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Sectoral Productivity and Economic Growth in Japan, 1970-98:
An Empirical Analysis Based on the JIP Database*

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1. Introduction

Following the collapse of the so-called “bubble economy,” Japan’s economy has entered a phase of unprecedentedly low growth. Looking for the causes of this stagnation, economists have mainly focused on demand-side factors, such as the deficiency of effective demand, damaged balance sheets of Japanese firms, and the bad loan problems. Although the necessity of structural reforms and deregulations has also been stressed, rigorous empirical analyses of the supply-side were scarce.

From the viewpoint of growth accounting, Japan’s low economic growth in the 1990s can be explained by the following three factors. The first factor is a slowdown of the labor supply caused by structural changes, such as population aging and a reduction of the work-week. The second factor is a slowdown of total factor productivity (TFP) growth. The third factor is a lack of effective demand and deflation. Many economists agree on the importance of the first factor. But they are not unanimous in their view on the significance of the other two factors, which are the subject of continuing controversy. Based on a growth accounting of the Japanese economy, Hayashi and Prescott (2002) argue that the economic stagnation in Japan in recent years can be explained by the first and the second factor, while the demand factor, in their view, does not play an important role. In contrast, M. Fukao (2003) and Yoshikawa (2003) hold that the scarcity of demand is the most important cause of the present stagnation. They also point out the possibility that the recent slowdown of Japan’s TFP growth is caused by the decline of capacity utilization and labor hoarding as a result of the recession.

In spite of the importance of the issue, Japan’s TFP growth has not been well studied in recent years. For example the growth accounting by Hayashi and Prescott (2002) is not very sophisticated in the sense that they did not take account of the quality of labor and capacity utilization. They treated the slowdown of TFP growth as exogenous and did not try to address important questions, such as why the TFP growth rate has declined and in what sector in particular TFP growth slowed down.

In this paper we conduct a detailed analysis of Japan's TFP growth by making use of the Japan Industrial Productivity Database (the JIP Database) which we have recently completed.[1] We try to answer the following questions:

(1) After the quality of labor and the capacity utilization have been taken account of, how much of the slowdown of Japan's economic growth in the 1990s can be attributed to the decline in TFP growth?
(2) In what sectors is TFP growth particularly low?
(3) What structural factors seem to have contributed to recent changes in sectoral TFP growth?

The paper is organized as follows: in the succeeding section, we conduct growth accounting at macro level. In the analysis we will take account of the quality of labor and capacity utilization. We also compare our results with preceding studies on this issue, such as Hayashi and Prescott (2002) and Jorgenson and Motohashi (2003). In section 3, we analyze sectoral TFP growth. We show that in

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[1] The JIP Database has been compiled by us (the four authors of this paper), several economists at ESRI, and graduate students from Keio, Hitotsubashi, Tsukuba and other universities as part of an ESRI (Economic and Social Research Institute, Cabinet Office, Government of Japan) research project. The result of this project is reported in Fukao, Miyagawa, Kawai, Inui, et al. (2003). The 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 nominal and real input-output tables, and some additional statistics, such as R&D stock, capacity utilization rate, Japan's international trade statistics by trade partner, inward and outward FDI, etc. at the detailed sectoral level. An Excel file version (in Japanese) of the JIP Database is available at <http://www.esri.go.jp/jp/archive/bun/bun170/170index.html>.

the 1990s, TFP growth slowed down in the manufacturing sectors but accelerated in several service sectors. In section 4, we examine possible structural factors that have contributed to recent changes in sectoral TFP growth by reviewing recent researches on sectoral productivity. In section 5, we will summarize our main results.

2. Supply-Side Causes of Japan's Stagnation: An Analysis at the Macro Level

In the succeeding section, we conduct growth accounting at the macro level using the JIP Database. We also compare our results with preceding studies on this issue.

2.1. Growth Accounting at the Macro Level

We begin by explaining our methodology of macro growth accounting. Let us assume that a macro production function at time t can be expressed as the following function of capital input K_t, labor input L_t, and an index of the technology level T_{jt}.

$$Y_{jt} = F(K_t, L_t, T_t) \qquad (1)$$

where Y_{jt} denotes real GDP at time t. We assume constant returns to scale. The capital input K_t is derived by an aggregation of several types of assets, structures and equipment. The labor input L_t is an aggregate of the number of workers cross-classified by sex, age, and educational attainment. The construction of these input aggregates is described in Appendix A.

Additionally we assume that the macro production function has a trans-log functional form. We also assume that because of the cost minimizing behavior of firms, the marginal product of each production factor is equal to its cost share.

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

$$\frac{\partial \ln F}{\partial \ln L} = \frac{\partial F}{\partial L}\frac{L}{Y} = \frac{w_L}{p}\frac{L}{Y} = s_L$$

where

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

denotes the average of cost share of capital at time t-1 and time t. w_K/p and w_L/p denote real service price of capital and real wage rate. Similarly,

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

denotes the average of the cost share of labor at time t-1 and time t.

By differentiating the production function (1) over time, we get

$$d\ln Y_t = \bar{s}_{Kt}\, d\ln K_t + \bar{s}_{Lt}\, d\ln L_t + d\ln A_t \qquad (2)$$

where $d\ln Y_t$, $d\ln K_t$, and $d\ln L_t$ denote $\ln Y_t$-$\ln Y_{t-1}$, $\ln K_t$-$\ln K_{t-1}$, and $\ln L_t$-$\ln L_{t-1}$ respectively. The last term on the right-hand side of equation (2), $d\ln A_t$ denotes the contribution of technology improvement $\ln T_t$-$\ln T_{t-1}$ to the increase in production at the macro-level.

$$dlnA_t = \frac{\partial \ln F}{\partial \ln T} d\ln T$$

$d\ln A_t$ is usually called TFP growth. It is difficult to measure and observe the states of technology T, but we can derive the contribution of technological change to production in the following way.

$$d\ln A_t = d\ln Y_t - (\bar{s}_{Kt}\, d\ln K_t + \bar{s}_{Lt}\, d\ln L_t) \qquad (3)$$

Subtracting the growth rate of the working age population $d\ln N_t$ from both sides of equation (2), we obtain our basic equation for growth accounting.[2]

$$d\ln Y_t - d\ln N_t = \bar{s}_{Kt}(d\ln K_t - d\ln N_t) + \bar{s}_{Lt}(d\ln MH_t - d\ln N_t)$$
$$+ \bar{s}_{Lt}(d\ln L_t - d\ln MH_t) + d\ln A_t \qquad (4)$$

where $d\ln MH_t$ denotes the growth rate of man-hours worked. The left-hand side of equation (4) denotes real GDP growth per working-age population. The four terms on the right-hand side denote

[2] The working age population is defined as persons aged 15-64. We obtained the data from Prime Minister's Office (various years) and Ministry of Public Management, Home Affairs, Posts and Telecommunications (2002).

the contribution of capital deepening, the contribution of the increase of man-hour input per working-age population, the contribution of the improvement of labor quality,[3] and the contribution of TFP growth respectively.

Insert Table 2.1.

Panel A of Table 2.1 summarizes the result of our growth accounting. Following Hayashi and Prescott (2002), we divided our data into three sub-periods, 1973-1983, 1983-1991, and 1991-1998. 1973 is the year of the first oil shock, and 1983 when recovery from the second oil shock began. This period was follow by the boom of the "bubble economy", which lasted until 1991. Finally, the years from 1991-1998 represent the period of economic stagnation. Panel B of Table 2.1. shows the growth rate of each production factor in each of the three periods. By comparing Panel A and Panel B we can derive the cost share of each factor. For example the average cost share of capital in 1991-98 was 0.33 (=0.96/2.88).

According to the JIP Database, real GDP growth declined from 3.94 % of 1983-91 to 1.25 % of 1991-98. This decline of 2.69 percentage-points can be decomposed into the following factors:

slowdown of the growth of the working age population: 0.79 percentage-points;

slowdown of TFP growth: 0.43 percentage-points;

slowdown of the growth of capital stock per working-age person: 0.51 percentage-points;

slowdown of the growth of man-hour per working age person: 0.72 percentage-points;

slowdown of the improvement of labor quality: 0.25 percentage-points.

All the above changes contributed to the decline in Japan's economic growth in the period from 1991-98. From a theoretical viewpoint, the above changes can be grouped – as argued in Section 1 - into the following three major factors.

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[3] In Appendix A we explain the definition of the labor quality index and the labor input index of the JIP Database.

First, structural changes - such as the aging of the population and the reduction of the work-week - have slowed down the labor input growth. The growth rate of labor quality also declined. According to the Solow-type neoclassical growth model (Solow, 1956), the decline in the working-age population growth rate by 0.79 percentage-points and the 0.25 percentage-point slowdown in labor quality have reduced Japan's balanced growth rate by 1.04 percentage-poins.

Secondly, the TFP growth rate declined by 0.43 percentage-points. According to the neoclassical growth model, the decline in TFP growth will also reduce the equilibrium growth rate of the real capital stock in balanced growth. If we assume a Cobb-Douglas production function with a capital share of one third, a 0.43 percentage-point decline in TFP growth will cause a 0.65 percentage-point (=0.43+0.43/3) decline in the balanced growth rate.

Thirdly, Japan was trapped in deflation in the 1990s. Probably, demand factors, such as the increasing unemployment and the stagnation of private investment have contributed to the decline in economic growth. It seems that a substantial part of the 0.72 percentage-point decline in the contribution of the growth of man-hour per working-age person and the 0.51 percentage-point decline in the contribution of capital deepening were caused by demand-side factors.

Insert Table 2.2.

Table 2.2 compares the result of the growth accounting of the US economy by Jorgenson, Ho, and Stitoh (2002) with our result on Japan.[4] Following Jorgenson et al., we have treated IT capital and non-IT capital as different factor inputs.[5] Compared with the US, Japan's TFP growth and labor

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[4] We should note that there are many differences in concepts and estimation procedures of variables between Jorgenson et al. (2002) and the JIP Database. For example, consumer durables and computer software are not included in capital in the JIP Database. The JIP Database is based on 1968 SNA, whereas Jorgenson et al. (2002) is based on 1993 SNA.

[5] Because of this difference, the estimated TFP growth in Panel B of Table 2.2 is slightly different from the TFP growth in Panel A of Table 2.1.

input growth were significantly lower in the 1990s. On the other hand, there was no large gap in the contribution of labor quality growth and capital deepening. Like the US, Japan has experienced a rapid increase in the contribution of IT capital deepening in the latter half of the 1990s.

To sum up our Japan-US comparison, it is confirmed that the three factors, i.e. the structural decline in labor input growth, the slowdown in TFP growth, and the scarcity of demand caused Japan's 'lost decade'.

2.2. Growth Accounting with Adjustment of Capacity Utilization

As Burnside, Eichenbaum and Rebelo (1995) and Basu (1996) have shown, there is a risk to underestimate (overestimate) TFP growth, if we do not take account of a decline (an increase) in the capacity utilization rate. Since the capacity utilization rate in Japan seems to have declined under the continuous stagnation of the 1990s, we may have overestimated the decline of the TFP growth in the previous section. In this section we examine this issue. We also compare our results with those of Hayashi and Prescott (2002).

The JIP Database contains sectoral capacity utilization rates, which are based on METI's *Index of Operating Ratio* in the case of the manufacturing and mining sectors and on the intermediate input-capital ratio and the BOJ's *Excess Capacity D.I.* in the case of the other sectors.[6] We used this data for the adjustment of TFP growth. Figure 2.1 shows the average capacity utilization rate of the manufacturing and primary sectors and that of other sectors. The average capacity utilization rate of the manufacturing and primary sectors has declined by 9.5 percentage-points from 1991 to 1998. In the case of the other sectors, the decline was negligible (0.5 percentage-points). The decline of the average capacity utilization rate of the macro-economy was relatively small (2.4 percentage-points).

[6] For more detail on estimation procedures of the sectoral capacity utilization rate, see Appendix A.

In order to adjust for this change of the capacity utilization rate, we estimated Japan's TFP growth using the following growth accounting equation.[7]

$$d\ln A_t = d\ln Y_t - (\bar{s}_{Kt}\, d\ln(\sum_j Z_{j,t} K_{j,t}) + \bar{s}_{Lt}\, d\ln L_t) \qquad (5)$$

where $Z_{j,t}$ and $K_{j,t}$ denotes the capacity utilization rate and real capital input in sector j.

Insert Table 2.3.

Table 2.3 shows the result of this growth accounting. According to the new growth accounting with adjustment of capacity utilization, the decline in TFP growth for the period 1983-91 to the 1991-98 period is 0.20 percentage-points, which is 0.23 percentage-points smaller than the corresponding result without the adjustment (Table 2.1). This difference derives from the fact that the capacity utilization rate was at its peak in 1991. Without the adjustment of capacity utilization, the TFP growth before (after) 1991 is overestimated (underestimated).

2.3 Comparison between Preceding Researches and Our Results

Let us compare our result with preceding growth accounting studies of the Japanese economy. Table 2.4 shows the result of Hayashi and Prescott (2002). Similar to ours, their result shows that the decline in Japan's economic growth is jointly caused by a slowdown of TFP growth, a slowdown of capital accumulation, and a decline in labor input. But compared with our result, their estimated decline in capital and labor inputs is much more moderate and, as a result, their estimated decline in TFP growth (2.2 percentage-point decline) is much larger.

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[7] When the capital stock is not fully utilized, the marginal productivity of capital might be different from the cost of capital. In the following growth accounting we did not take account of this possibility. As Morison (1993) has shown, we can tackle this issue more rigorously by estimating the variable cost function. Using micro data of Japanese manufacturing firms, Fukao and Kwon (2003) estimated variable cost functions and made adjustments of capacity utilization and scale economies. They found that the rate of technological progress, which is defined as a downward shift of the variable cost function, declined form 1994 to 1998 in many manufacturing sectors.

Insert Table 2.4.

Probably we can explain this difference by the following factors.

First, Hayashi and Prescott do not take account of changes of in the quality of labor. As Panel B of Table 2.1 shows, the improvement of labor quality has slowed down in the recent years. They overestimate the decline in TFP growth by neglecting changes in labor quality.

Secondly, they do not take account of changes in capacity utilization. This factor also contributed their overestimation of the decline in TFP growth.

Thirdly, in their growth accounting they use real GNP, not GDP as an output measure. And they include Japan's net external assets in the capital stock. In GNP statistics, the rate of return to domestic capital is in gross term and includes capital depreciation. On the other hand, the rate of return to Japan's external assets is recorded in net term. Therefore, the appropriate capital cost of net external assets for growth accounting is usually smaller than the cost of capital located in Japan. Hayashi and Prescott (2002) did not take account of this difference and assumed that the cost share of capital was constant over time. Since Japan has accumulated a huge amount of net external assets in the 1990s,[8] Hayashi and Prescott seems to have overestimated the cost share of capital in the 1990s, the contribution of capital deepening in the 1990s, and, as a result, the decline in Japan's TFP growth from the 1980s to the 1990s.

Another important study is that by Jorgenson and Motohashi (2003). They found that Japan's TFP growth rate declined from 0.96% of 1975-90 to 0.61% of 1990-95 but accelerated to 1.04% during 1995-2000. This optimistic result is mainly based on their assumption on the deflator of

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[8] From the end of 1991 to the end of 1998, Japan has accumulated net external assets of 71.7 trillion yen (*Annual Report of National Accounts 2001*, Economic and Social Research Institute, Cabinet Office, Government of Japan.)

information technology (IT) products.[9] They assumed that the relative price of IT products compared with non-IT products in Japan has declined in a similar way as in the US. They used their own IT product deflator, which is calculated as ((US IT product price)/(US non-IT product price))*(Japan's non-IT product price) instead of Japan's official statistics. Since the relative price of IT products declined more drastically in the US than in Japan, this procedure raises their estimation of the GDP growth rate and the TFP growth rate.[10]

Jorgenson and Motohashi adopt this procedure because they believe that quality improvements of IT products are not sufficiently taken into account in the case of Japan's price statistics.[11] Although they raised an important question, it seems to be brave to directly apply US relative prices to Japan. We need a more rigorous analysis of the international price gap and the size of a hypothetical price decline, which is equivalent to the actual quality improvement of IT products.

3. Sectoral Productivity Growth in Japan

In the previous section we saw that the decline of Japan's TFP growth in the 1990s was not large when we make adjustments of the capacity utilization. In this section, we analyze Japan's TFP growth over the last three decades at a detailed sectoral level, which was almost impossible before

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[9] There are many other differences of estimation procedures between our study and Jorgenson and Motohashi's (2003). They explicitly treat land as a production factor, but we neglected land input. The inclusion of land lowers the cost share of other inputs. This difference makes their estimate of TFP growth higher than ours. They also include consumer durables and computer software in capital input, which we did not.

[10] The lower price of IT products means larger IT investment. This factor reduces the estimate of the TFP growth rate.

[11] Colecchia and Schreyer (2002) adopted similar approach in their comparative analysis of OECD countries.

the compilation of the JIP Database.[12]

3.1. TFP Growth at the 3-Digit Industry Level

First, let us explain our methodology. For the growth accounting of 84 sectors we use the following equation.

$$d\ln A_{j,t} = d\ln Q_{j,t} - (\bar{s}_{K,j,t}\, d\ln Z_{j,t}K_{j,t} + \bar{s}_{L,j,t}\, d\ln L_{j,t} + \bar{s}_{M,j,t}\, d\ln M_{j,t}) \quad (6)$$

Where $d\ln A_{j,t}$ denotes the TFP growth rate from time t-1 to t in sector j, while $d\ln Q_{j,t}$ denotes the growth rate of real gross output. $K_{j,t}$, $L_{j,t}$, and $M_{j,t}$ denote the capital, labor, and real intermediate input in sector j at time t. $M_{j,t}$ is a composite index of 84 commodities and services, which is based on the annual real IO tables of the JIP Database. $Z_{j,t}$ denotes the capacity utilization rate. s_{Kt}, s_{Lt}, and s_{Mt} with upper bars denote the average of cost share of the capital, labor, and intermediate input in sector j at time t-1 and time t. In a similar way as in Table 2.3, we made adjustments of changes in capacity utilization here.

As Domar (1961) has shown, the contribution of TFP growth in each sector to macro TFP growth is given by that sector's TFP growth rate multiplied by the Domar weight.[13] Table 3.1 shows each industry's TFP growth and its contribution to the macro TFP growth rate for the three

[12] 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. In order to obtain access to the KDB, scholars need to get permission from Keio University.

[13] In ordinary growth accounting at the macro-level, real value added is used as a measure of output. In the case of sectoral growth accounting, real gross output is usually used as a measure of output. Because of this conceptual difference, the simple weighted average of sectoral TFP growth is not equal to macro TFP growth. Domar (1961) has shown that to equalize these, we need to weight these by using each industry's gross output divided by the value added of the whole economy.

sub-periods.[14] This result is summarized in Figure 3.1 and 3.2 at the two-digit industry level. The correspondence between the 3-digit JIP classification and our 2-digit classification is reported in Table 3.1.

Insert Table 3.1, Figure 3.1 and Figure 3.2

According to our result, the slowdown of TFP growth mainly occurred in the manufacturing sector. The manufacturing sector's contribution to macro TFP growth declined from 0.74 percentage-points in 1983-91 to -0.03 percentage-points in 1991-98.[15] On the other hand, TFP growth in the non-manufacturing sectors has accelerated in the 1990s. The non-manufacturing sectors' contribution to macro TFP growth has increased from -0.34 percentage-points in 1983-91 to 0.22 percentage-points in 1991-98.[16]

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[14] In Table 3.2, each industry's contribution for period (T, T') is calculated as a chain index:

$$\sum_{t=T+1}^{T'} \frac{DW_{j,t} + DW_{j,t-1}}{2} \{ d\ln Q_{j,t} - (\bar{s}_{K,j,t} d\ln Z_{j,t} K_{j,t} + \bar{s}_{L,j,t} d\ln L_{j,t} + \bar{s}_{M,j,t} d\ln M_{j,t}) \}$$

where $DW_{j,\,t}$ denotes the Domar weight for industy j in period t. On the other hand, in the case of our macro growth accounting in Table 2.3, we directly compare factor inputs at the beginning and the end period.

$$\{ (\ln Q_{j,T'} - \ln Q_{j,T}) - \{ \frac{s_{K,j,T'} + s_{K,j,T}}{2} (\ln Z_{j,T'} K_{j,T'} - \ln Z_{j,T} K_{j,T}) + \frac{s_{L,j,T'} + s_{L,j,T}}{2} (\ln L_{j,T'} - \ln L_{j,T}) \}$$

Because of this difference, the total of all industries' contribution to macro TFP growth in Table 3.2 is not identical with the result in Table 2.3.

[15] Based on growth accounting at 2-digit industry level, Nishimura, Minetaki, Shirai, and Kurokawa (2002) concluded that there was decline in the rate of technical progress in the 1990s in Japan and this decline occurred in both manufacturing and non-manufacturing industries.

[16] Cabinet Office (2002) obtains results opposite to ours. Based on growth accounting at the 2-digit industry level, the study concluded that TFP growth in the manufacturing sector did not substantially decline in 1990s. Moreover, the sharp decline of TFP growth in the non-manufacturing sector contributed to the slowdown in macro TFP growth in the 1990s. Probably the following three factors are responsible for the difference between the results of the Cabinet Office study and ours.

4. Possible Structural Factors behind the Recent Change in Sectoral TFP Growth

What structural factors contributed to the recent change in the sectoral TFP growth pattern? In this subsection, we examine this issue by reviewing our recent researches on sectoral productivity.

4.1. Deregulation and the Acceleration of TFP Growth in the Non-manufacturing Sector

First, let us consider about the acceleration of TFP growth in the non-manufacturing sector. Probably the most important source of this change is deregulation. The following is a list of major deregulation policies implemented in the 1990s.[17]

Commerce: Revision of the Large Scale Retail Store Law (1992)

Telecommunication: Privatization of NTT (1985), introduction of the competition principles in all market areas (1985), liberalization of public-leased-public interconnections (1996), abolition of foreign capital regulations (excluding NTT and KDD), complete privatization of KDD (1998).

Finance and insurance: Approval of mail-order sales business of insurance products (1996), partial liberalization of brokerage commission in security trade (1998), initiation of over-the-counter

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First, the Cabinet Office study uses value added as a measure of output, whereas we used gross output. As Baily (1986) has shown, TFP growth based on gross output is usually different from TFP growth based on value added. Secondly, the Cabinet Office study takes account neither of changes in capacity utilization in non-manufacturing sectors nor of changes in the quality of labor. Thirdly, in order to evaluate each factor's contribution to output growth, the Cabinet Office study uses that factor's distribution share, whereas we used cost share. In the 1990s, the distribution share of labor was higher than the cost share of labor, and labor input in the manufacturing sectors declined more drastically than in non-manufacturing sectors. Because of this difference, the Cabinet Office study arrives at a higher TFP growth in the manufacturing sector than we do.

[17] This list is mainly based on Statistics and Research Bureau, Bank of Japan (1999) and Ministry of Foreign Affairs, Government of Japan (1999).

sales of investment trust funds by banks (1998).

Transportation: Change from the license system to the permission system and abolishment of requirement for fare revision permission in truck industry (1990), approval for individual assessment on fares cheaper than the average cost price in the taxi industry (1993), introduction of a flexible airline fare system (1996) and abolishment of double and triple tracking standards (1997) in domestic aviation.

Electric Utility: Relaxation of restrictions on electric power wholesaling (1995).

Employment placement: Expansion of occupations (mainly non-manufacturing occupations) to be covered by fee-charging employment placement agencies (1990, 1997).

These deregulations increased new entries, including M&A of Japanese firms by foreign firms, and more price competition in the non-manufacturing sector, where market competition was relatively limited compared with the manufacturing sector.[18]

Using the JIP Database, Nakanishi and Inui (2003) have tested whether Japan's deregulations have contributed to TFP growth. For this study they prepared a panel data set of a sectoral deregulation index for 68 industries and for every five-year period from 1970 onwards. This index is a frequency measure. A value of industry *i* and year *t* denotes the percentage of regulations abolished by year *t* in relation to the total number of regulations that existed in the starting year 1970.[19] The chronology of Japan's deregulation is taken from Sumitomo-Life Research Institute (1999) and Ministry of Public Management, Home Affairs, Posts and Telecommunications (2000). Table 4.1

[18] On this issue, see Sumitomo-Life Research Institute (1999) and Ministry of Foreign Affairs, Government of Japan (1999).

[19] In the case of industries where there was no regulation in 1970, the deregulation index is set to one.

shows their deregulation index at a relatively aggregated level. We can see that the manufacturing sector was not regulated even in 1970, whereas deregulation in non-manufacturing sector accelerated in 1990s. The increase in the deregulation index was particularly large - more than 20 percentage-points - in communication, wholesale and retail trade, and finance, insurance and retail from 1980 to 1998. This finding is consistent with our result of rapid TFP growth in these industries.

Insert Table 4.1.

The main results of Nakanishi and Inui's regression analysis are reported in Table 4.2. The dependent variable is each industry's TFP growth. As explanatory variables they used the deregulation index, the growth rate of R&D stock, the growth rate of IT stock, the spill-over effect of IT capital growth in other industries, the subsidiaries-production ratio, and a time trend. They pooled data of 68 industries for every five-year period from 1980 to 1998 and estimated a fixed effect model. They found that the increase in the deregulation index has a significant positive effect on that industry's TFP growth.

Insert Table 4.2.

We have seen that in the 1990s substantial deregulations were accomplished in the non-manufacturing industries, especially in communication, wholesale and retail trade, and finance, insurance and real estate, and this change seems to have contributed to the acceleration of TFP growth in these industries. But we should also note that compared with other developed countries Japan's TFP growth in the non-manufacturing sector is still quite low.

Table 4.3 compares the TFP growth rates during the 1990s in major service sectors in Japan, Australia and the U.S.[20] TFP growth rates in Australia are taken from McLachlan, Clark, and

[20] We should note that a rigorous international comparison of the TFP growth is very difficult, because of the difference in the calculation methods, the industrial classification, and the periods of estimation.

Monday (2002). TFP growth rates in the US are taken from Yoshikawa and Matsumoto (2001). In these studies value added is used as a measure of output. For this international comparison we calculated Japan's value added based TFP growth rate of the service industries from the JIP Database. Compared with Australia, Japan's TFP growth rate in the 1990s was lower in six out of nine industries. Compared with the US, Japan's TFP growth rate in the 1990s was lower in five out of eight industries. And in the case of average of service industries, Japan's TFP growth is still lower than that of the other countries.

Insert Table 4.3.

The most developed economies have experienced a shift in the production structure from manufacturing to services. Hence, in order to maintain the pace of TFP growth in the economy as a whole, an acceleration of TFP growth in the service industries is very important.

4.2. Decomposition Analysis of TFP Growth in the Manufacturing Sector.

Next let us consider the slowdown of TFP growth in the manufacturing sector.

As Baily, Hulten and Campbell (1992) and Foster, Haltiwagner and Krizan (1998) have shown in their productivity decomposition analysis, the start-up of productive establishments and the closure of unproductive establishments substantially contributed to US TFP growth. As Figure 4.1 shows, the start-up rate (number of newly opened establishments/number of all establishments) and the closure rate in Japan are about one half of the corresponding values for the US in the 1980s. Moreover, the gap has widened in 1990s. In particular, the start-up rate in Japan's manufacturing sector has declined to about 2% in recent years. Probably this factor has contributed to the slowdown in TFP growth in Japan's manufacturing sector.

Insert Figure 4.1

Using firm level data of the Ministry of International Trade and Industry's Kigyo Katsudo Kihon Chosa (Basic Survey on Business Activities by Enterprises), Fukao and Kwon (2003) studied this issue.[21] Adopting the methodology used by Baily, Hulten and Campbell (1992) and Forster, Haltiwanger and Krizan (1998), they decomposed the manufacturing sector's TFP growth of the 1994-98 period into the following five factors. [22]

Within effect: $\sum_{i \in s} \theta_{it-\tau} \Delta \ln TFP_{it}$,

Between effect: $\sum_{i \in s} \Delta\theta_{it} (\ln TFP_{it-\tau} - \overline{\ln TFP_{t-\tau}})$,

Covariance effect: $\sum_{i \in s} \Delta\theta_{it} \Delta \ln TFP_{it}$,

Entry effect: $\sum_{i \in N} \theta_{it} (\ln TFP_{it} - \overline{\ln TFP_{t-\tau}})$ and

Exit effect: $\sum_{i \in X} \theta_{it-\tau} (\overline{\ln TFP_{t-\tau}} - \ln TFP_{it-\tau})$,

where θ_{it} denotes firm i's sales share in year t. TFP_{it} denotes firm i's TFP level in year t.[23, 24] TFP_t with an upper bar denotes the industry average TFP level. N is the set of newly entered firms and X, the set of exited firms.

Fukao and Kwon's (2003) decomposition result is reported in Tables 4.4 and 4.5.[25] Following

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[21] Using the same micro-data Nisimura, Nakajima, and Kiyono (2003) studied the productivity of exiting firms and conducted a productivity decomposition based on the method used by Griliches and Regev (1995) and Aw, Chen, and Roberts (2001). They were the first to point out that the average TFP level of exiting firms is higher than that of staying firms in some industries.

[22] We should note that Fukao and Kwon's (2003) decomposition is based on firm level data whereas the preceding researches in the US are based on establishment level data.

[23] Because of the limitation of the data they could not take account of the change in labor quality in their TFP analysis. Probably because of this difference, their estimate of TFP growth is higher than our results in Sections 2 and 3. They also assume that working hours and the capacity utilization rate at each firm are identical with those of the industry average.

[24] They divide the manufacturing firm data into 58 sets of different industries and evaluated each firm's relative TFP level in relation to the industry average.

[25] Switch-in and switch-out effect in Table 4.4 and 4.5 denote contribution of the firms' which moved from one industry to another industry to the industry average of TFP level.

preceding studies, they conducted a decomposition for the upturn period (1994-96) and for the downturn period (1996-98) separately. Table 4.6 compares their results with those of preceding studies for the US and South Korea.

Insert Table 4.4, Table 4.5, and Table 4.6

Their major findings are as follows.

1. The exit effect of the whole manufacturing sector in 1996-98 was negative and substantially contributed to the decline in TFP growth in the manufacturing sector. The negative exit effect means that the average TFP level of exiting firms is higher than that of staying firms.
2. The entry effect was positive both in the upturn and the downturn period. But as a result of the low entry rate, the size of the entry effect was not large.
3. The redistribution effect - that is, the share effect plus the covariance effect - was positive but relatively small in comparison with the US.
4. the within effect, i.e. the effect of TFP growth within staying firms, was the largest factor among all the effects. And this effect changed pro-cyclically.

The above results seem to indicate that the promotion of new entries and making both the exit process and the reallocation process of resources more efficient are very important for an acceleration of TFP growth in Japan's manufacturing sector. These factors, moreover, are closely related with the allocation of funds through the financial system. Therefore, the problems in Japan's banking system are likely to have contributed to the slowdown of Japan's TFP growth and their solution forms an integral part of any attempt to raising the TFP growth rate.[26]

[26] Using regression analysis based on cross industry data, Fukao and Kwon (2003) found that there is a significant negative correlation between the exit effect and that industry's average liability-asset ratio. That is, in industries where the liability-asset ratio is high, the exit effect tends to be negative.

4. Conclusions

Using the newly compiled data, the Japan Industrial Productivity (JIP) Database, we analyzed Japan's sectoral TFP growth in recent years. Let us summarize our main results.

1. After taking account of the quality of labor and the capacity utilization rate we found the decline in TFP growth at the macro-level from the 1980s to the 1990s not to be so great. The decline in TFP growth from the 1983-91 period to the 1991-98 period is 0.20 percentage-points. Hayashi and Prescott (2002) seem to have overestimated the size of the TFP growth decline.
2. On the other hand, there was a substantial change in the pattern of sectoral TFP growth. The slowdown in TFP growth mainly occurred in the manufacturing sector. The manufacturing sector's contribution to macro-TFP growth declined from 0.74 percentage-points in 1983-91 to -0.03 percentage-points in 1991-98. In contrast, TFP growth in the non-manufacturing sectors accelerated during the 1990s. Non-manufacturing sectors' contribution to macro-TFP growth increased from -0.34 percentage-points in 1983-91 to 0.22 percentage-points in 1991-98.
3. In the 1990s, substantial deregulations were accomplished in non-manufacturing industries, especially in communication, wholesale and retail trade, and finance, insurance and real estate, and this change seems to have contributed to the acceleration of TFP growth in these industries. But we should also note that, compared with other developed countries, Japan's TFP growth in the non-manufacturing sector is still quite low.
4. Regarding the manufacturing sector in the 1990s, the following three factors seems to have contributed to the low level of TFP growth. First, new entries were very limited. Secondly, the exit effect was negative, that is, the average TFP level of exiting firms was higher than that of staying firms. Thirdly, the reallocation effect of resources was small.

Appendix A: Data Sources and Estimation Methods of the JIP Database

In this appendix we briefly explain how the JIP Database is compiled.

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 are 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, are compiled in terms of production activities. In order to make adjustments for this difference in 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 the distribution of each asset among sectors, which is available in 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 to a calendar year basis.

Estimation of the 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 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. 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 obtained annual capital formation data by industry or by capital goods. However, we do not have a 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.

Estimation of IT Capital Stock

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.[27]

In the National Accounts of Japan, only order-made software investment is estimated by making use of the Survey on Specified Service Industries. In countries like the US, the UK 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 US, the US and Australia.

Aggregate IT investment including software investment in Japan increased by 12.4% per annum from 1970 to 1998 (Figure 4-1), exceeding the average growth rate of total investment (3.2%). The ratio of IT investment to total investment increased from 2.8% in 1970 to 31.4% in 1998.

(Insert Figure A-1)

However, it did not increase uniformly like US IT investment. In the early 1990s, its growth stagnated. Probably the stagnation was caused by the following two factors. First, investment in tangible IT assets except computers and computer peripherals was strongly affected by business cycles. Second, investment in in-house software did not increase in the early 1990s, because

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[27] Recently, many researchers have focused on the effects of IT investment on productivity growth. In the US, 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 US. 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 Japan's economic growth using a sectoral database which is at a more aggregated level than the JIP Database.

Japanese firms have reduced costly in-house software and made an effort to increase outsourcing or utilize more standardized software since the bubble collapsed.

The IT capital stock also increased rapidly. In 1970, the IT capital stock at 1990 prices was only 5.6 trillion yen. In 1998, it reached 136 trillion yen. It grew at11.4.% per annum over this 28-year period. The real growth rate was similar to the nominal growth rate until 1990. However, the price fall in tangible IT capital goods contributed to the real growth of IT capital stock in the 1990s.

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

Data Description

Our measures of labor input in the JIP Database are constructed by combining the value estimates from the input-output table matrices and data from several labor force surveys. We constructed a detailed data set of the number of workers N_{ljt}, hours worked H_{ljt}, and the hourly wage W_{ljt} (l: 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 (15): 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-29, 70-74, 75-79, 80-84,85-.

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

Status (2): Employed, Self-employed.

Sectors (84): JIP classification.

Year: 1970-2000.

Estimation of N_{ljt}, H_{ljt}, and $W_{ljt.}$ Cross-Classified by Industry and Employment Status

First of all, we estimate the number of workers, hours worked and hourly wages cross-classified only by industry and employment status for each year. We combine several data sources such as the Population Census, Labor Force Survey, Manufacturing Census, Monthly Labor Survey, Basic Survey on Wage Structure and others. Those estimates are adjusted to equal the sum of workers and income for employee with the estimates of the input-output table and the System of National Accounts. The opportunity cost of self-employed and family workers should be estimated. There are several alternative methods. We estimate it based on the ratio of marginal productivity between self-employed and employed workers which is derived from fitted values of the production function.

Estimation of N_{kjt}, H_{kjt}, and $W_{kjt.}$ Cross-Classified by More Detailed Category of Workers

The next step is to disaggregate our previous estimates to more detailed types of workers (gender, age, educational attainment). The estimation of the number of workers is based mainly on the Population Census. However, Japan's census statistics do not report the detailed tables cross-classified. We estimates it from several related tables based on some assumptions.

The hours worked and hourly wages are estimated using the Basic Survey on Wage Structure and Monthly Labor Survey. These data are based mainly on the Monthly Labor Survey whose coverage is wider and more reliable. The Information of the Basic Survey on Wage Structure is used only as the difference ratios from average. We derived the wage rates of the self-employed from an estimation result of the production function.

Estimation of the Sectoral Labor Input

The final step of our estimation of labor input is to estimate the Divisia index of price, quantity and quality for each sector. The total annual man-hour input of category l workers in industry j at time t is defined as the product of the number of workers and the average annual hours per worker:

$$MH_{ljt} = N_{kjt} H_{kjt}$$

We define the growth of total real labor input in industry j at time t as a weighted average of the growth rates of man-hour input of all the categories.

$$d\ln L_{jt} = \sum_{l} \bar{v}^{L}{}_{ljt} d\ln MH_{ljt}$$

where $v^{L}{}_{ljt}$ with an upper bar denotes the average of the compensation shares of time t-1, $v^{L}{}_{ljt-1}$ and the compensation shares of time t, $v^{L}{}_{ljt}$. $v^{L}{}_{ljt}$ is defined by

$$v^{L}{}_{ljt} = \frac{w_{ljt} MH_{ljt}}{\sum_{l} w_{ljt} MH_{ljt}}$$

We made some adjustment on MH_{jt} and w_{ljt} so that the total cost over all categories of workers in each industry is equal to the total value of labor compensation in that industry as given by the Input-Output table of the JIP Database.

We may now define an index of "quality of sectoral labor input," or index of compositional change, as the ratio of labor input to working-hours:

$$d\ln Q_{jt} = d\ln L_{jt} - \ln MH_{jt}$$

where MH_{jt} is defined by

$$MH_{jt} = \sum_{l} N_{kjt} H_{kjt}$$

A rising Q_{jt} means that the percentage of the higher paid categories in the workforce has increased in industry j over time.

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

Data Sources

Every five years, the relatively reliable linked IO table is available. Therefore we chose the years 1970, 75, 80 85, 90, 95 and the final year 98 as our benchmark years. Major data sources for 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 Extended Input-Output Tables, Research and Statistics Department, Economic and Industry Policy Bureau, Ministry of Economy, Trade and Industry.

For other years we used METI's extended IO tables for every year.

Compilation Process

Among the above IO tables, there are some differences in the rule of compilation and concepts. We adjusted these differences. The lease industry's physical capital, which is rented to other industries, is treated as capital input in the lease industry. The cost of R&D in each sector is included in the production cost of that industry. The JIP Database is based on the 1968 SNA. Therefore, software investment is not included in investment. And depreciation of government capital is not included in the consumption expenditure of the government.

Next, we constructed converters to make adjustments for changes in industry classifications over time and aggregated the IO data into our 84 sectors.

We compiled 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.

The real values in linked IO tables are created by using price statistics such as the wholesale price index and the business service price index of the Bank of Japan in a way similar to the real values in the SNA statistics. Therefore, real values of output and intermediate input and implicit deflators in the JIP Database have basically similar characteristics as the corresponding SNA statistics of except for the treatment of the base year. Japan's long-term SNA statistics are based on a price vector of a single year. In the case of the JIP Database, real values and implicit deflators are created by linking real values of different base years.

A4. Estimation of the Supplementary Tables

In the JIP Database we have also estimated the following supplementary tables.

(1) Trade Statistics by Industry and by Trade Partner Country: 1980, 1985, 1990, 1995, and 2000.

Using the supplementary converter table of the *Input-Output Tables*, Management and Coordination Agency; we converted the trade statistics of the HS 9-digit level, which are available at <http://www. customs.go.jp>, into 302 manufacturing sectors, which are classified by economic activities. Using the *Linked Input-Output Tables*, Management and Coordination Agency, and wholesale price statistics of the Bank of Japan, we also calculated the trade statistics in constant 1990 prices.

(2) Inward and Outward Direct Investment and Service Trade Statistics by Industry

The data are based on Ito and Fukao (2003).

(3) Statistics on Japan's Industrial Structure: Advertisement-Sales Ratio, Land Input per Worker, Herfindahl Index, Top 4-Frim Concentration Rate, Share of Firms Belong to Vertical and Horizontal *Keiretsu* Firms, etc.

The data are based on Ito and Fukao (2003).

(4) Sectoral Capacity Utilization Rate

For manufacturing and mining industries after 1973, we used the *Index of Operating Ratio*, Ministry of Economy, Trade and Industry, which is available at < http://www.meti.go.jp/english/statistics>. For other industries before 1991 and manufacturing and mining industries before 1972, we employed the following estimation procedure. Following Burnside, Eichenbaum and Rebelo (1995) and Basu (1996), we assumed that the capacity utilization rate is closely correlated with the intermediate input-capital ratio. Following the "Wharton Method," we lineally linked peak values of the intermediate input-capital ratio in each boom period and treated these interpolated values as the intermediate input-capital ratio at full capacity. Further, we used the (actual intermediate input-capital ratio)/(intermediate input-capital ratio at full capacity) as our capacity utilization rate.

In the case of the period after 1991, the Japanese economy stayed in stagnation and many firms answered to *The Short-Term Economic Survey of Enterprises in Japan* (*Tankan*) of the Bank of Japan that they had excess capacity even at Japan's official business cycle peaks of May 1997 and October 2000.[28] It seems inappropriate to assume that the capacity utilization rate was close to one around these peaks. Therefore we did not adopt the Wharton-type method for the period from 1991. For the non-manufacturing and non-mining sectors in this period we estimated the capacity utilization rate using the Diffusion Index of Excess Capacity (Excess Capacity D.I.), which is reported in *The Short-Term Economic Survey of Enterprises in Japan* (*Tankan*), Bank of Japan.[29] We used the following procedures. First, we estimated a model in which METI's Index of Operating Ratio is the dependent variable and BOJ's Excess Capacity D.I., a time trend, and industry dummies are the explanatory variables, using seasonally adjusted quarterly panel data of 112 quarters and twelve manufacturing sectors for which both METI's Index of Operating Ratio and the BOJ's Excess Capacity D.I. are available. Secondly, we calculated a theoretical value of the capacity utilization rate for each non-manufacturing sector by substituting this sector's Excess Capacity D.I. in the estimated equation. Thirdly, we linked this theoretical value for the period of 1991-1998 with the capacity utilization rate for the period of 1970-91, which is derived by the Wharton-type method.[30]

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[28] Official peak dates are available in *Business Cycle Reference Dates*, Economic and Social Research Institute, Cabinet Office, Government of Japan (<http://www.esri.cao.go.jp/>).

[29] The data is available at < http://www.boj.or.jp.en/ >.

[30] In the case of agriculture, education, medical services, and other public services, the BOJ's excess capacity D.I. is not available. We adopted the Wharton-type method in the case of these industries even for the period after 1991.

(5) Sectoral R&D Stock and R&D Stock Cost Data

Data on sectoral R&D investment flows and a breakdown of investment costs are available in the *Survey of Research and Development*, Management and Coordination Agency. Using these data and price statistics, we estimated the sectoral R&D stock in 1990 prices and R&D stock cost by the perpetual inventory method. We used the sectoral R&D stock depreciation rate estimated by the Science and Technology Agency (1985).

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Table 2.2. Sources of Economic Growth: 1973-98

Table 2.2. Panel A. Growth Accounting without Adjustment of Capacity Utilization Rates: 1973-98

(annual rate, %)

	Growth rate of real GDP	Growth rate of working age population	Growth rate of (real GDP／working age population)	Growth rate of TFP	Contribution of the growth of (real capital/working age population)	Contribution of the growth of (labor input/working age population)		
						Subtotal	Contribution of the growth of (man-hour input/working age population)	Contribution of the improvement of labor quality
	a=c+b	b	c	d=c-e-f	e	f=g+h	g	h
1973-83	3.56%	0.88%	2.68%	-0.27%	1.83%	1.12%	0.46%	0.65%
1983-91	3.94%	0.84%	3.09%	0.54%	1.47%	1.08%	0.62%	0.46%
1991-98	1.25%	0.06%	1.19%	0.11%	0.96%	0.12%	-0.10%	0.21%

Working age population is defined as persons aged 15-64.

Table 2.2. Panel B. Growth Rates of Factor Inputs

(annual rate, %)

	Growth rate of (real capital/working age population)	Growth rate of (man-hour input/working age population)	Growth rate of labor quality index
1973-83	6.35%	0.65%	0.92%
1983-91	4.31%	0.95%	0.70%
1991-98	2.88%	-0.14%	0.32%

Table. 2.2 Sources of Economic Growth: US-Japan Comparison

Table 2.2 Panel A. The Result of Growth Accounting for the US Economy by Jorgenson et al (2002): 1973-2000 (Annual Rate, %)

	Real GDP Growth	Man-hour growth	Labor productivity (GDP/man-hour) growth	TFP growth	Contribution of labor quality growth	Contribution of capital sevices/man-hour growth		
						Sub-total	Contribution of IT capital	Contribution of non-IT capital
	a	b	c=a-b	d=c-e-f	e	f=g+h	g	h
1973-1995	2.78%	1.44%	1.33%	0.26%	0.27%	0.80%	0.37%	0.43%
1995-2000	4.07%	1.99%	2.07%	0.62%	0.21%	1.24%	0.87%	0.37%

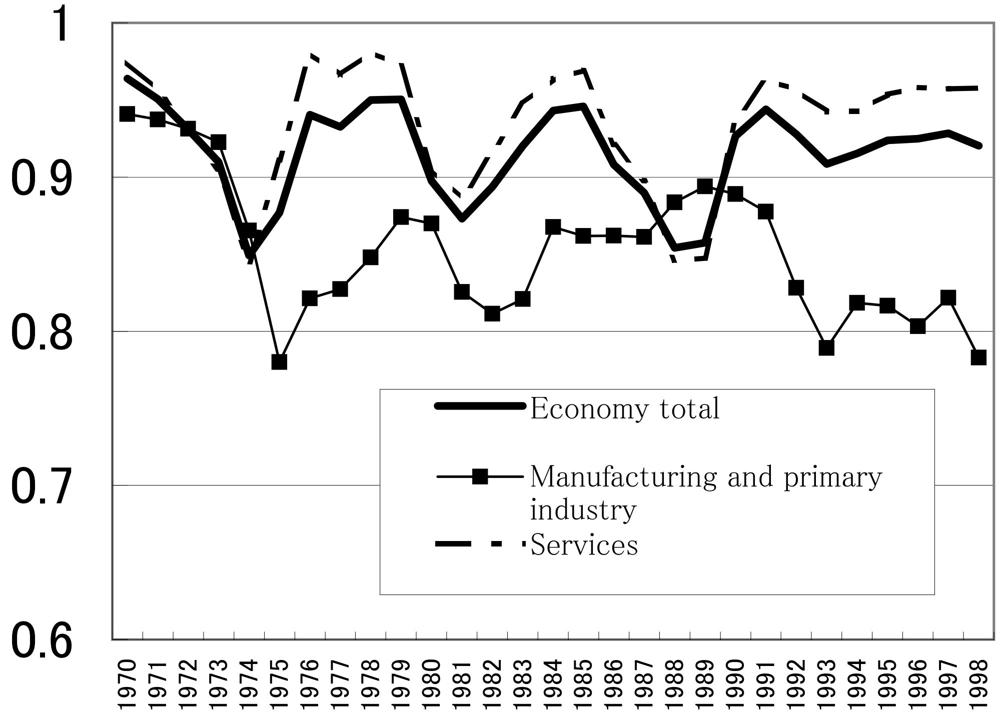
Jorgenson et al. (2002)

Table 2.2 Panel B. The Result of Growth Accounting for the Japanese Economy: 1973-1998 (annual rate, %)

	Real GDP Growth	Man-hour growth	Labor productivity (GDP/man-hour) growth	TFP growth	Contribution of labor quality growth	Contribution of capital services/man-hour growth		
						Sub-total	Contribution of IT capital	Contribution of non-IT capital
	a	b	c=a-b	d=c-e-f	e	f=g+h	g	h
1973-83	3.56%	1.53%	2.03%	-0.30%	0.65%	1.68%	0.16%	1.52%
1983-91	3.94%	1.79%	2.15%	0.40%	0.46%	1.29%	0.37%	0.92%
1991-98	1.25%	-0.08%	1.34%	0.03%	0.21%	1.10%	0.33%	0.76%
						1995-98	0.52%	0.63%

Calculated from JIP database.

Figure 2.1. Movement of Capacity Utilization Rate: 1970-98



Source: JIP Database

Table 2.3. Growth Accounting with Adjustment of Capacity Utilization: 1973–98

(annual rate, %)

	Growth rate of (real GDP／working age population)	Growth rate of TFP	Contribution of the growth of (real capital*capacity utilization rate/working age population)	Contribution of the growth of (labor input/working age population)
	a	b=a−c−d	c	d
1973–83	2.68%	−0.30%	1.87%	1.12%
1983–91	3.09%	0.43%	1.58%	1.08%
1991–98	1.19%	0.23%	0.84%	0.12%

Table 2.4. The Result of Growth Accounting by Hayashi and Prescott (2002): 1973-98

(annual rate, %)

	Growth rate of (real GNP／working age population)	Growth rate of TFP	Contribution of the growth of (real capital/working age population)	Contribution of the growth of (man-hour/working age population)
	a	b=a-c-d	c	d
1960-73	7.2%	4.1%	4.1%	-1.0%
1973-83	2.2%	0.5%	2.1%	-0.4%
1983-91	3.6%	2.4%	1.4%	-0.3%
1991-2000	0.5%	0.2%	1.1%	-0.8%

Working age population is defined as persons aged 20-69.

Table 3.2. Sources of Japan's TFP Growth by Industry: 1973-98 (annual rate, %)

JIP Industry Code	JIP industry name	Industry name (two digit classification)	TFP Growth			Industry contributions to macro TFP growth		
			a			(Domar weight)*a		
			1973-83	1983-91	1991－98	1973-83	1983-91	1991－98
1	Rice, wheat production	Agriculture, forestry, and fishery	-3.570%	-1.418%	-3.034%	-0.070%	-0.020%	-0.020%
2	Other cultivation and seed planting	Agriculture, forestry, and fishery	0.865%	-2.267%	-0.122%	0.016%	-0.034%	-0.001%
3	Livestock, poultry	Agriculture, forestry, and fishery	2.066%	1.830%	0.821%	0.030%	0.019%	0.007%
4	Veterinary, farming services	Agriculture, forestry, and fishery	-1.974%	-0.497%	-1.821%	-0.004%	-0.001%	-0.002%
5	Forestry	Agriculture, forestry, and fishery	-0.422%	-0.931%	2.769%	-0.008%	-0.004%	0.009%
6	Marine products	Agriculture, forestry, and fishery	0.728%	0.136%	0.379%	0.006%	-0.001%	0.003%
7	Coal, lignite mining	Mining	-5.699%	-1.211%	-3.425%	-0.009%	-0.002%	-0.001%
8	Metal mining	Mining	-0.489%	7.249%	-9.659%	0.000%	0.002%	0.000%
9	Crude oil, natural gas exploration	Mining	-6.924%	4.206%	-4.385%	-0.003%	0.001%	-0.001%
10	Quarry, gravel extraction, other mining	Mining	1.896%	0.116%	0.046%	0.015%	0.000%	0.000%
11	Livestock products	Food processing	-0.452%	0.142%	0.112%	-0.009%	0.000%	0.001%
12	Processed marine products	Food processing	3.407%	-4.024%	0.014%	0.040%	-0.061%	0.000%
13	Rice polishing, flour milling	Food processing	-1.075%	-2.787%	1.073%	-0.022%	-0.028%	0.011%
14	Other foods	Food processing	0.090%	0.005%	-0.356%	0.009%	-0.005%	-0.011%
15	Beverages	Food processing	-0.503%	-0.012%	-0.113%	-0.007%	-0.002%	-0.001%
16	Tobacco	Food processing	0.905%	6.678%	-6.131%	0.003%	0.021%	-0.019%
17	Silk	Textile, apparel and leather products	3.053%	0.106%	0.084%	0.024%	0.000%	0.000%
18	Spinning	Textile, apparel and leather products	1.638%	0.782%	-1.529%	0.004%	0.001%	-0.001%
19	Fabrics and other textile products	Textile, apparel and leather products	0.732%	-1.267%	-0.286%	0.016%	-0.024%	-0.003%
20	Apparel and accessories	Textile, apparel and leather products	-2.083%	2.339%	-0.439%	-0.053%	0.043%	-0.007%
21	Lumber and wood products	Wood, paper and printing	4.068%	-0.865%	-0.047%	0.114%	-0.010%	0.000%
22	Furniture	Wood, paper and printing	1.123%	-0.135%	-0.855%	0.014%	-0.001%	-0.008%
23	Pulp, paper, paper products	Wood, paper and printing	0.362%	0.505%	0.253%	0.009%	0.013%	0.005%
24	Publishing and printing	Wood, paper and printing	0.685%	-0.819%	-0.537%	0.020%	-0.022%	-0.013%
25	Leather and leather products	Textile, apparel and leather products	0.685%	0.766%	-0.154%	0.002%	0.003%	-0.001%
26	Rubber products	Chemicals	0.137%	2.856%	-1.582%	0.001%	0.025%	-0.012%
27	Basic chemicals	Chemicals	0.447%	1.023%	0.874%	0.017%	0.035%	0.024%
28	Chemical fibers	Chemicals	3.343%	0.250%	-0.106%	0.014%	0.000%	0.000%
29	Other chemicals	Chemicals	1.972%	2.256%	0.256%	0.063%	0.071%	0.008%
30	Petroleum products	Petroleum and coal products	-0.053%	2.061%	-1.326%	0.021%	0.039%	-0.012%
31	Coal products	Petroleum and coal products	0.494%	0.707%	-1.351%	0.009%	0.003%	-0.003%
32	Stone, clay & glass products	Other manufacturing	0.239%	0.577%	0.689%	0.004%	0.015%	0.015%
33	Steel manufacturing	Metal	-0.368%	2.926%	0.548%	-0.001%	0.061%	0.005%
34	Other steel	Metal	-1.133%	0.437%	-0.299%	-0.116%	0.019%	-0.010%
35	Non-ferrous metals	Metal	0.834%	0.643%	1.201%	0.014%	0.017%	0.017%
36	Metal products	Metal	1.068%	-0.844%	-0.222%	0.030%	-0.032%	-0.006%
37	General machinery equipment	General and precision machinery	1.767%	0.778%	-0.897%	0.167%	0.075%	-0.081%
38	Electrical machinery	Electronic and electric equipment	0.091%	-0.229%	0.190%	0.000%	-0.003%	0.001%
39	Equipment and supplies for household us	Electronic and electric equipment	1.730%	3.235%	-0.334%	0.070%	0.132%	-0.014%
40	Other electrical machinery	Electronic and electric equipment	3.079%	4.427%	1.714%	0.105%	0.304%	0.130%
41	Motor vehicles	Transportation equipment	0.624%	0.104%	-0.170%	0.052%	0.009%	-0.013%
42	Ships	Transportation equipment	0.481%	1.828%	-2.512%	0.018%	0.018%	-0.007%
43	Other transportation equipment	Transportation equipment	0.637%	-0.538%	-0.785%	0.008%	-0.005%	-0.006%
44	Precision machinery & equipment	General and precision machinery	1.788%	1.787%	-0.195%	0.024%	0.021%	-0.004%
45	Other manufacturing	Other manufacturing	-0.095%	0.273%	-0.302%	-0.009%	0.010%	-0.011%
46	Construction	Construction and civil engineering	-1.691%	0.899%	-1.999%	-0.248%	0.110%	-0.221%
47	Civil engineering	Construction and civil engineering	0.048%	0.885%	-0.814%	0.013%	0.061%	-0.067%
48	Electricity	Electric, gas, and water supply	-1.824%	1.399%	-0.136%	-0.060%	0.041%	-0.003%
49	Gas, heat supply	Electric, gas, and water supply	-0.619%	2.706%	0.991%	-0.002%	0.012%	0.005%
50	Waterworks	Electric, gas, and water supply	-1.329%	0.719%	-1.841%	-0.010%	0.003%	-0.011%
51	Water supply for industrial use	Electric, gas, and water supply	-1.346%	-0.209%	-1.850%	0.000%	0.000%	-0.001%
52	Waste disposal	Electric, gas, and water supply	-9.904%	0.178%	-4.630%	-0.038%	0.003%	-0.019%
53	Wholesale	Wholesale and retail	3.091%	-3.450%	3.137%	0.360%	-0.426%	0.390%
54	Retail	Wholesale and retail	-1.737%	-0.147%	0.069%	-0.169%	-0.028%	0.007%
55	Finance	Finance, insurance, and real estate	-0.684%	3.129%	0.015%	-0.026%	0.173%	0.000%
56	Insurance	Finance, insurance, and real estate	3.123%	2.361%	3.574%	0.054%	0.055%	0.065%
57	Real estate	Finance, insurance, and real estate	-3.923%	-4.634%	-0.472%	-0.120%	-0.155%	-0.017%
58	Housing	Imputed housing rent	-3.621%	0.434%	1.559%	-0.260%	0.031%	0.139%
59	Railway	Transport	-0.137%	-0.134%	-4.035%	-0.008%	-0.006%	-0.055%
60	Road transportation	Transport	-0.382%	-0.633%	-1.631%	-0.015%	-0.027%	-0.068%
61	Water transportation	Transport	-2.079%	-1.198%	-1.125%	-0.057%	-0.013%	-0.014%
62	Air transportation	Transport	-2.257%	1.112%	1.804%	-0.010%	0.007%	0.010%
63	Other transportation, packing	Transport	0.260%	-0.882%	-2.003%	0.001%	-0.010%	-0.019%
64	Telegraph, telephone	Communication and broadcasting	-0.723%	3.465%	6.481%	-0.016%	0.062%	0.137%
65	Mail	Communication and broadcasting	-5.717%	5.370%	-2.653%	-0.021%	0.021%	-0.011%
66	Education (private, non-profit)	Public services, general government, a	-1.480%	1.146%	1.570%	-0.014%	0.014%	0.021%
67	Research	Public services, general government, a	3.861%	2.027%	3.762%	0.006%	0.005%	0.010%
68	Medical, hygiene (private)	Public services, general government, a	3.004%	-1.565%	-1.851%	0.099%	-0.060%	-0.074%
69	Other public services	Public services, general government, a	-2.582%	0.711%	-0.598%	-0.020%	-0.013%	-0.002%
70	Advertising	Business services	3.001%	0.783%	-2.361%	0.029%	0.011%	-0.030%
71	Rental of office equipment and goods	Business services	2.080%	-11.249%	1.367%	0.023%	-0.183%	0.035%
72	Other services for businesses	Business services	-4.500%	3.091%	-0.390%	-0.175%	0.169%	-0.031%
73	Entertainment	Private services	-2.826%	-1.170%	-1.681%	-0.061%	-0.036%	-0.045%
74	Broadcasting	Communication and broadcasting	-0.126%	-2.800%	0.284%	-0.002%	-0.014%	0.001%
75	Restaurants	Private services	0.197%	-0.675%	1.136%	0.010%	-0.033%	0.057%
76	Inns	Private services	-0.542%	-2.686%	1.992%	-0.008%	-0.038%	0.027%
77	Laundry, hair-cutting , public bath	Private services	-3.787%	2.719%	-0.489%	-0.036%	0.031%	-0.005%
78	Other services for individuals	Private services	-1.658%	4.421%	-0.733%	-0.015%	0.047%	-0.009%
79	Education (public)	Public services, general government, a	-3.205%	1.076%	-0.255%	-0.119%	0.040%	-0.010%
80	Medical, hygiene (public)	Public services, general government, a	2.197%	-1.891%	-0.156%	0.025%	-0.022%	-0.006%
81	Public administration	Public services, general government, a	-1.000%	-1.574%	0.440%	-0.073%	-0.107%	0.034%
82	Medical, hygiene (non-profit)	Public services, general government, a	2.179%	-0.652%	-1.156%	0.017%	-0.007%	-0.016%
83	Others (non-profit)	Public services, general government, a	0.911%	-1.449%	2.314%	0.010%	-0.018%	0.031%
84	Activities not elsewhere classified	Public services, general government, a	n.a.	n.a.	n.a.	0.000%	0.000%	0.000%
	Manufacturing subtotal	Manufacturing subtotal				0.655%	0.743%	-0.028%
	Total	Total				-0.307%	0.403%	0.197%

Figure 3.1. Industry Contributions to Aggregate TFP Growth

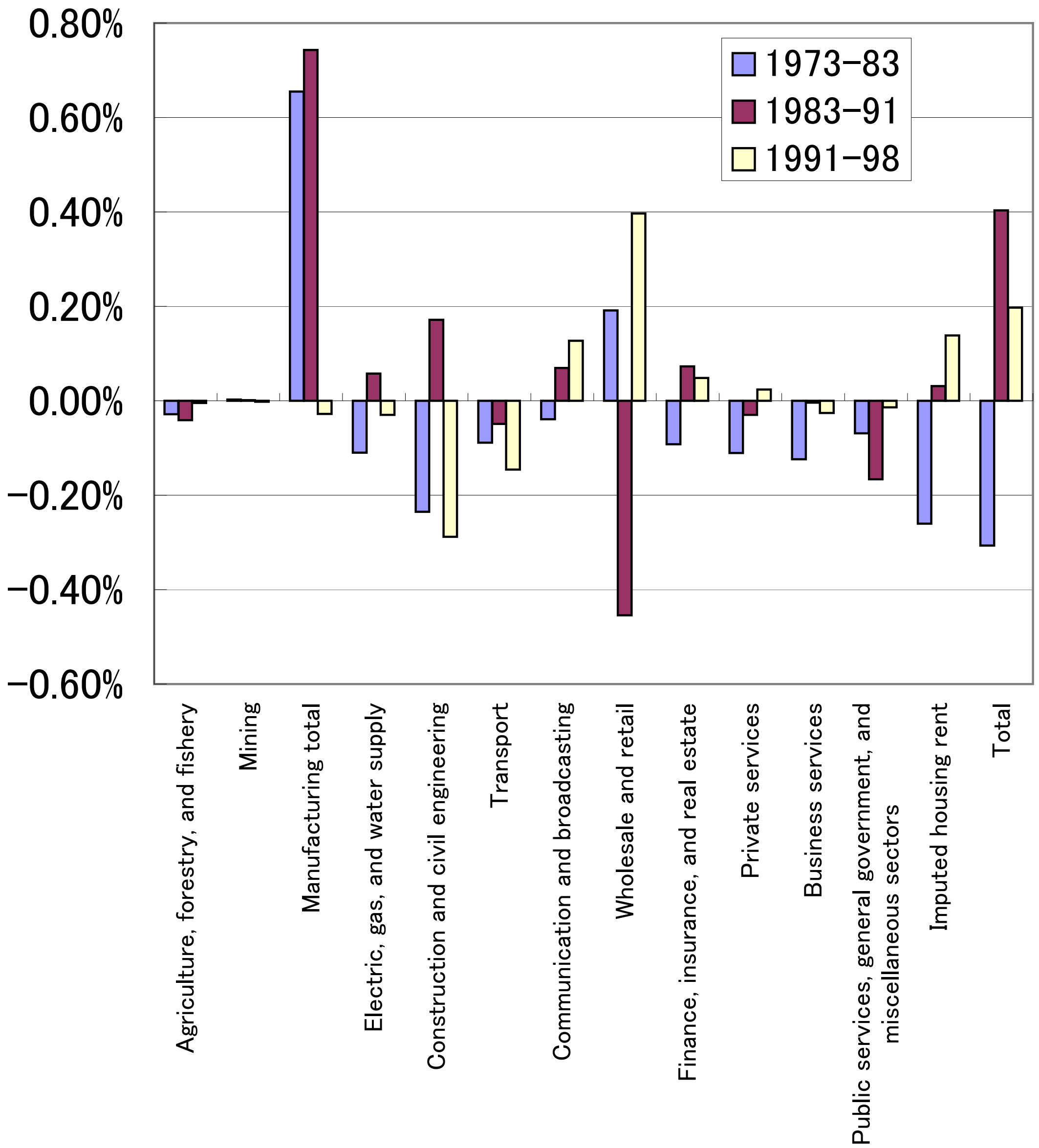


Figure 3.2. Industry Contributions to Aggregate TFP Growth: Manufacturing Industry

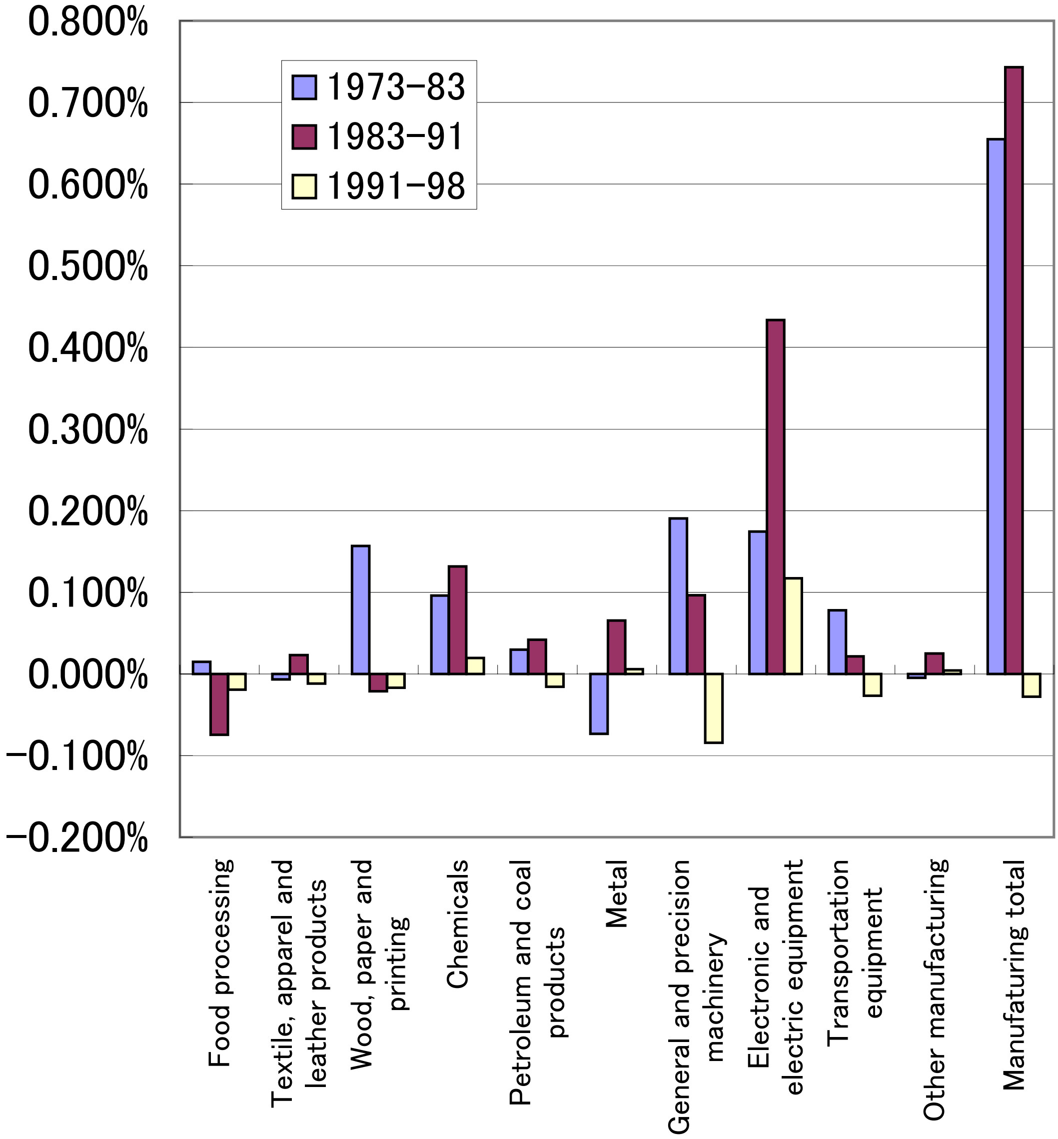


Table 4.1. Nakanishi and Inui's (2003) Frequency Measure of Deregulation: 1970, 1980, 1990 and 1998

	1970	1980	1990	1998
Manufacturing	0.811	0.811	0.785	0.765
Electricity, gas and water supply	0.340	0.345	0.341	0.426
Construction	0.667	0.667	0.750	0.750
Transport	0.315	0.329	0.343	0.453
Communication	0.503	0.495	0.735	0.795
Wholesale and retail trade	0.251	0.331	0.397	0.540
Finance, insurance and real estate	0.301	0.341	0.500	0.635
Other services	0.560	0.571	0.588	0.599

Source: Nakanishi and Inui (2003).

Table 4.2. Nakanishi and Inui's (2003) Result on Determinants of Sectoral TFP Growth

Dependant variable: Sectoral TFP growth		
Fixed effect model		
Explanatory variables	Coefficients	t-statistics
Growth rate of deregulation index	0.071	2.314
Growth rate of own R&D stock	0.010	1.506
Growth rate of IT capital	-0.002	-0.199
Spillover effect of the growth of IT capital in other industries	0.000	0.000
Subsidiaries paid by the government/production of that industry	0.001	0.972
Time trend	-0.001	-2.499
Number of Observations: 340 Adjusted R-squared: 0.080		

Source: Nakanishi and Inui (2003).

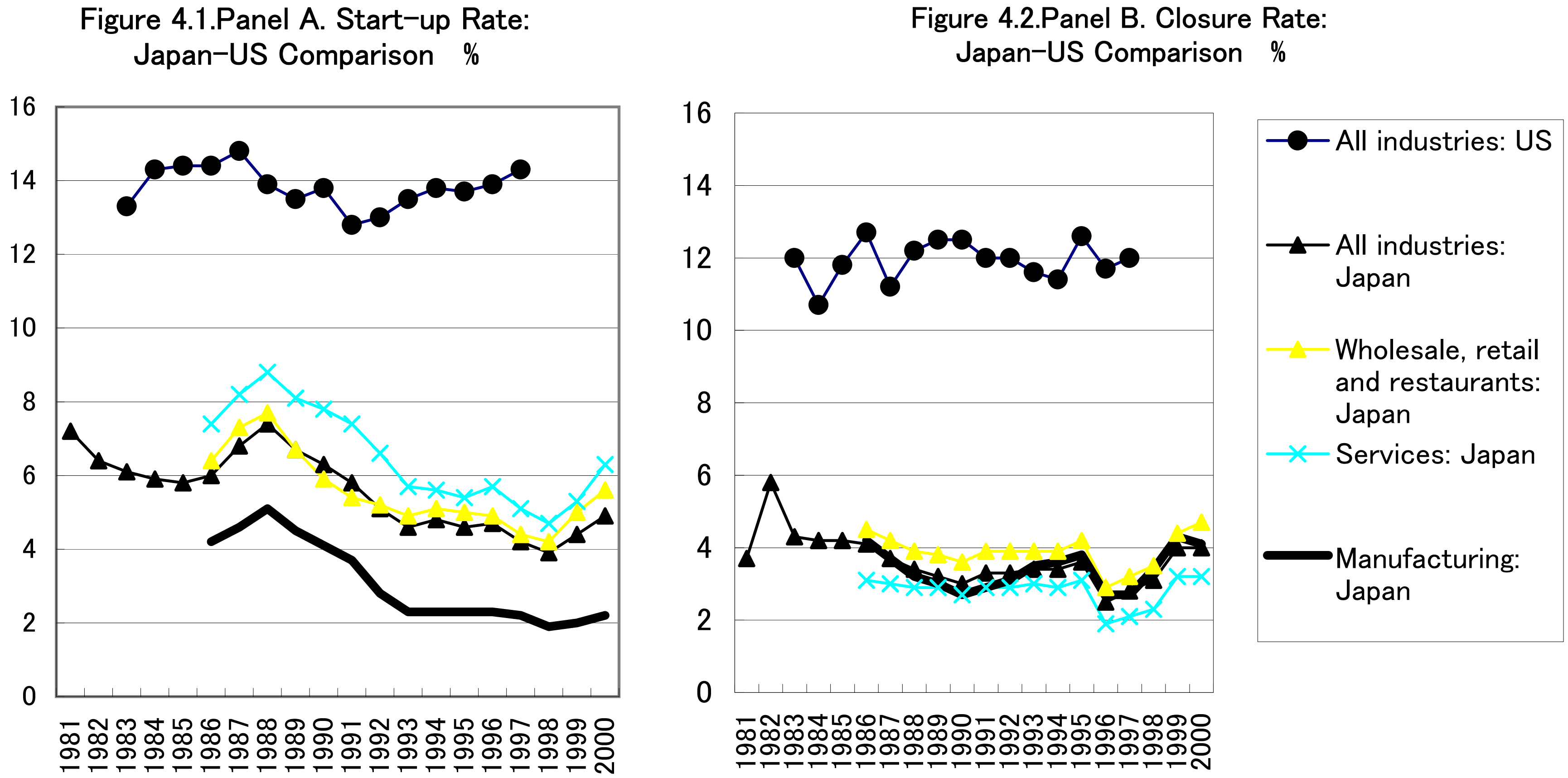
Table 4.3. International Comparison of (Value Added Based) TFP Growth

(annual rate, %)

	Australia 1993-2000	US 1990～1999	Japan 1990～1998
Source	McLachlan, Clark, and Monday (2002)	Yoshikawa and Matsumoto (2001)	JIP Database
Electricity, gas and water	1.6	1.0	-0.1
Construction	1.1	-0.7	-3.8
Wholesale	5.2	3.6	5.1
Retail	1.1	2.0	0.4
Restaurants	0.3	n.a.	1.6
Transportation	1.8	2.3	-3.0
Communication	4.0	2.4	6.0
Finance and insurance	1.2	1.5	1.8
Entertainment	-3.7	0.5	-4.5
Service sector average	2.2	1.8	0.9

Note: The average value of the TFP growth rate in the service sector is the weighted average of the industries' TFP growth rates in the table. Each industry's value added in Japan is used as a weight.

Figure 4.1 Start-up and Closure Rate of Establishments: Japan-US Comparison



Both the US and the Japanese data are based on statistics of employment insurance program.
Sources: Small Business Administration, US Government (1998), Small and Medium Enterprise Agency, Ministry of Industry, Trade and Industry, Japanese Government (2001), and Study Group on "Industry Hollowing-out" and Tariff Policy, Ministry of Finance, Jap

Table 4.4. Decomposition of Sectoral TFP Growth: Upturn Period, 1994-96 **(Growth in Two Years)**

Industry	Within effect	Between effect	Covariance effect	Total effect among stayers	Entry effect	Exit effect	Switch-in effect	Switch-out effect	Net-entry effect	Industry total
	a	b	c	d=a+b+c	e	f	g	h	i=e+f+g+h	j=d+i
Livestock products	-0.006	-0.002	0.001	-0.007	-0.003	-0.001	-0.001	0.003	-0.002	-0.010
Seafood processing	0.011	0.002	0.001	0.014	0.010	-0.007	0.009	0.002	0.014	0.028
Manufacture of Flour and grain mills products	0.030	0.003	-0.004	0.030	0.010	-0.013	-0.001	0.000	-0.003	0.027
Manufacture of miscellaneous food and related products	0.098	0.002	-0.012	0.088	0.014	-0.001	0.002	-0.003	0.013	0.100
Soft drinks, carbonated water, alcoholic beverages, tea and tabacco	0.003	0.001	0.000	0.004	0.001	-0.003	0.000	0.000	-0.001	0.003
Prepared animal foods and organic fertilizers	-0.049	-0.003	0.003	-0.049	-0.009	-0.001	-0.007	0.004	-0.013	-0.062
Silk reeling plants and spinning mills	-0.071	0.008	0.007	-0.056	-0.026	0.001	0.012	-0.013	-0.026	-0.081
Woven fablic and knitting mills	0.060	-0.003	0.009	0.066	0.009	-0.015	0.007	0.004	0.004	0.070
Dyed and finished textiles	-0.190	-0.001	0.001	-0.189	-0.027	0.009	-0.003	-0.010	-0.031	-0.220
Miscellaneous textile mill products	0.072	-0.001	0.005	0.075	0.022	0.004	0.017	-0.004	0.039	0.114
Apparel	0.041	0.000	-0.004	0.037	0.042	-0.002	0.000	0.002	0.042	0.079
Manufacture of miscellaneous textile apparel and accessories	0.066	-0.005	0.000	0.061	0.024	-0.012	0.027	-0.004	0.035	0.096
Sawing, planning mills and plywood products	0.010	0.010	0.021	0.042	0.000	0.005	0.000	0.000	0.005	0.047
Miscellaneous manufacture of wood products	0.023	0.006	0.004	0.033	0.023	-0.014	0.047	0.043	0.099	0.133
Manufacture of furniture and fixture	0.146	-0.001	0.005	0.150	0.047	0.000	0.002	-0.004	0.045	0.196
Pulp and paper	0.016	0.001	0.000	0.017	0.003	-0.003	0.003	-0.001	0.002	0.018
Coated and glazed paper	0.032	-0.005	0.020	0.047	0.011	0.007	-0.002	0.002	0.018	0.065
Newspaper industries	0.021	-0.002	0.005	0.024	0.010	-0.001	0.002	0.001	0.012	0.036
Publishing industries	0.031	-0.002	0.002	0.032	0.005	0.000	0.002	0.002	0.008	0.040
Publishing and allied industries	0.043	-0.008	-0.001	0.034	0.013	0.003	0.001	0.001	0.018	0.052
Industrial inorganic chemicals	0.059	-0.002	0.009	0.066	0.021	0.005	0.016	-0.007	0.034	0.100
Industrial organic chemicals	0.023	0.001	-0.002	0.022	0.017	0.000	0.000	0.003	0.020	0.042
Chemical fiber	-0.001	0.000	0.000	-0.001	-0.004	0.006	-0.003	0.000	0.000	-0.001
Oil and fat products, soaps, synthetic detergents, surface-active ag	-0.015	0.003	0.005	-0.008	-0.008	-0.006	-0.001	0.002	-0.012	-0.020
Drugs and medicines	0.055	0.000	0.000	0.055	0.017	-0.007	0.001	0.000	0.011	0.066
Miscellaneous chemical and allied products	-0.061	-0.006	0.004	-0.063	-0.006	0.010	-0.009	0.002	-0.003	-0.066
Petroleum refining	0.004	0.000	0.000	0.004	0.000	-0.002	0.000	0.000	-0.003	0.002
Miscellaneous chemical and allied products	0.101	0.017	-0.054	0.064	0.000	-0.058	0.008	0.009	-0.041	0.023
Manufacture of plastic products	0.025	0.000	0.004	0.029	0.010	0.002	0.001	-0.003	0.010	0.038
Tires and inner tubes	-0.001	-0.001	0.000	-0.001	0.000	0.010	-0.001	-0.001	0.008	0.007
Miscellaneous rubber products	0.006	-0.004	0.002	0.005	-0.004	-0.003	-0.002	0.000	-0.008	-0.004
Manufactrure of leather tanning, leather products and fur skins	0.104	-0.006	0.044	0.142	0.056	0.003	0.000	-0.008	0.051	0.193
Glass and its products	0.009	0.001	0.005	0.016	-0.003	-0.003	0.000	0.002	-0.004	0.012
Cement and its products	0.017	-0.004	0.005	0.018	0.009	-0.004	0.005	-0.001	0.009	0.027
Miscellaneous ceramic, stone and clay products	0.036	-0.002	-0.002	0.031	0.002	0.003	0.000	0.000	0.006	0.037
Pig iron and steel	0.012	-0.001	0.000	0.012	0.002	0.000	0.000	-0.004	-0.002	0.010
Miscellaneous iron and steel	0.055	-0.008	0.015	0.062	0.010	-0.001	0.009	0.005	0.023	0.085
Smelting and refining of non-ferrous metals	0.027	-0.008	-0.001	0.018	0.003	0.004	0.003	-0.003	0.006	0.025
Miscellaneous non-ferrous processing metal products	0.042	-0.001	0.010	0.051	0.013	-0.002	0.005	0.002	0.018	0.069
Fabricated constructional and architedtural metal products	0.036	-0.001	0.000	0.035	0.008	-0.003	0.007	-0.006	0.006	0.042
Miscellaneous fabricated metal products	0.027	-0.002	0.003	0.028	0.004	-0.004	0.015	0.002	0.018	0.046
Metal working machinery	0.145	-0.023	0.028	0.151	0.028	0.008	0.032	-0.037	0.031	0.182
Special industry machinery	0.036	-0.001	0.001	0.036	0.004	-0.001	0.013	0.000	0.015	0.051
Office, service industry and household machines	0.018	0.001	0.002	0.021	0.008	0.006	0.002	-0.006	0.009	0.030
Miscellaneous machinery and machine parts	0.023	-0.002	0.003	0.023	0.009	-0.001	0.004	0.001	0.013	0.037
Industrial electric apparatuses	0.006	-0.003	0.002	0.005	0.000	0.003	-0.002	-0.001	0.000	0.005
Household electric appliances	0.012	0.005	0.016	0.033	0.005	-0.001	0.004	0.009	0.017	0.050
Communication equipment and related products	-0.001	0.000	0.005	0.003	0.000	-0.003	0.002	0.002	0.002	0.005
Electronic data processing machines and electronic equipment	0.005	0.001	-0.001	0.005	0.001	0.003	-0.001	-0.001	0.002	0.007
Electronic communication equipment and related products	0.076	0.000	0.002	0.078	0.010	0.002	0.015	0.001	0.027	0.106
Miscellaneous electrical machinery equipment and supplies	-0.025	0.002	0.004	-0.018	-0.006	-0.002	-0.010	0.006	-0.012	-0.030
Motor vehicles, parts and accessories	0.007	-0.001	0.002	0.008	0.000	0.000	0.000	0.000	-0.001	0.007
Miscellaneous transportation equipment	0.011	-0.001	0.006	0.016	-0.005	0.000	0.002	-0.002	-0.005	0.012
Medical instruments and apparatuses	0.068	-0.004	0.008	0.072	0.034	0.007	0.006	-0.008	0.039	0.111
Optical instruments and lenses	0.046	-0.016	0.016	0.046	0.010	-0.033	-0.006	-0.004	-0.033	0.013
Watches, clocks, clockwork-operated devices and parts	-0.048	0.008	-0.017	-0.057	-0.006	0.012	-0.007	0.000	-0.001	-0.058
Miscellaneous precision instrument	0.073	-0.006	0.001	0.068	0.026	-0.002	0.004	-0.001	0.027	0.095
Miscellaneous manufacturing industries	0.007	-0.002	0.000	0.005	0.009	0.004	0.014	0.013	0.040	0.045
Weighted average of all the industries	0.029	-0.001	0.003	0.030	0.008	-0.002	0.006	0.002	0.014	0.044
Share of each facor in industry's TFP growth	0.65	-0.03	0.06	0.68	0.17	-0.04	0.14	0.04	0.32	1.00

Table 4.5. Decomposition of Sectoral TFP Growth: Downturn Period, 1996-98 **(Growth in Two Years)**

Industry	Within effect	Between effect	Covariance effect	Total effect among stayers	Entry effect	Exit effect	Switch-in effect	Switch-out effect	Net-entry effect	Industry total
	a	b	c	d=a+b+c	e	f	g	h	i=e+f+g+h	j=d+i
Livestock products	-0.008	-0.002	0.001	-0.008	-0.006	0.001	-0.002	0.002	-0.005	-0.014
Seafood processing	0.016	-0.004	0.005	0.017	0.013	-0.009	0.000	-0.003	0.001	0.018
Manufacture of Flour and grain mills products	0.032	0.003	0.000	0.035	0.051	-0.006	0.000	0.001	0.045	0.080
Manufacture of miscellaneous food and related products	0.000	0.001	0.003	0.004	0.009	-0.004	0.002	-0.001	0.007	0.011
Soft drinks, carbonated water, alcoholic beverages, tea and taba	-0.001	0.000	0.000	-0.001	-0.001	0.001	-0.001	0.000	-0.001	-0.001
Prepared animal foods and organic fertilizers	-0.013	-0.003	0.002	-0.013	-0.006	0.003	-0.004	0.005	-0.002	-0.015
Silk reeling plants and spinning mills	-0.040	0.003	0.013	-0.024	-0.015	0.027	0.032	-0.002	0.042	0.017
Woven fablic and knitting mills	-0.033	-0.002	0.003	-0.032	0.000	0.000	0.002	-0.005	-0.004	-0.036
Dyed and finished textiles	-0.002	-0.002	0.019	0.015	-0.002	-0.019	0.000	0.004	-0.017	-0.003
Miscellaneous textile mill products	-0.057	-0.001	0.011	-0.047	-0.026	-0.002	-0.008	-0.003	-0.039	-0.086
Apparel	-0.033	0.007	-0.007	-0.034	0.006	-0.015	-0.001	-0.002	-0.012	-0.046
Manufacture of miscellaneous textile apparel and accessories	-0.059	0.000	-0.007	-0.065	-0.013	0.001	0.008	0.006	0.001	-0.064
Sawing, planning mills and plywood products	-0.069	0.001	0.007	-0.061	-0.023	0.008	-0.013	-0.003	-0.031	-0.092
Miscellaneous manufacture of wood products	-0.015	-0.016	0.004	-0.027	-0.027	-0.015	-0.014	0.008	-0.049	-0.076
Manufacture of furniture and fixture	-0.049	-0.001	0.007	-0.043	-0.024	-0.006	-0.004	0.002	-0.032	-0.075
Pulp and paper	0.000	0.001	0.002	0.003	-0.004	0.004	0.003	-0.003	0.000	0.003
Coated and glazed paper	-0.021	-0.003	0.005	-0.019	-0.015	0.006	0.000	-0.001	-0.010	-0.029
Newspaper industries	-0.030	-0.001	0.003	-0.028	0.009	-0.005	-0.002	0.000	0.002	-0.026
Publishing industries	-0.026	-0.004	0.003	-0.026	0.000	-0.001	0.000	0.001	0.000	-0.026
Publishing and allied industries	-0.019	-0.001	0.003	-0.016	0.007	-0.001	-0.001	-0.001	0.004	-0.012
Industrial inorganic chemicals	0.036	0.003	0.004	0.043	0.004	0.002	0.003	-0.004	0.004	0.047
Industrial organic chemicals	0.012	-0.001	0.001	0.013	0.010	-0.009	0.003	-0.001	0.003	0.016
Chemical fiber	0.000	-0.002	0.000	-0.002	0.000	0.000	-0.003	0.003	0.000	-0.002
Oil and fat products, soaps, synthetic detergents, surface-active	-0.008	0.001	0.003	-0.005	0.001	0.000	-0.001	-0.001	0.000	-0.005
Drugs and medicines	0.005	0.000	0.001	0.006	0.002	-0.013	0.001	0.000	-0.010	-0.004
Miscellaneous chemical and allied products	0.004	-0.001	0.007	0.010	0.002	0.009	0.001	0.007	0.018	0.028
Petroleum refining	0.001	-0.002	0.003	0.003	0.002	0.000	0.000	0.000	0.002	0.004
Miscellaneous chemical and allied products	0.015	-0.003	0.003	0.016	0.008	-0.002	0.006	0.008	0.019	0.035
Manufacture of plastic products	-0.038	-0.002	0.005	-0.036	0.000	-0.001	-0.003	0.001	-0.003	-0.039
Tires and inner tubes	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001
Miscellaneous rubber products	-0.048	0.002	-0.003	-0.048	-0.003	0.007	-0.001	0.003	0.006	-0.042
Manufactrure of leather tanning, leather products and fur skins	-0.072	-0.006	0.011	-0.067	-0.016	-0.004	0.001	-0.001	-0.021	-0.088
Glass and its products	-0.011	0.002	0.005	-0.004	0.001	0.003	0.001	0.003	0.008	0.004
Cement and its products	0.011	-0.006	0.007	0.012	0.009	-0.013	-0.003	-0.001	-0.008	0.004
Miscellaneous ceramic, stone and clay products	0.013	0.003	0.012	0.029	0.013	-0.005	0.006	0.005	0.018	0.047
Pig iron and steel	-0.003	0.000	0.002	-0.001	0.004	-0.003	0.001	-0.001	0.001	0.000
Miscellaneous iron and steel	-0.034	0.002	0.000	-0.033	-0.006	-0.002	-0.007	0.002	-0.013	-0.046
Smelting and refining of non-ferrous metals	-0.008	0.000	-0.001	-0.009	-0.002	0.003	0.006	-0.016	-0.009	-0.017
Miscellaneous non-ferrous processing metal products	0.018	0.000	0.000	0.018	0.008	-0.005	0.009	-0.003	0.009	0.027
Fabricated constructional and architedtural metal products	-0.033	0.001	-0.003	-0.034	0.003	-0.005	-0.002	-0.003	-0.007	-0.041
Miscellaneous fabricated metal products	-0.009	-0.001	0.004	-0.006	0.003	0.004	-0.001	-0.012	-0.006	-0.012
Metal working machinery	-0.004	-0.007	0.012	0.001	0.000	-0.010	0.006	-0.003	-0.007	-0.006
Special industry machinery	-0.023	0.000	0.005	-0.018	0.001	-0.003	-0.004	-0.002	-0.009	-0.026
Office, service industry and household machines	-0.015	-0.003	0.007	-0.012	0.004	-0.009	-0.003	0.000	-0.007	-0.019
Miscellaneous machinery and machine parts	-0.004	0.001	0.003	0.000	0.001	-0.005	-0.001	0.001	-0.004	-0.004
Industrial electric apparatuses	-0.021	-0.001	0.002	-0.019	-0.005	-0.001	-0.001	0.002	-0.005	-0.025
Household electric appliances	0.023	-0.003	0.003	0.023	0.017	-0.010	0.017	0.002	0.027	0.050
Communication equipment and related products	0.010	-0.005	0.000	0.006	0.002	0.001	0.001	0.001	0.005	0.010
Electronic data processing machines and electronic equipment	-0.001	0.000	0.002	0.001	0.003	-0.003	0.001	0.000	0.001	0.002
Electronic communication equipment and related products	0.021	-0.009	0.010	0.022	0.010	-0.013	0.003	-0.002	-0.002	0.020
Miscellaneous electrical machinery equipment and supplies	0.047	-0.011	0.014	0.050	0.000	0.001	0.010	0.002	0.013	0.063
Motor vehicles, parts and accessories	-0.009	0.000	0.002	-0.007	0.000	-0.001	0.000	0.000	-0.001	-0.008
Miscellaneous transportation equipment	-0.004	-0.006	0.012	0.002	0.000	-0.002	-0.012	-0.003	-0.016	-0.014
Medical instruments and apparatuses	-0.055	0.003	0.007	-0.044	-0.009	-0.018	-0.004	0.000	-0.031	-0.076
Optical instruments and lenses	-0.032	0.004	0.020	-0.007	0.004	-0.008	-0.007	0.010	-0.001	-0.008
Watches, clocks, clockwork-operated devices and parts	-0.016	-0.003	0.009	-0.009	0.009	0.010	-0.004	0.010	0.025	0.015
Miscellaneous precision instrument	-0.073	-0.004	0.009	-0.067	-0.007	-0.004	-0.004	0.000	-0.015	-0.083
Miscellaneous manufacturing industries	-0.010	-0.005	0.008	-0.008	0.011	-0.007	-0.005	-0.005	-0.006	-0.014
Weighted average of all the industries	-0.008	-0.002	0.004	-0.005	0.002	-0.003	0.000	-0.001	-0.002	-0.007
Share of each facor in industry's TFP growth	1.17	0.22	-0.62	0.77	-0.31	0.46	0.00	0.08	0.23	1.00

Table 4.6 Comparison of Productivity Decompositions between Japan, the US and Korea

Source	Country	Unit of analysis	Period	TFP growth total %	Contribution of each effect						
					Within effect	Redistribution effect subtotal	Share effect	Covariance effect	Net entry effect subtotal	Entry effect	Exit effect
				a=b+c+f	b	c=d+e	d	e	f=g+h	g	h
Downturn											
Hahn(2000)	South Korea	Establishment	1995-98	4.7	-0.09	1.79			3.06		
					(-0.02)	(0.38)			(0.65)		
Baily, Hulten and Campbell(1992)	US	Establishment	1977-82	2.4	-1.10	2.54			0.96		
					(-0.46)	(1.06)			(0.40)		
Foster, Haltiwanger, and Krizan(1998)	US	Establishment	1977-82	2.7	-0.24	2.24	-0.89	3.13	0.68		
					(-0.09)	(0.83)	(-0.33)	(1.16)	(0.25)		
Fukao and Kwon	Japan	Firm	1996-98	-0.7	-0.80	0.27	-0.15	0.42	-0.16	0.21	-0.37
			(fiscal year)		(1.17)	(-0.40)	(0.22)	(-0.62)	(0.23)	(-0.31)	(0.54)
Upturn											
Hahn(2000)	South Korea	Establishment	1990-95	23.0	13.11	-0.69			10.58		
					(0.57)	(-0.03)			(0.46)		
Baily, Hulten and Campbell(1992)	US	Establishment	1982-87	15.6	13.57	3.12			-1.09		
					(0.87)	(0.20)			(-0.07)		
Foster, Haltiwanger, and Krizan(1998)	US	Establishment	1982-87	7.3	3.80	2.41	-1.31	3.72	1.02		
					(0.52)	(0.33)	(-0.18)	(0.51)	(0.14)		
Fukao and Kwon	Japan	Firm	1994-96	4.4	2.87	0.13	-0.13	0.26	1.08	1.36	0.00
			(fiscal year)		(0.65)	(0.03)	(-0.03)	(0.06)	(0.24)	(0.31)	0.00

The entry and exit effect of Fukao and Kwon (2003) includes switch-in and switch-out effect respectively.
Values in parentheses denote share of each effect in total TFP growth.

Figure A.1. Aggregate IT Investment in Japan (in 1990 prices)