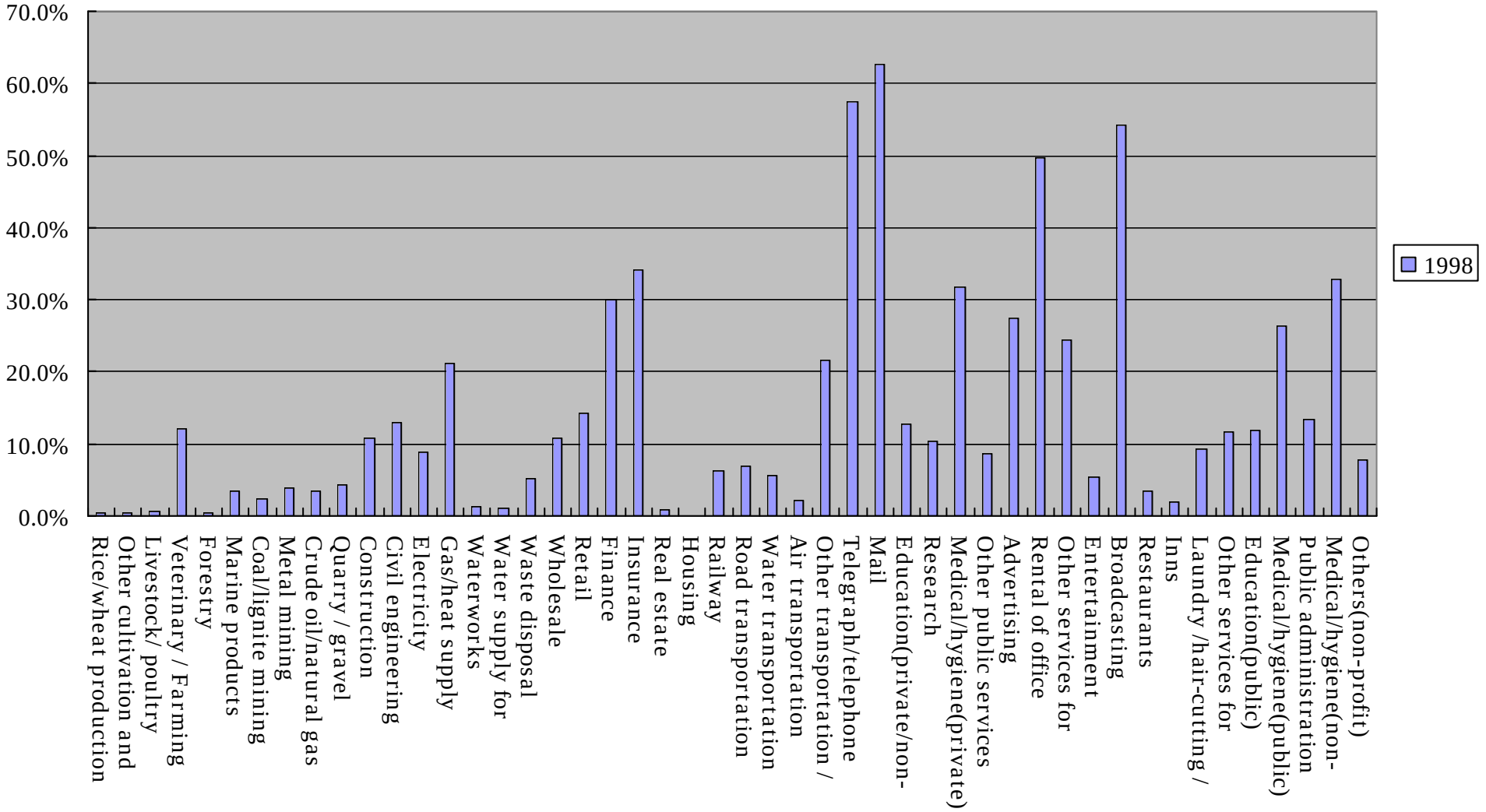


Table 5-1. Definition of Variables for Analysis of Determinants of TFP Growth

Dependent Variable:		
Sectoral TFP Growth Rate:		
GTFP(j, t)	Average annual growth rate of TFP in sector j from year t to the next benchmark year	
Independent Variables:		[Expected Sign of Coefficients]
R&D and IT investment		
RDOWN(j, t)	R&D intensity: Ratio of R&D expenditures by sector j to sector j's gross output in year t	[+]
RDSUP(j, t)	Suppliers' R&D: Ratio of R&D expenditures by sector j's suppliers to sector j's gross output in year t	[+]
ITOWN(j, t)	IT investment ratio: Ratio of average annual net increase of IT capital stock to sector j's gross output	[+]
ITSUP(j, t)	Suppliers' IT investment: Ratio of average annual net increase of IT capital stock owned by sector j's suppliers to sector j's gross output	[+]
Growth Rate of Capacity Utilization Index		
GUTI(j, t)	Average annual growth rate of sector j's capacity utilization index (METI data)	[+]
GUTI2(j, t)	Average annual growth rate of ratio of real intermediate input to real capital stock in sector j	[+]
Openness		
OPEN	Ratio of sum of exports and imports of sector j's output to sector j's gross output	[+]
EXP	Ratio sector j's exports to sector j's gross output	[+]
IMP	Ratio sector j's imports to sector j's gross output	[+]

Table 5-2. The Impact of R&D and IT Investment on TFP Growth: Manufacturing Sector, FGLS Estimation

	Dependent Variable(GTFP)						
	With Sector Dummies					Without Sector Dummies	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RDOWN	0.6593	0.7590	0.7774	0.7399	0.6289	0.4397	0.4129
	(2.57) **	(2.83) ***	(3.07) ***	(2.61) ***	(2.36) **	(3.50) ***	(3.05) ***
RDSUP	0.8645	1.0088	0.9648	0.9984	0.9986	0.1372	0.3840
	(1.69) *	(1.95) *	(1.90) *	(1.90) *	(1.87) *	(0.73)	(1.44)
ITOWN	4.5425	4.1885	5.2817	4.1031	5.6508	3.1893	3.5150
	(2.19) **	(2.15) **	(2.79) ***	(2.14) **	(3.02) ***	(1.87) *	(2.13) **
ITSUP	37.9423	31.9275	41.0299	30.8530	39.8425	26.5801	31.9195
	(3.10) ***	(1.91) *	(2.54) **	(1.79) *	(2.39) **	(2.26) **	(2.30) **
GUTI		-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0001
		(-2.16) **	(-2.48) **	(-1.91) *	(-1.94) *	(-3.37) ***	(-1.89) *
OPEN			0.0822				
			(4.12) ***				
EXP				-0.0122			
				(-0.36)			
IMP					0.1071		0.0346
					(4.55) ***		(2.92) ***
_cons	-0.0035	0.0358	0.0240	0.0360	0.0146	0.0343	0.0288
	(-1.04)	(4.42) ***	(2.77) ***	(3.98) ***	(1.53)	(7.80) ***	(5.17) ***
No. of obs	203	169	169	169	169	169	169
No. of group	34	34	34	34	34	34	34

Note: 1) The numbers in parentheses are z-statistics.
2) All regressions include year dummies.
3) *P=.10, **P=.05, ***P=.01 (two-tailed test)
4) In each estimation, we assumed a model with heteroscedasticity across groups and first-order autocorrelation, where the correlation parameter is the same for all groups.

Table 5-3. The Impact of R&D and IT Investment on TFP Growth: Non-manufacturing Sector, FGLS Estimation

	Dependent Variable(GTFP)			
	With Sector Dummies		Without Sector dummies	
	(1)	(2)	(3)	(4)
RDOWN	1.37	1.34	0.12	0.12
	(2.24) **	(2.19) **	(0.44)	(0.42)
RDSUP	4.23	4.17	1.31	1.55
	(1.93) *	(1.88) *	(0.85)	(0.81)
ITOWN	1.40	1.50	0.79	0.78
	(2.11) **	(2.14) **	(1.41)	(1.37)
ITSUP	-20.37	-21.77	-1.89	-3.52
	(-1.30)	(-1.35)	(-0.23)	(-0.41)
GUTI2		-0.024		0.01
		(-0.79)		(0.21)
_cons	-0.02	-0.02	-0.01	-0.01
	(-2.55) **	(-2.53) **	(-1.26)	(-1.25)
No. of obs	120	120	120	120
No. of groups	20	20	20	20

Note: 1) The numbers in parentheses are z-statistics.
2) All regressions include year dummies.
3) *P=.10, **P=.05, ***P=.01 (two-tailed test)
4) In each estimation, we assumed a model with heteroscedasticity across groups and first-order autocorrelation, where the correlation parameter is the same for all groups.

Table A-1 JIP Type of Capital Goods, Depreciation Rate, National Wealth Survey, and Fixed Capital Formation Matrix

JIP type of capital goods		Depreciation rate	The National Wealth Survey of 1970				Fixed Capital Formation Matrix of 1990	
			Classification code			Type of capital goods	Row code	Sector name
1	Farm	0.024		710		Animals	114011	Citrus fruits
				720		Plants	114012	Apples
				79V		Unclassifiable	114019	Other fruits
							115029	Other crops for beverages
							121019	Other dairy farming products
							121099	Other livestock
							122011	Sericulture
2	Other furniture	0.118		135		Air curtain and automatic door device	1519011	Ropes and nets
				136		Arcade and sun-shading device	1519021	Carpets and floor mats
				137		Simplified shop arrangement	1521011	wearing apparel
				138		Others	1529011	Cotton and Bedding
				13V		Unclassifiable	1619099	Other wooden products, n.e.c.
			14			Unclassifiable building	1711011	Wooden furniture and fixtures
			1V			Unclassifiable buildings and building attachments	1711031	Metallic furniture and fixtures
				622		Furniture, electrical and gas machinery		
3	Nuclear fuel	0.438		290		Power generation, transmission and distribution equipment	2722041	Nuclear fuels
4	Household appliances	0.165		131		Water supply, sewage, hygiene, gas equipment	3013011	Refrigerators and air conditioning apparatus
				132		Heating, cooling ventilation and boiler equipment	2891011	Gas and oil appliances and heating and cooking apparatus
					25	Refrigerators and air conditioning apparatus		
5	Other fabricated metal products	0.092		629		Others	2899021	Metal containers, fabricated plate and sheet metal
				62V		Unclassifiable	2899099	Other metal products, n.e.c.
			6V			Unclassifiable		
6	Steam engines and turbines	0.052			23	Boilers, atomic reactor, turbines	3011011	Boilers
							3011021	Turbines
7	General industrial, including materials handling equipment	0.107		133		Lift equipment	3012011	Conveyors
					20	Industrial furnaces	3019011	Pumps and compressors
					24	Pumps, compressors, blower fan machine, hydraulic equipment	3023011	Industrial robots
					26	broadcasting, packing, cargo, conveyors	3019099	Other general industrial machinery and equipment
					30	Power transmission apparatus and other machinery		
8	Instruments	0.135	61			Tools	3031099	Other general machines and parts
				134		Fire fighting and disaster informing device	3019021	Sewing machines and wool knitting machinery
							3031011	Metal molds
							3019031	Machinists precision tools
9	Mining and oil field machinery	0.204			11	Mining, civil engineering and construction machinery	3021011	Mining, civil engineering and construction machinery
					12	Crushing, grinding and grading machinery	2811011	Metal products for construction
10-1	Chemical machinery	0.150			18	Chemical machinery	3022011	Chemical machinery
10-2	Chemical machinery	0.103			18	Chemical machinery	3022011	Chemical machinery
11	Metalworking machines	0.123			21	Machine tools	3024011	Metal machine tools
					22	Other metal processing machinery	3024021	Metal processing machinery
12	Agricultural machinery, except tractors	0.118			10	Agricultural machinery	3029011	Agricultural machinery
13	Special industrial machinery	0.103			13	Food and beverage processing machinery	3029021	Textile machinery
					14	Textile machinery and sewing machines	3019021	Sewing machines and wool knitting machinery
					15	Sawmill, wood working, veneer, and fiber board machinery	3029031	Food processing machinery
					16	Pulp and paper machinery	3029091	Sawmill, wood working, veneer and plywood machinery
					17	Printing, bookbinding and paper-processing machinery	3029092	Pulp equipment and paper machinery
					19	Synthetic resin processing machinery	3029093	Printing, bookbinding and paper-processing machinery
							3029094	Casting equipment
							3029095	Plastic processing machinery
							3029099	Other special industrial machinery, n.e.c.
14	Photocopy and related equipment	0.180		621		Business and communication machinery	3111011	Copy machine
					29	Precision machinery		

JIP type of capital goods		Depreciation rate	The National Wealth Survey of 1970				Fixed Capital Formation Matrix of 1990	
			Classification code			Type of capital goods	Row code	Sector name
15	Office computing, and accounting machinery	0.312		621		Business and communication machinery	3111092	Word processing machine
					29	Precision machinery	3111099	Other office machines, n.e.c.
16	Service industry machinery	0.150		627		Vending machine	3112011	Vending machines
					28	Other electric machinery	3112012	Amusement machinery
							3112019	Other machinery for service industry
17	Household electric appliances	0.183		622		Furniture, electrical and gas machinery	3211011	Electric audio equipment
							3211021	Radio and television sets
							3211099	Other household electric appliances
18	Computer and the peripheral equipment	0.312		620		Electric computer	3311011	Electric computing equipment (main parts)
					29	Precision machinery	3311021	Electric computing equipment (accessory equipment)
19	Communications equipment: Business services	0.150		621		Business and communication machinery	3321011	Wired communication equipment
					27	Applied electronic equipment and communication equipment	3321021	Radio communication equipment
							3321099	Other communication equipment
20	Video and applied electronic equipment	0.183			27	Applied electronic equipment and communication equipment	3331011	Applied electronic equipment
							3211031	Video recording and playback equipment
21	Electricity transmission and distribution apparatuses	0.050		130		Electricity and lighting equipment	3411011	Generators
					28	Other electric machinery	3411012	Electric motors
							3411021	Relay switches and switchboards
							3411031	Other electricity transmission and distribution apparatuses
							3411099	Other industrial heavy electrical equipment
							3332011	Electric measuring instruments
22	Electric lighting fixtures and apparatus	0.183		130		Electricity and lighting equipment	3421011	Electric lighting fixtures and apparatus
					28	Other electric machinery		
23	Passenger cars	0.333		530		Passenger cars	3511011	Passenger motor cars
							3541011	Motor vehicle bodies
24	Trucks, buses, and truck trailers	0.123		539		Others	3521011	Trucks, buses and other cars
				53V		Unclassifiable	3541011	Motor vehicle bodies
25	Motorcycles and bicycles	0.333		590		Tricycles and motorcycles	3531011	Two-wheel motor vehicles
				591		bicycle and rearcar	3629011	Bicycles
26	Other transport equipment	0.107		599		Others	3629099	Other transport equipment, n.e.c.
				59V		Unclassifiable	3629091	Transport equipment for industrial use
			5V			Unclassifiable		
27	Ships and boats	0.061	41			Steel vessels	3611011	Steel ships
			42			Wooden vessels	3611021	Ships except steel ships
			49			Others		
			4V			Unclassifiable		
28	Internal combustion engines	0.206	41			Steel vessels	3611031	Internal combustion engines for vessels
			42			Wooden vessels	3011031	Engines
			49			Others		
			4V			Unclassifiable		
29	Railroad equipment	0.059	51			Rolling stock	3621011	Rolling stock
30	Aircraft	0.083	52			Aircraft	3622011	Aircrafts
31	Other (in Private non-residential equipment)	0.147		623		Timepieces, testing machines and measuring apparatus	3711011	Camera
				624		Optical instruments and camera	3711099	Other photographic and optical instruments
				625		Medical instruments	3719031	Medical instruments
				626		Equipment for amusement, sport, public entertainment, barber's shop and beauty	3712011	Watches and clocks
							3719021	Analytical instruments, testing machine, measuring
							3719011	Professional and scientific instruments
							3911021	Sporting and athletic goods
							3919011	Musical instruments
							3919021	Record
							3919099	Miscellaneous manufacturing products

JIP type of capital goods		Depreciation rate	The National Wealth Survey of 1970				Fixed Capital Formation Matrix of 1990	
			Classification code			Type of capital goods	Row code	Sector name
32	Residential construction	0.048		110		steel-frame reinforced concrete buildings	4111011	Residential construction (wooden)
				111		Reinforced concrete buildings	4111021	Residential construction (non-wooden)
				112		Brick buildings		
				113		Stone buildings		
				114		Block buildings		
				115		Metal buildings		
				116		Wooden buildings		
				117		Mortared wooden buildings		
				118		Simplified buildings		
				11V		Unclassifiable		
				800		Construction in process		
33	Non-residential construction	0.086		120		steel-frame reinforced concrete buildings	4112011	Non-residential construction (wooden)
				121		Reinforced concrete buildings	4112021	Non-residential construction (non-wooden)
				122		Brick buildings		
				123		Stone buildings		
				124		Block buildings		
				125		Metal buildings		
				126		Wooden buildings		
				127		Mortared wooden buildings		
				128		Simplified buildings		
				12V		Unclassifiable		
				800		Construction in process		
34	Other (Private nonresidential structure)	0.023		211		Paved road	4131011	Public construction of roads
				219		Others	4131021	Public construction of rivers, drainages and others
				21V		Unclassifiable	4131031	Agricultural public construction
				220		Sewage disposing equipment	4132099	Other civil engineering and construction
				229		Others		
				22V		Unclassifiable		
				900		Land formation and improvements		
				292		Smoke disposing equipment		
				293		Advertising equipment		
				294		Equipment for stadium, ground, recreation ground and schools		
				295		Garden		
				299		Others		
				29V		Unclassifiable		
			2V			Unclassifiable		
				800		Construction in process		
35	Railroad replacement track	0.028		210		Railway equipment	4132011	Railway construction
				800		Construction in process		
36	Electric light and power	0.021		290		Power generation, transmission and distribution equipment	4132021	Electric power facilities construction
				800		Construction in process		
37	Telecommunications	0.024		291		Broadcasting and communication equipment	4132031	Telecommunication facilities construction
				800		Construction in process		

Table A-2 Real Capital Stock by Economic Activity

unit: million yen

JIPclassification		1970	1975	1980	1985	1990	1995	1998
1	Rice, wheat production	5261377	8292584	13626258	20203435	26811594	32280555	36402843
2	Other cultivation and seed planting	2264987	3349922	4684845	6769750	8967666	11423435	12697583
3	Livestock, poultry	3028425	4153038	4921234	5505924	6042569	6238610	6244314
4	Veterinary, Farming services	843309	999296	1126760	1281054	1535308	1638079	1659317
5	Forestry	1200029	2495593	4385359	5496873	5460875	5904110	6005102
6	Marine products	1940124	3402410	5270437	6353193	6963809	6897891	6242499
7	Coal, lignite mining	174381	313993	319023	296896	276116	277817	267496
8	Metal mining	33304	88632	79881	62002	51133	48686	65847
9	Crude oil, natural gas exploration	212179	188910	205800	232537	204120	217933	321481
10	Quarry, gravel extraction, other mining	805983	1888186	1674220	1484024	1379367	1436858	1443948
11	Livestock products	374600	594208	793728	955542	1184204	1369305	1381281
12	Processed marine products	227543	423162	541691	641613	820979	903016	891532
13	Rice polishing, flour milling	52359	112152	175820	258922	272705	302898	306242
14	Other foods	1278124	2292524	2995507	3727584	4698644	5503847	5575422
15	Beverages	727850	1233171	1294070	1739602	2618409	2771474	3021548
16	Tobacco	151544	288361	594977	736623	764847	878246	967521
17	Silk	500524	1003102	872177	785292	843143	859947	768424
18	Spinning	428759	751240	629002	555158	616657	614680	561833
19	Fabrics and other textile products	2040973	3422502	3128475	3093294	3748636	4094845	3990357
20	Apparel and accessories	452907	954557	1031380	1249727	1825739	2155484	2084957
21	Lumber and wood products	893438	1558743	1431149	1365678	1665466	1817401	1883135
22	Furniture	361128	657108	670200	769272	1105923	1348914	1413131
23	Pulp, paper, paper products	1432648	2699948	3094633	3258033	5036152	5902571	6487512
24	Publishing and printing	819195	1328974	1682583	2679634	4975701	6433186	7269645
25	Leather and leather products	48078	95240	120819	212512	327175	355299	334497
26	Rubber products	259075	597926	722392	985932	1421376	1724252	1852499
27	Basic chemicals	4499118	6379268	6683900	7497470	8894698	10040409	10533472
28	Chemical fiber	1074280	1396172	1332643	1345888	1408844	1447589	1418602
29	Other chemicals	1470338	2320917	2752912	3420649	4963870	6601045	7439885
30	Petroleum products	2342825	3577473	3653008	3442276	3224116	3976316	3986610
31	Coal products	551415	957249	995477	935540	933178	881487	827853
32	Stone, clay & glass products	1709775	2891925	3539201	4369811	5199446	5548816	5561735
33	Steel manufacturing	8029384	11832502	9223481	7401241	6165430	5619969	5361591
34	Other steel	2377872	4949335	9105631	11550811	14994504	16710639	15433809
35	Non-ferrous metals	1135310	1948424	2243744	2896964	3233277	3600057	4052238
36	Metal products	2016447	3637527	3525639	3971695	5655920	6787478	6923612
37	General machinery equipment	3532967	5830884	7685537	12316417	18197354	23558729	26372736
38	Electrical machinery	528688	939354	1087211	2274051	4716704	6237464	6663394
39	Equipment and supplies for household use	846677	1322241	1889837	3115768	5586174	8186314	9575084
40	Other electrical machinery	2373731	3381452	4559056	8604925	14043841	17602145	20610236
41	Motor vehicles	4208698	7852041	10069055	13098969	18490095	22864688	25204013
42	Ships	704354	2292488	1938366	2137078	1964326	2396430	2386864
43	Other transportation equipment	472777	852361	1058248	1393661	1710143	1851839	1914595
44	Precision machinery & equipment	484104	802236	1354661	2181104	2900758	3203629	3549995
45	Other manufacturing	2732310	4605773	5003612	7355024	9490550	10249720	10626430
46	Construction	2868813	5421003	5422780	5986574	7866968	9271344	8992514
47	Civil engineering	1451257	3288010	4689461	6758334	7433733	8095657	7901440
48	Electricity	9918812	19873268	40682481	50759747	59258697	71758828	77176200
49	Gas, heat supply	618202	1399396	2259265	2547661	3126939	3985376	4259227
50	Waterworks	4173500	8320140	13110995	17032504	20869246	24601812	26883715
51	Water supply for industrial use	627931	1092283	1465172	1696843	1911629	2080268	2130660
52	Waste disposal	21917	79260	240710	445464	830475	1304290	1480228
53	Wholesale	9028931	15964960	19195072	21656518	26011278	27232369	30172034
54	Retail	7966548	15779579	20185188	21898328	25337116	26139714	24497495
55	Finance	2117131	3906749	5164840	5497356	7303275	7305745	7892178
56	Insurance	262610	652861	1000418	1671050	2920744	3895921	4181043
57	Real estate	18034507	29498783	39707259	58162453	93513873	110930203	115212645
58	Housing	41943922	100333603	152485085	177260262	209375188	242555682	259737363
59	Railway	7451473	13800843	21485021	27353192	33906115	40657793	43636117
60	Road transportation	3349711	8027629	13576507	21992077	31436373	35104567	38583748
61	Water transportation	3994657	7368022	7827642	9569917	9762246	9924441	9867455
62	Air transportation	1521562	2744053	3654823	4765971	6590199	6947424	6981023
63	Other transportation, packing	428284	749845	769132	1237755	2990021	4685630	6360175
64	Telegraph, telephone	4926381	12100799	17174790	20450846	24639997	30319620	37499586
65	Mail	61460	159640	308556	450911	647733	987291	1275194

JIPclassification		1970	1975	1980	1985	1990	1995	1998
66	Education (private, non-profit)	623731	2741447	5468818	10067370	14773678	18107204	19508195
67	Research	82256	323150	423440	806282	1327055	2074332	2131010
68	Medical, hygiene (private)	1077256	2011940	3792674	6942592	12488525	15150129	17354448
69	Other public services	113804	314324	315156	327159	316296	434979	609054
70	Advertising	149005	322150	472553	775588	1100408	2369735	2725047
71	Rental of office equipment and goods	930695	2427962	3696187	7897737	23499386	36574337	47546487
72	Other services for businesses	1033415	1787871	2487327	4560073	6993211	8823274	11503152
73	Entertainment	2744541	4405138	5735691	7652028	12245319	17394543	21189388
74	Broadcasting	69737	370865	701373	1083197	1714159	2434052	3111450
75	Restaurants	1808620	4384052	6637128	8584405	9613024	9302801	8538186
76	Inns	2226726	3759908	5222457	8367307	13642297	15072203	14719575
77	Laundry, hair-cutting , public bath	1316592	1892054	2314145	2360272	2487401	2504894	2393927
78	Other services for individuals	344735	801442	1403298	2486929	4032032	4552278	5173559
79	Education (public)	3342257	7005863	11821601	14672286	13851566	13905025	13500498
80	Medical, hygiene (public)	252802	634179	2102652	6310104	8256201	7899524	6538076
81	Public administration	17784491	35424673	50282841	63162243	77878830	103097870	113621855
82	Medical, hygiene (non-profit)	196042	446810	1036852	1933526	3392050	6090035	7156727
83	Others(non-profit)	243505	580406	938203	1762071	2339152	3430231	4364724
84	Activities not elsewhere classified	-	-	-	-	-	-	-
	Total	222011730	431150065	609031234	776954378	1007073973	1197765525	1294988124

Table A-3 Average Annual Change in Real Capital Stock by Economic Activity (%)

JIP classification		1970-75	1975-80	1980-85	1985-90	1990-95	1995-98
1	Rice, wheat production	9.5	10.4	8.2	5.8	3.8	4.1
2	Other cultivation and seed planting	8.1	6.9	7.6	5.8	5.0	3.6
3	Livestock, poultry	6.5	3.5	2.3	1.9	0.6	0.0
4	Veterinary, Farming services	3.5	2.4	2.6	3.7	1.3	0.4
5	Forestry	15.8	11.9	4.6	-0.1	1.6	0.6
6	Marine products	11.9	9.1	3.8	1.9	-0.2	-3.3
7	Coal, lignite mining	12.5	0.3	-1.4	-1.4	0.1	-1.3
8	Metal mining	21.6	-2.1	-4.9	-3.8	-1.0	10.6
9	Crude oil, natural gas exploration	-2.3	1.7	2.5	-2.6	1.3	13.8
10	Quarry, gravel extraction, other mining	18.6	-2.4	-2.4	-1.5	0.8	0.2
11	Livestock products	9.7	6.0	3.8	4.4	2.9	0.3
12	Processed marine products	13.2	5.1	3.4	5.1	1.9	-0.4
13	Rice polishing, flour milling	16.5	9.4	8.0	1.0	2.1	0.4
14	Other foods	12.4	5.5	4.5	4.7	3.2	0.4
15	Beverages	11.1	1.0	6.1	8.5	1.1	2.9
16	Tobacco	13.7	15.6	4.4	0.8	2.8	3.3
17	Silk	14.9	-2.8	-2.1	1.4	0.4	-3.7
18	Spinning	11.9	-3.5	-2.5	2.1	-0.1	-3.0
19	Fabrics and other textile products	10.9	-1.8	-0.2	3.9	1.8	-0.9
20	Apparel and accessories	16.1	1.6	3.9	7.9	3.4	-1.1
21	Lumber and wood products	11.8	-1.7	-0.9	4.0	1.8	1.2
22	Furniture	12.7	0.4	2.8	7.5	4.1	1.6
23	Pulp, paper, paper products	13.5	2.8	1.0	9.1	3.2	3.2
24	Publishing and printing	10.2	4.8	9.8	13.2	5.3	4.2
25	Leather and leather products	14.7	4.9	12.0	9.0	1.7	-2.0
26	Rubber products	18.2	3.9	6.4	7.6	3.9	2.4
27	Basic chemicals	7.2	0.9	2.3	3.5	2.5	1.6
28	Chemical fiber	5.4	-0.9	0.2	0.9	0.5	-0.7
29	Other chemicals	9.6	3.5	4.4	7.7	5.9	4.1
30	Petroleum products	8.8	0.4	-1.2	-1.3	4.3	0.1
31	Coal products	11.7	0.8	-1.2	-0.1	-1.1	-2.1
32	Stone, clay & glass products	11.1	4.1	4.3	3.5	1.3	0.1
33	Steel manufacturing	8.1	-4.9	-4.3	-3.6	-1.8	-1.6
34	Other steel	15.8	13.0	4.9	5.4	2.2	-2.6
35	Non-ferrous metals	11.4	2.9	5.2	2.2	2.2	4.0
36	Metal products	12.5	-0.6	2.4	7.3	3.7	0.7
37	General machinery equipment	10.5	5.7	9.9	8.1	5.3	3.8
38	Electrical machinery	12.2	3.0	15.9	15.7	5.7	2.2
39	Equipment and supplies for household use	9.3	7.4	10.5	12.4	7.9	5.4
40	Other electrical machinery	7.3	6.2	13.5	10.3	4.6	5.4
41	Motor vehicles	13.3	5.1	5.4	7.1	4.3	3.3
42	Ships	26.6	-3.3	2.0	-1.7	4.1	-0.1
43	Other transportation equipment	12.5	4.4	5.7	4.2	1.6	1.1
44	Precision machinery & equipment	10.6	11.0	10.0	5.9	2.0	3.5
45	Other manufacturing	11.0	1.7	8.0	5.2	1.6	1.2
46	Construction	13.6	0.0	2.0	5.6	3.3	-1.0
47	Civil engineering	17.8	7.4	7.6	1.9	1.7	-0.8
48	Electricity	14.9	15.4	4.5	3.1	3.9	2.5
49	Gas, heat supply	17.8	10.1	2.4	4.2	5.0	2.2
50	Waterworks	14.8	9.5	5.4	4.1	3.3	3.0
51	Water supply for industrial use	11.7	6.0	3.0	2.4	1.7	0.8
52	Waste disposal	29.3	24.9	13.1	13.3	9.4	4.3
53	Wholesale	12.1	3.8	2.4	3.7	0.9	3.5
54	Retail	14.6	5.0	1.6	3.0	0.6	-2.1
55	Finance	13.0	5.7	1.3	5.8	0.0	2.6
56	Insurance	20.0	8.9	10.8	11.8	5.9	2.4
57	Real estate	10.3	6.1	7.9	10.0	3.5	1.3
58	Housing	19.1	8.7	3.1	3.4	3.0	2.3
59	Railway	13.1	9.3	4.9	4.4	3.7	2.4
60	Road transportation	19.1	11.1	10.1	7.4	2.2	3.2
61	Water transportation	13.0	1.2	4.1	0.4	0.3	-0.2
62	Air transportation	12.5	5.9	5.5	6.7	1.1	0.2
63	Other transportation, packing	11.9	0.5	10.0	19.3	9.4	10.7
64	Telegraph, telephone	19.7	7.3	3.6	3.8	4.2	7.3
65	Mail	21.0	14.1	7.9	7.5	8.8	8.9

JIP classification		1970-75	1975-80	1980-85	1985-90	1990-95	1995-98
66	Education (private, non-profit)	34.5	14.8	13.0	8.0	4.2	2.5
67	Research	31.5	5.6	13.7	10.5	9.3	0.9
68	Medical, hygiene (private)	13.3	13.5	12.9	12.5	3.9	4.6
69	Other public services	22.5	0.1	0.8	-0.7	6.6	11.9
70	Advertising	16.7	8.0	10.4	7.2	16.6	4.8
71	Rental of office equipment and goods	21.1	8.8	16.4	24.4	9.3	9.1
72	Other services for businesses	11.6	6.8	12.9	8.9	4.8	9.2
73	Entertainment	9.9	5.4	5.9	9.9	7.3	6.8
74	Broadcasting	39.7	13.6	9.1	9.6	7.3	8.5
75	Restaurants	19.4	8.6	5.3	2.3	-0.7	-2.8
76	Inns	11.0	6.8	9.9	10.3	2.0	-0.8
77	Laundry, hair-cutting , public bath	7.5	4.1	0.4	1.1	0.1	-1.5
78	Other services for individuals	18.4	11.9	12.1	10.1	2.5	4.4
79	Education (public)	16.0	11.0	4.4	-1.1	0.1	-1.0
80	Medical, hygiene (public)	20.2	27.1	24.6	5.5	-0.9	-6.1
81	Public administration	14.8	7.3	4.7	4.3	5.8	3.3
82	Medical, hygiene (non-profit)	17.9	18.3	13.3	11.9	12.4	5.5
83	Others (non-profit)	19.0	10.1	13.4	5.8	8.0	8.4
84	Activities not elsewhere classified	-	-	-	-	-	-
	Total	14.2	7.2	5.0	5.3	3.5	2.6